Washington University ChE433 heat exchanger experiment E0002 P 2 Young model F302DY4P 9/23/ 3

CASE 1

SIZE 4- 18 TYPE BEM, MULTI-PASS	FLOW, SEGMENTAL	BAFFLES, RATING
---------------------------------	-----------------	-----------------

SIZE 4- 18 TYPE BEM, MULTI-PASS F	LOW, SEGMENTAL BAFFLES, RATING
	HOT TUBE SIDE COLD SHELL SIDE
	Tube Shell
	SENSIBLE LIQ SENSIBLE LIQ
TOTAL FLOW RATE KLB/HR	SENSIBLE LIQ SENSIBLE LIQ .100 .200 IN OUT IN OUT
	IN OUT IN OUT
TEMPERATURE DEGF	140.0 63.8* 40.0 77.9*
DENSITY LB/FT3	61.2913 62.3159 62.5352 62.1641
	.4726 1.0585 1.4791 .8876
SPECIFIC HEAT BTU/LB-F	.9973 1.0023 1.0058 1.0006
THERMAL COND. BTU/HR-FT-F	.3723 .3536 .3466 .3575
MOLAR MASS LB/LBMOL	18.02 18.02
TEMP, AVG & SKIN DEGF	101.9 82.6 59.0 81.9
	.6779 .8397 1.1294 .8466
	50.00 165.00 50.00 165.00
	.01 10.00 .00 10.00
VELOCITY, CALC & MAX ALLOWED FT/	S .10 10.00 .03 10.00
	00010
FOULING RESISTANCE HR-FT2-F/B	
FILM COEFFICIENT BTU/HR-FT2	-F 189.24 133.23
TOTAL HEAT DUTY REQUIRED MEGBTU/H	
	'= .40,BYPASS= .92,BAFF=1.00) 14.8
OVERALL COEFF REQUIRED BTU/HR-F	
	T2-F 73.07 71.93
CDDAN & LOODED COULT DIO/IIIC I	75.07
SHELLS IN SERIES 1 PARALLEL 1	TOTAL EFF AREA FT2 7.1
	EFFECTIVE AREA FT2/SHELL 7.1
	TEMA SHELL TYPE E ; REAR HEAD FXTS
	,
BAFFLE TYPE HORZ SEGMENTL	CROSS PASSES PER SHELL PASS 4
	BAFFLE CUT, PCT SHELL I.D. 30.00
	CUT DISTANCE FROM CENTER, IN764
SPACING, OUTLET IN. 4.309	
	IMPINGEMENT BAFFLE INCLUDED NO
PAIRS OF SEALING DEVICES 1	TUBESHEET BLANK AREA, % .0
TUBE TYPE PLAIN	MATERIAL ELECTROLYTIC COPPER
NO. OF TUBES/SHELL 76	EST MAX TUBE COUNT 36
TUBE LGTH, OVERALL FT 1.500	MATERIAL ELECTROLYTIC COPPER EST MAX TUBE COUNT 36 TUBE PITCH IN3125
TUBE LGTH, EFF FT 1.436	TUBE OUTSIDE DIAM IN250
	TUBE INSIDE DIAM IN214
	TUBE SURFACE RATIO, OUT/IN 1.184
SHL NOZZ ID, IN&OUT 1.0 1.0	TUBE NOZZ ID, IN&OUT IN8 .8

^{*} CALCULATED ITEM--HEAT BALANCE CODE = 8

 $\hfill\square \mbox{Washington}$ University ChE433 heat exchanger experiment \hfill E0002 P \hfill Young model F302DY4P 9/23/ 3

S U P P L E M E	N T A R	Y F	R E S U	L T S	
HT PARAMETERS SHE	LI TUBE	SHELI	SIDE PERFO	RMANCE	
WALL CORRECTION 1.04		_		W FT/S	.03
PRANDTL NUMBER 7				W FT/S	
RYNLD NO, AVG 65					
RYNLD NO, IN BUN 49					
RYNLD NO, OUT BUN 82				,	
FOULNG LAYER IN001		SHELI	SIDE FLOW.	% OF TOTA	L
			•	LOW	
THERMAL RESISTANCE, % (
SHELL TUBE FOULING				В	
53.39 45.00 1.56					
PCT OVER DESIGN TOT FOUL RESIST	.000217	TUBE PA	ASSLANE BYE	PASS F	= .00
DIFF RESIST		1022 11	100211112 211	1100	• • • •
	.000010	SHELI	SIDE HEAT	TRANSFER F.	ACTORS
DIAMETRAL CLEARANCES				MA) (FIN)	
BUNDLE TO SHELL IN					
TUBE TO BAFFLE HOLE IN					
BAFFLE TO SHELL IN					
	.1000	ППР	(III LODD II	HIND ZONE,	• 330
SHELL NOZZLE DATA	TN OUT	SHELI	. PRESSURE	DROP % OF	т∩тат.
HT UNDR NOZ IN.			I INDOONE	DROI, 0 OI	= 10.2
HT OPP NOZ IN.			JF.		= 8.9
VELOCITY FT/S					= 6.7
DENSITY LB/FT3 62					
NOZZ RHO*VSQ LB/FT-S2					
BUND RHO*VSQ LB/FT-S2		OOTHHI	NOZZIL		- 33.7
BOND IMIO VOQ EB/11 02	± ±				
TUBE NOZZLE DATA	TN OUT	WETGE	IT PER SHET	.T. T.B	
VELOCITY FT/S					150.
DENSITY LB/FT3 61				=	
PRESS. DROP %					100.
□□Washington University		exchanc	mer experim	nent	E0002 P
Young model F302DY4P	y one roo neac	CHOHAI	ger emperm		9/23/ 3
roung moder roughri					CASE 2
SIZE 4- 18 TYPE BEM, MU	ILTI-PASS FLO	W. SEGME	ENTAL BAFFI	ES. RATING	
3122 1 10 1112 2211, 11	3211 11100 120			COLD S	
		Tube	222 2122	Shel	
			BLE LTO	SENS	
TOTAL FLOW RATE KLB,	/HR	021101	.100	52115	.300
TOTAL THOM RATE REE,				IN	
TEMPERATURE DEGI	Ŧ			40.0	
	- FT3 6				
				1.4791	
				1.0058	
THERMAL COND. BTU,					
MOLAR MASS LB/1		• 5 , 25	18.02		18.02
TEMP, AVG & SKIN	DEGF				
VISCOSITY, AVG & SKIN			.8998		.9082
, , , , , , , , , , , , , , , , , , ,	- •				

4

PRESSURE, IN & DESIGN PSIA	50.00 165.00 50.00	165.00
PRESSURE DROP, TOT & ALLOWED PSI VELOCITY, CALC & MAX ALLOWED FT/S	.01 10.00 .00 s .10 10.00 .05	10.00
FOULING RESISTANCE HR-FT2-F/B' FILM COEFFICIENT BTU/HR-FT2-	ru .00010 .0 -F 189.20 15	0010 3.05
TOTAL HEAT DUTY REQUIRED MEGBTU/HIEFF TEMP DIF, DEGF (LMTD= 37.8,FOVERALL COEFF REQUIRED BTU/HR-FOULEAN & FOULED COEFF BTU/HR-FOULEAN & FOULED COEFF	R = .43,BYPASS= .92,BAFF=1.00) F2-F	.008340 15.2 76.95 77.27
SHELLS IN SERIES 1 PARALLEL 1 PASSES, SHELL 1 TUBE 4 SHELL DIAMETER IN. 3.820	EFFECTIVE AREA FT2/SHELL	7.1
	BAFFLE CUT, PCT SHELL I.D. CUT DISTANCE FROM CENTER, IN. IMPINGEMENT BAFFLE INCLUDED	30.00
TUBE TYPE PLAIN NO. OF TUBES/SHELL 76 TUBE LGTH, OVERALL FT 1.500 TUBE LGTH, EFF FT 1.436 TUBE LAYOUT DEG 60 PITCH RATIO 1.250 SHL NOZZ ID, IN&OUT 1.0 1.0	TUBE OUTSIDE DIAM IN. TUBE INSIDE DIAM IN. TUBE SURFACE RATIO, OUT/IN	36 .3125 .250 .214 1.184
* CALCULATED ITEMHEAT BALANCE \(\subseteq \text{Washington University ChE433 heading model F302DY4P} \)	at exchanger experiment	E0002 P 5 9/23/3 CASE 2
HT PARAMETERS SHELL TUBE WALL CORRECTION 1.041 .000 PRANDTL NUMBER 8.4 4.7 RYNLD NO, AVG 92. 224. RYNLD NO, IN BUN 75. 333. RYNLD NO,OUT BUN 111. 135. FOULNG LAYER IN0014 .0014	NOMINAL VEL,X-FLOW FT/S NOMINAL VEL,WINDOW FT/S CROSSFLOW COEF BTU/HR-FT2- WINDOW COEF BTU/HR-FT2- SHELLSIDE FLOW, % OF TOTAL HEAT TRANSFER X-FLOW	F 153.9 F 153.0
THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL 49.92 48.35 1.68 .06 PCT OVER DESIGN .41 TOT FOUL RESIST .000217 DIFF RESIST .000054	BUNDLE TO SHELL BYPASS C BAFFLE TO SHELL LEAKAGE E	= 68.85 = 11.03 = 17.52 = .00

		che433b	(40).OUT		
DIAMETRAL CLEARA	ANCES	TOTAL	=(BETA)(GAN	MMA) (FIN)	= .598
BUNDLE TO SHELL	IN5000	BETA	(BAFF CUT H	FACTOR)	= .920
TUBE TO BAFFLE HOL					
BAFFLE TO SHELL					
DAFFILE TO SHELL	in1000	END	(111 1000 11	N END ZONE)	
SHELL NOZZLE DAT	דוו∩ ואד גי	י פשבד	T DDFQQIIDF	DDOD 9 OF	T ∩ T A T
HT UNDR NOZ IN.				DROI, 6 OI	= 9.7
HT OPP NOZ IN.			NE		= 7.1
VELOCITY FT/S					= 5.5
DENSITY LB/FT3					= 39.8
NOZZ RHO*VSQ LB/FT	3-S2 3 3	OUTLET	NOZZLE		= 37.9
BUND RHO*VSQ LB/FT					
TUBE NOZZLE DATA	IN OUT	WEIG	HT PER SHEI	LL, LB	
VELOCITY FT/S	.15 .15	DRY		=	150.
DENSITY LB/FT3	61.291 62.389	WET		=	
PRESS. DROP %					
□□Washington Unive			der experi	nent	E0002 P 6
Young model F302DY		ac exeman	ger experi	iiCIIC	9/23/ 3
Tourig moder F302D1	. 4.5				CASE 3
SIZE 4- 18 TYPE BE	·M MIITUT DACC E	TOM CECM	ENITAT DAREI		
312E 4- 10 11FE BE				COLD SI	
				Shell	
				SENS	
TOTAL FLOW RATE	KLB/HR				
				IN	
TEMPERATURE	DEGF	140.0	52.5*	40.0	61.8*
DENSITY	LB/FT3	61.2913	62.4259	62.5352	62.3371
VISCOSITY	CP	.4726	1.2330	1.4791	1.0880
SPECIFIC HEAT	BTU/LB-F	.9973	1.0038	1.0058	1.0025
THERMAL COND.					
MOLAR MASS			18.02		18.02
поши писо	HD/ HDI10H				
TEMP, AVG & SKIN	DEGF				
VISCOSITY, AVG & S					
PRESSURE, IN & DES					
FRESSORE, IN & DES	oldn folk	30.00	103.00	30.00	103.00
PRESSURE DROP, TOT	. & ALLOWED PSI	.01	10.00	.00	10.00
VELOCITY, CALC & M					
villegill, chile a h	IIII IIIIOWID II,		10.00	• 0 /	10.00
FOULING RESISTANCE	: HR-FT2-F/P	STU .	00010	_ (00010
FILM COEFFICIENT					
TIDA CODITICIDA	D10/IIK 112				73.07
TOTAL HEAT DUTY RE					.008737
EFF TEMP DIF, DEGF			7CC- 02 D7		
			ASS93, DA	Arr-1.00)	
OVERALL COEFF REQU					82.10
CLEAN & FOULED COE	F.F. BTU/HK-E	'T2-F	83.8	38	82.26
SHELLS IN SERIES	1 מדדגמגמ 1	שים זעש∩ש		ਦਾਸ਼ਾ 2	7 1
PASSES, SHELL					
SHELL DIAMETER IN.	3.820	TEMA SHE	LL TYPE E	; REAR H	EAD FXTS
			~~~		_
BAFFLE TYPE H	IORZ SEGMENTL	CROSS PA	SSES PER SI	HELL PASS	4

		cne433b(40).00T		
SPACING, CENTRAL IN. 4	.309 B	SAFFLE CUT, PCT SHELL I.D.		30.00
SPACING, INLET IN. 4	.309 C	UT DISTANCE FROM CENTER, I	ν.	.764
SPACING, OUTLET IN. 4	309	,		
BAFFLE THICKNESS IN.	105 +	MPINGEMENT BAFFLE INCLUDED		NO
PAIRS OF SEALING DEVICES	I T	UBESHEET BLANK AREA, %		.0
		IATERIAL ELECTROLY	ric co	)PPER
NO. OF TUBES/SHELL	76 E	ST MAX TUBE COUNT		36
TUBE LGTH, OVERALL FT 1	.500 T	UBE PITCH IN.		.3125
TUBE LGTH, EFF FT 1				.250
TUBE LAYOUT DEG		UBE INSIDE DIAM IN.		.214
PITCH RATIO 1				1.184
SHL NOZZ ID, IN&OUT 1.0				
one word ib, indoor i.o	1.0 1	obb Nobb 1b, indoor in.	• 0	• 0
+ CAICHIAMED IMEM HEAM D	ATANCE C	PODE - 0		
* CALCULATED ITEMHEAT B				
□□Washington University ChE	1433 heat	exchanger experiment		002 P 7
Young model F302DY4P				23/ 3
			CF	ASE 3
S U P P L E M E N	T A R	Y RESULTS		
HT PARAMETERS SHELL	TUBE	SHELLSIDE PERFORMANCE		
WALL CORRECTION 1.040	.000	NOMINAL VEL, X-FLOW FT/S		.05
PRANDTL NUMBER 8.8	4 8	NOMINAL VEL, WINDOW FT/S		.10
PVNID NO AVG 119	210	CROSSELOW COEE BTIL/HD-F		
RYNLD NO, AVG 119. RYNLD NO, IN BUN 102.	219.	WINDOW CORE DELL'UD DE	12-F	174.0
RINLD NO, IN BUN 102.	333.	WINDOW COEF BTU/HR-F	T. Z - E	1/5.5
RYNLD NO, OUT BUN 138.				
FOULNG LAYER IN0014	.0014			
		HEAT TRANSFER X-FLOW		81.26
THERMAL RESISTANCE, % OF TO	TAL	TUBE TO BAFFLE LEAKAGE	A =	2.69
SHELL TUBE FOULING MET	'AL	MAIN CROSSFLOW		
46.78 51.38 1.78 .	06	BUNDLE TO SHELL BYPASS		
	4.0			
TOT FOUL RESIST .0	.19	TUBE PASSLANE BYPASS	- -	0.00
	00023	TODE TASSLANE BITASS	r –	.00
DIFF RESIST .U	00023			
DIAMETRAL CLEARANCES		SHELLSIDE HEAT TRANSFER		_
BUNDLE TO SHELL IN.	.5000	BETA (BAFF CUT FACTOR)		– .
TUBE TO BAFFLE HOLE IN.	.0284	GAMMA (TUBE ROW ENTRY EFC'	r) =	.651
BAFFLE TO SHELL IN.	.1000	END (HT LOSS IN END ZON)	E) =	.994
SHELL NOZZLE DATA IN	OUT	SHELL PRESSURE DROP, % (	OF TOI	CAL
HT UNDR NOZ IN25		WINDOW	=	
HT OPP NOZ IN25		END ZONE	=	
VELOCITY FT/S .33	2.2			4.8
DENSITY LB/FT3 62.535				40.7
NOZZ RHO*VSQ LB/FT-S2 6		OUTLET NOZZLE	=	39.2
BUND RHO*VSQ LB/FT-S2 4	4			
TUBE NOZZLE DATA IN	OUT	WEIGHT PER SHELL, LB		
VELOCITY FT/S .15	.15	DRY =	=	150.
DENSITY LB/FT3 61.291			=	165.
PRESS. DROP % 1.9	1.2			<del>-</del>
□□Washington University ChE		exchanger evneriment	무이어	) N 2 P R
BENGSHINGCON OHIVEISICY CHE	iioo iieat	. Chondinger Chretiment	<u> </u>	, U Z I U

	74P				9/23/ 3
					CASE 4
SIZE 4- 18 TYPE BE					
			JBE SIDE		
		Tube		Snell	L
	IXI D /IID	SENSI	BLE LIQ	SENS	TRTE TIÖ
TOTAL FLOW RATE	KLB/HK	T.).	.100	T.).	.500
	DECE	1 1 0 0	OOT	1N	00.1
TEMPERATURE					
DENSITY VISCOSITY					
SPECIFIC HEAT					
THERMAL COND.					
MOLAR MASS					
MOLAR MASS	TP/ TPMOT		18.02		10.02
TEMP, AVG & SKIN	DECE				
VISCOSITY, AVG & SKIN					
PRESSURE, IN & DES					
TRESSORE, IN & DEC	IGN ISIA	30.00	103.00	30.00	103.00
PRESSURE DROP, TOT	' & ALLOWED PS'	г 01	10 00	0.1	10 00
VELOCITY, CALC & M					
villoutity office with	iiii iiiiiowib ii,	• • • • • • • • • • • • • • • • • • • •	10.00	• 0 0	10.00
FOULING RESISTANCE	HR-FT2-F/F	3TU .(	00010	. (	00010
FILM COEFFICIENT					
TOTAL HEAT DUTY RE	OUIRED MEGBTU/	HR			.008984
EFF TEMP DIF, DEGF			ASS= .93,BAE	FF=1.00)	
OVERALL COEFF REQU			,	•	87.40
CLEAN & FOULED COE			89.08	3	87.20
SHELLS IN SERIES	1 PARALLEL 1	TOTAL EFF	AREA	FT2	7.1
SHELLS IN SERIES PASSES, SHELL					
	1 TUBE 4	EFFECTIVE	AREA	FT2/SHELL	7.1
PASSES, SHELL	1 TUBE 4	EFFECTIVE	AREA	FT2/SHELL	7.1
PASSES, SHELL	1 TUBE 4 3.820	EFFECTIVE TEMA SHEI	E AREA LL TYPE E	FT2/SHELL ; REAR HE	7.1 EAD FXTS
PASSES, SHELL SHELL DIAMETER IN.	1 TUBE 4 3.820  IORZ SEGMENTL	EFFECTIVE TEMA SHEI CROSS PAS	E AREA LL TYPE E SSES PER SHE	FT2/SHELL ; REAR HE ELL PASS	7.1 EAD FXTS
PASSES, SHELL SHELL DIAMETER IN. BAFFLE TYPE	1 TUBE 4 3.820 IORZ SEGMENTL IN. 4.309	EFFECTIVE TEMA SHEI CROSS PAS BAFFLE CU	C AREA LL TYPE E SSES PER SHE JT, PCT SHEI	FT2/SHELL ; REAR HE ELL PASS LL I.D.	7.1 EAD FXTS 4 30.00
PASSES, SHELL SHELL DIAMETER IN.  BAFFLE TYPE SPACING, CENTRAL SPACING, INLET SPACING, OUTLET	1 TUBE 4 3.820 MORZ SEGMENTL IN. 4.309 IN. 4.309 IN. 4.309	EFFECTIVE TEMA SHEI CROSS PAS BAFFLE CU CUT DISTA	E AREA LL TYPE E SSES PER SHE JT, PCT SHEI ANCE FROM CE	FT2/SHELL ; REAR HE ELL PASS LL I.D. ENTER, IN.	7.1 EAD FXTS 4 30.00 .764
PASSES, SHELL SHELL DIAMETER IN.  BAFFLE TYPE SPACING, CENTRAL SPACING, INLET SPACING, OUTLET BAFFLE THICKNESS	1 TUBE 4 3.820 HORZ SEGMENTL IN. 4.309 IN. 4.309 IN. 4.309 IN. 125	EFFECTIVE TEMA SHEI  CROSS PAS BAFFLE CU CUT DISTA	AREA L TYPE E SSES PER SHE T, PCT SHEI ANCE FROM CE	FT2/SHELL ; REAR HE ELL PASS LL I.D. ENTER, IN.	7.1 EAD FXTS 4 30.00 .764 NO
PASSES, SHELL SHELL DIAMETER IN.  BAFFLE TYPE SPACING, CENTRAL SPACING, INLET SPACING, OUTLET	1 TUBE 4 3.820 HORZ SEGMENTL IN. 4.309 IN. 4.309 IN. 4.309 IN. 125	EFFECTIVE TEMA SHEI  CROSS PAS BAFFLE CU CUT DISTA	AREA L TYPE E SSES PER SHE T, PCT SHEI ANCE FROM CE	FT2/SHELL ; REAR HE ELL PASS LL I.D. ENTER, IN.	7.1 EAD FXTS 4 30.00 .764 NO
PASSES, SHELL SHELL DIAMETER IN.  BAFFLE TYPE SPACING, CENTRAL SPACING, INLET SPACING, OUTLET BAFFLE THICKNESS	1 TUBE 4 3.820  IORZ SEGMENTL IN. 4.309 IN. 4.309 IN. 4.309 IN. 125 DEVICES 1	EFFECTIVE TEMA SHEI  CROSS PAS BAFFLE CU CUT DISTA  IMPINGEME TUBESHEET	AREA L TYPE E SSES PER SHE LT, PCT SHEI ANCE FROM CE CNT BAFFLE I	FT2/SHELL ; REAR HE ELL PASS LL I.D. ENTER, IN. INCLUDED A, %	7.1 EAD FXTS 4 30.00 .764 NO
PASSES, SHELL SHELL DIAMETER IN.  BAFFLE TYPE SPACING, CENTRAL SPACING, INLET SPACING, OUTLET BAFFLE THICKNESS PAIRS OF SEALING DE TUBE TYPE	1 TUBE 4 3.820  IORZ SEGMENTL IN. 4.309 IN. 4.309 IN. 4.309 IN125 DEVICES 1	EFFECTIVE TEMA SHEI  CROSS PAS BAFFLE CU CUT DISTA  IMPINGEME TUBESHEET	C AREA LL TYPE E SSES PER SHE LANCE FROM CE CONT BAFFLE D C BLANK AREA	FT2/SHELL ; REAR HE ELL PASS LL I.D. ENTER, IN. INCLUDED A, % LECTROLYTIC	7.1 EAD FXTS 4 30.00 .764 NO
PASSES, SHELL SHELL DIAMETER IN.  BAFFLE TYPE SPACING, CENTRAL SPACING, INLET SPACING, OUTLET BAFFLE THICKNESS PAIRS OF SEALING D  TUBE TYPE NO. OF TUBES/SHELL	1 TUBE 4 3.820  IORZ SEGMENTL IN. 4.309 IN. 4.309 IN. 125 DEVICES 1  PLAIN 76	EFFECTIVE TEMA SHEI  CROSS PAS BAFFLE CU CUT DISTA  IMPINGEME TUBESHEET  MATERIAL EST MAX T	C AREA LL TYPE E SSES PER SHE LANCE FROM CE COUNT BAFFLE D CUBE COUNT	FT2/SHELL ; REAR HE ELL PASS LL I.D. ENTER, IN. INCLUDED A, % LECTROLYTIC	7.1 EAD FXTS  4 30.00 .764  NO .0  C COPPER 36
PASSES, SHELL SHELL DIAMETER IN.  BAFFLE TYPE SPACING, CENTRAL SPACING, INLET SPACING, OUTLET BAFFLE THICKNESS PAIRS OF SEALING D  TUBE TYPE NO. OF TUBES/SHELL TUBE LGTH, OVERALL	1 TUBE 4 3.820  IORZ SEGMENTL IN. 4.309 IN. 4.309 IN. 125 DEVICES 1  PLAIN 76 FT 1.500	EFFECTIVE TEMA SHEI  CROSS PAS BAFFLE CU CUT DISTA  IMPINGEME TUBESHEET  MATERIAL EST MAX T TUBE PITC	C AREA LL TYPE E SSES PER SHE LT, PCT SHEI ANCE FROM CE CNT BAFFLE I C BLANK AREA CUBE COUNT	FT2/SHELL ; REAR HE ELL PASS LL I.D. ENTER, IN. INCLUDED A, % LECTROLYTIC IN.	7.1 EAD FXTS  4 30.00 .764  NO .0  C COPPER 36 .3125
PASSES, SHELL SHELL DIAMETER IN.  BAFFLE TYPE SPACING, CENTRAL SPACING, INLET SPACING, OUTLET BAFFLE THICKNESS PAIRS OF SEALING D  TUBE TYPE NO. OF TUBES/SHELL TUBE LGTH, OVERALL TUBE LGTH, EFF	1 TUBE 4 3.820  IORZ SEGMENTL IN. 4.309 IN. 4.309 IN. 125 DEVICES 1  PLAIN 76 FT 1.500 FT 1.436	EFFECTIVE TEMA SHEI  CROSS PAS BAFFLE CU CUT DISTA  IMPINGEME TUBESHEET  MATERIAL EST MAX T TUBE PITC TUBE OUTS	C AREA LL TYPE E SSES PER SHE LT, PCT SHEI ANCE FROM CE CHT BAFFLE I BLANK AREA EI CUBE COUNT CH SIDE DIAM	FT2/SHELL ; REAR HE ELL PASS LL I.D. ENTER, IN. INCLUDED A, % LECTROLYTIC IN. IN.	7.1 EAD FXTS  4 30.00 .764  NO .0  C COPPER 36 .3125 .250
PASSES, SHELL SHELL DIAMETER IN.  BAFFLE TYPE SPACING, CENTRAL SPACING, INLET SPACING, OUTLET BAFFLE THICKNESS PAIRS OF SEALING D  TUBE TYPE NO. OF TUBES/SHELL TUBE LGTH, OVERALL TUBE LGTH, EFF TUBE LAYOUT	1 TUBE 4 3.820  IORZ SEGMENTL IN. 4.309 IN. 4.309 IN. 125 DEVICES 1  PLAIN 76 FT 1.500 FT 1.436 DEG 60	EFFECTIVE TEMA SHEI  CROSS PAS BAFFLE CU CUT DISTA  IMPINGEME TUBESHEET  MATERIAL EST MAX TUBE PITC TUBE OUTS TUBE INSI	C AREA L TYPE E SSES PER SHE LIT, PCT SHEI LINCE FROM CE CIT BAFFLE I CIT BAFFLE I CIT BLANK AREA EI CUBE COUNT CH SIDE DIAM EDE DIAM	FT2/SHELL ; REAR HE ELL PASS LL I.D. ENTER, IN. INCLUDED A, % LECTROLYTIC IN. IN. IN.	7.1 EAD FXTS  4 30.00 .764  NO .0  C COPPER 36 .3125 .250 .214
PASSES, SHELL SHELL DIAMETER IN.  BAFFLE TYPE SPACING, CENTRAL SPACING, INLET SPACING, OUTLET BAFFLE THICKNESS PAIRS OF SEALING D  TUBE TYPE NO. OF TUBES/SHELD TUBE LGTH, OVERALD TUBE LGTH, EFF TUBE LAYOUT PITCH RATIO	1 TUBE 4 3.820  IORZ SEGMENTL IN. 4.309 IN. 4.309 IN. 125 DEVICES 1  PLAIN 76 FT 1.500 FT 1.436 DEG 60 1.250	EFFECTIVE TEMA SHEI  CROSS PAS BAFFLE CU CUT DISTA  IMPINGEME TUBESHEET  MATERIAL EST MAX TUBE PITO TUBE OUTS TUBE INSI	C AREA L TYPE E  SSES PER SHE LIT, PCT SHEIL ANCE FROM CE CIT BAFFLE I C BLANK AREA  EI CUBE COUNT CH SIDE DIAM CACE RATIO,	FT2/SHELL ; REAR HE ELL PASS LL I.D. ENTER, IN. INCLUDED A, % LECTROLYTIC IN. IN. IN. OUT/IN	7.1 EAD FXTS  4 30.00 .764  NO .0  C COPPER 36 .3125 .250 .214 1.184
PASSES, SHELL SHELL DIAMETER IN.  BAFFLE TYPE SPACING, CENTRAL SPACING, INLET SPACING, OUTLET BAFFLE THICKNESS PAIRS OF SEALING D  TUBE TYPE NO. OF TUBES/SHELL TUBE LGTH, OVERALL TUBE LGTH, EFF TUBE LAYOUT	1 TUBE 4 3.820  IORZ SEGMENTL IN. 4.309 IN. 4.309 IN. 125 DEVICES 1  PLAIN 76 FT 1.500 FT 1.436 DEG 60 1.250	EFFECTIVE TEMA SHEI  CROSS PAS BAFFLE CU CUT DISTA  IMPINGEME TUBESHEET  MATERIAL EST MAX TUBE PITO TUBE OUTS TUBE INSI	C AREA L TYPE E  SSES PER SHE LIT, PCT SHEIL ANCE FROM CE CIT BAFFLE I C BLANK AREA  EI CUBE COUNT CH SIDE DIAM CACE RATIO,	FT2/SHELL ; REAR HE ELL PASS LL I.D. ENTER, IN. INCLUDED A, % LECTROLYTIC IN. IN. IN. OUT/IN	7.1 EAD FXTS  4 30.00 .764  NO .0  C COPPER 36 .3125 .250 .214 1.184
PASSES, SHELL SHELL DIAMETER IN.  BAFFLE TYPE SPACING, CENTRAL SPACING, INLET SPACING, OUTLET BAFFLE THICKNESS PAIRS OF SEALING D  TUBE TYPE NO. OF TUBES/SHELL TUBE LGTH, OVERALL TUBE LGTH, EFF TUBE LAYOUT PITCH RATIO SHL NOZZ ID, IN&OU	1 TUBE 4 3.820  IORZ SEGMENTL IN. 4.309 IN. 4.309 IN125 DEVICES 1  PLAIN 76 FT 1.500 FT 1.436 DEG 60 1.250 IT 1.0 1.0	EFFECTIVE TEMA SHEI  CROSS PAS BAFFLE CU CUT DISTA  IMPINGEME TUBESHEET  MATERIAL EST MAX T TUBE PITC TUBE OUTS TUBE INST TUBE SURE TUBE NOZZ	C AREA L TYPE E  SSES PER SHE LIT, PCT SHEIL ANCE FROM CE CIT BAFFLE I C BLANK AREA  EI CUBE COUNT CH SIDE DIAM CACE RATIO,	FT2/SHELL ; REAR HE ELL PASS LL I.D. ENTER, IN. INCLUDED A, % LECTROLYTIC IN. IN. IN. OUT/IN	7.1 EAD FXTS  4 30.00 .764  NO .0  C COPPER 36 .3125 .250 .214 1.184
PASSES, SHELL SHELL DIAMETER IN.  BAFFLE TYPE SPACING, CENTRAL SPACING, OUTLET BAFFLE THICKNESS PAIRS OF SEALING D  TUBE TYPE NO. OF TUBES/SHELL TUBE LGTH, OVERALL TUBE LGTH, EFF TUBE LAYOUT PITCH RATIO SHL NOZZ ID, IN&OUT  * CALCULATED ITE	1 TUBE 4 3.820  IORZ SEGMENTL IN. 4.309 IN. 4.309 IN. 125 DEVICES 1  PLAIN 76 FT 1.500 FT 1.436 DEG 60 1.250 IT 1.0 1.0	EFFECTIVE TEMA SHEI  CROSS PAS BAFFLE CU CUT DISTA  IMPINGEME TUBESHEET  MATERIAL EST MAX T TUBE PITC TUBE OUTS TUBE INSI TUBE SURE TUBE NOZZ	C AREA L TYPE E SSES PER SHE LY, PCT SHEI LNCE FROM CE CH BAFFLE CUBE COUNT CH SIDE DIAM CACE RATIO, Z ID, IN&OUT	FT2/SHELL ; REAR HE ELL PASS LL I.D. ENTER, IN. INCLUDED A, % LECTROLYTIC IN. IN. IN. OUT/IN I IN.	7.1 EAD FXTS  4 30.00 .764  NO .0  C COPPER 36 .3125 .250 .214 1.184 .8 .8
PASSES, SHELL SHELL DIAMETER IN.  BAFFLE TYPE SPACING, CENTRAL SPACING, INLET SPACING, OUTLET BAFFLE THICKNESS PAIRS OF SEALING D  TUBE TYPE NO. OF TUBES/SHELD TUBE LGTH, OVERALD TUBE LGTH, EFF TUBE LAYOUT PITCH RATIO SHL NOZZ ID, IN&OUT  * CALCULATED ITE DUMASHINGTON UNIVERSE ***  ***  ***  ***  ***  **  **  **	1 TUBE 4 3.820  IORZ SEGMENTL IN. 4.309 IN. 4.309 IN. 125 DEVICES 1  PLAIN 76 FT 1.500 FT 1.436 DEG 60 1.250 IT 1.0 1.0  CMHEAT BALANCE Prsity ChE433 here	EFFECTIVE TEMA SHEI  CROSS PAS BAFFLE CU CUT DISTA  IMPINGEME TUBESHEET  MATERIAL EST MAX T TUBE PITC TUBE OUTS TUBE INSI TUBE SURE TUBE NOZZ	C AREA L TYPE E SSES PER SHE LY, PCT SHEI LNCE FROM CE CH BAFFLE CUBE COUNT CH SIDE DIAM CACE RATIO, Z ID, IN&OUT	FT2/SHELL ; REAR HE ELL PASS LL I.D. ENTER, IN. INCLUDED A, % LECTROLYTIC IN. IN. IN. OUT/IN I IN.	7.1 EAD FXTS  4 30.00 .764  NO .0  C COPPER 36 .3125 .250 .214 1.184 .8 .8
PASSES, SHELL SHELL DIAMETER IN.  BAFFLE TYPE SPACING, CENTRAL SPACING, OUTLET BAFFLE THICKNESS PAIRS OF SEALING D  TUBE TYPE NO. OF TUBES/SHELL TUBE LGTH, OVERALL TUBE LGTH, EFF TUBE LAYOUT PITCH RATIO SHL NOZZ ID, IN&OUT  * CALCULATED ITE	1 TUBE 4 3.820  IORZ SEGMENTL IN. 4.309 IN. 4.309 IN. 125 DEVICES 1  PLAIN 76 FT 1.500 FT 1.436 DEG 60 1.250 IT 1.0 1.0  CMHEAT BALANCE Prsity ChE433 here	EFFECTIVE TEMA SHEI  CROSS PAS BAFFLE CU CUT DISTA  IMPINGEME TUBESHEET  MATERIAL EST MAX T TUBE PITC TUBE OUTS TUBE INSI TUBE SURE TUBE NOZZ	C AREA L TYPE E SSES PER SHE LY, PCT SHEI LNCE FROM CE CH BAFFLE CUBE COUNT CH SIDE DIAM CACE RATIO, Z ID, IN&OUT	FT2/SHELL ; REAR HE ELL PASS LL I.D. ENTER, IN. INCLUDED A, % LECTROLYTIC IN. IN. IN. OUT/IN I IN.	7.1 EAD FXTS  4 30.00 .764  NO .0  C COPPER 36 .3125 .250 .214 1.184 .8 .8

# 

HT PARAMETERS						0.5
WALL CORRECTION						
PRANDTL NUMBER				L VEL, WINDO		
RYNLD NO, AVG						
RYNLD NO, IN BUN			MINDOM	COEF.	BTU/HR-FT2	-F' 199.1
RYNLD NO, OUT BUN			~			_
FOULNG LAYER IN.	.0014					
EURDMAL DEGLOSSANGE	0 00 00			RANSFER X-F		
THERMAL RESISTANCE						
SHELL TUBE FOU						
43.73 54.31 1	.89	.06	RONDLE	TO SHELL B	IPASS C	. = 12.11
PCT OVER DESIGN TOT FOUL RESIST	,	24	BAFFLE	TO SHELL L	EAKAGE E	1 = 16.34
DIFF RESIST			TOBE P	ASSLANE BYP	ASS F	= .00
			CHET			
DIAMETRAL CLEARA	NODO		SHEL	LSIDE HEAT	TRANSFER F	ACTORS - C12
BUNDLE TO SHELL						
TUBE TO BAFFLE HOL						
BAFFLE TO SHELL						
BAFFLE IO SHELL	IN.	.1000	END	(HI LOSS IN	END ZONE)	994
SHELL NOZZLE DAT	ın tn	OIIT	CHEI	T DDFCCIIDF	DDOD & OF	י ייירייא ז
HT INDR NOZ IN	25	001	MUNDOM	I INDOONE	DROI, 8 OI	= 9 1
HT UNDR NOZ IN. HT OPP NOZ IN. VELOCITY FT/S DENSITY LB/FT3	25		END ZO	NE		= 5.4
VELOCITY FT/S	.25	<i>1</i> 1	CDUGG	EI OM		- J.4
DENGITY IB/FT3	62 535	62 375	TMIET	NO771F		- 4.1 - //1 1
NOZZ RHO*VSQ LB/FT	02.555	10		NOZZIE		= 39.9
BUND RHO*VSQ LB/FT			OOIDEI	NOZZIE		_ 33.3
DOND KHO VSQ HB/II	52 7	,				
TUBE NOZZLE DATA	TN	TUO	WEIG	HT PER SHEL	T., T.B	
VELOCITY FT/S	. 15	. 14	DRY		= =	150.
DENSITY LB/FT3	61.291	62.448	WET		=	165.
VELOCITY FT/S DENSITY LB/FT3 PRESS. DROP %	1.8	1.1				100.
□□Washington Unive						
Young model F302DY	_			J 1		9/23/ 3
						CASE 5
SIZE 4- 18 TYPE BE	M, MULTI-	-PASS FLO	W, SEGM	ENTAL BAFFL	ES, RATING	;
				UBE SIDE		
			Tube		Shel	.1
			SENS	IBLE LIQ	SENS	IBLE LIQ
TOTAL FLOW RATE	KLB/HR			.100		.600
			IN	OUT	IN	OUT
TEMPERATURE	DEGF		140.0	48.4*	40.0	55.2*
DENSITY	LB/FT3	6	1.2913	62.4633	62.5352	62.4012
VISCOSITY	CP		.4726	1.3071	1.4791	1.1888
SPECIFIC HEAT	BTU/LB-1	F	.9973	1.0044	1.0058	1.0034
THERMAL COND.			.3723	.3491	.3466	.3511
MOLAR MASS	LB/LBMO	L		18.02		18.02
		_				
TEMP, AVG & SKIN				67.7		
VISCOSITY, AVG & S				1.0068		
PRESSURE, IN & DES	IGN PSI	$\mathcal{H}$	50.00	165.00	50.00	165.00

PRESSURE DROP, TOT & ALLOWED PSI VELOCITY, CALC & MAX ALLOWED FT/S	.01 10.00 .01 10. .10 10.00 .10 10.	00
FOULING RESISTANCE HR-FT2-F/BTU FILM COEFFICIENT BTU/HR-FT2-F	.00010 .00010 190.50 219.33	
TOTAL HEAT DUTY REQUIRED MEGBTU/HR EFF TEMP DIF, DEGF (LMTD= 33.1,F= OVERALL COEFF REQUIRED BTU/HR-FT2 CLEAN & FOULED COEFF BTU/HR-FT2	- 01	.0 38
SHELLS IN SERIES 1 PARALLEL 1 TPASSES, SHELL 1 TUBE 4 ESHELL DIAMETER IN. 3.820 T	FFECTIVE AREA FT2/SHELL 7	.1
SPACING, OUTLET IN. 4.309 BAFFLE THICKNESS IN125 I PAIRS OF SEALING DEVICES 1	AFFLE CUT, PCT SHELL I.D. 30.  UT DISTANCE FROM CENTER, IN7  MPINGEMENT BAFFLE INCLUDED  UBESHEET BLANK AREA, %	00 64
TUBE TYPE PLAIN MOON OF TUBES/SHELL 76 ETUBE LGTH, OVERALL FT 1.500 TUBE LGTH, EFF FT 1.436 TUBE LAYOUT DEG 60 TUBE LAYOUT 1.250 TUBE LAYOUT 1.0 TUBE LAYOUT 1	UBE INSIDE DIAM IN2 UBE SURFACE RATIO, OUT/IN 1.1	36 25 50 14 84
* CALCULATED ITEMHEAT BALANCE C UNIVERSITY ChE433 heat Young model F302DY4P		3
S U P P L E M E N T A R		9
HT PARAMETERS SHELL TUBE WALL CORRECTION 1.037 .000 PRANDTL NUMBER 9.2 4.9 RYNLD NO, AVG 171. 214. RYNLD NO, IN BUN 153. 333. RYNLD NO, OUT BUN 190. 121.	NOMINAL VEL, WINDOW FT/S . CROSSFLOW COEF BTU/HR-FT2-F 220 WINDOW COEF BTU/HR-FT2-F 221	08 15 .2 .6
FOULNG LAYER IN0014 .0014	SHELLSIDE FLOW, % OF TOTAL HEAT TRANSFER X-FLOW 81.	44
THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL 41.18 56.77 1.98 .07 PCT OVER DESIGN03 TOT FOUL RESIST .000217 DIFF RESIST000004	TUBE TO BAFFLE LEAKAGE A = 3.  MAIN CROSSFLOW B = 67.  BUNDLE TO SHELL BYPASS C = 12.  BAFFLE TO SHELL LEAKAGE E = 16.  TUBE PASSLANE BYPASS F = .  SHELLSIDE HEAT TRANSFER FACTORS	96 87
DIAMETRAL CLEARANCES	TOTAL = (BETA) (GAMMA) (FIN) = .6	26

BUNDLE TO SHELL TUBE TO BAFFLE HOLI BAFFLE TO SHELL	IN5000	BETA	(BAFF CUT F (TUBE ROW E (HT LOSS IN	ACTOR)	= .920 = .680 = .994
SHELL NOZZLE DATA HT UNDR NOZ IN. HT OPP NOZ IN. VELOCITY FT/S DENSITY LB/FT3 NOZZ RHO*VSQ LB/FT- BUND RHO*VSQ LB/FT-	.25 .25 .49 .49 62.535 62.401 -s2 14 14	WINDOW END ZOI CROSS I	NE FLOW NOZZLE		TOTAL = 9.0 = 5.0 = 4.2 = 41.4 = 40.4
TUBE NOZZLE DATA VELOCITY FT/S DENSITY LB/FT3 PRESS. DROP %  Univeryoung model F302DY	.15 .14 61.291 62.463 1.8 1.1 rsity ChE433 heat	DRY WET		= = ent	150. 165. E0002 P 12 9/23/ 3 CASE 6
SIZE 4- 18 TYPE BEN		HOT TO	JBE SIDE		ELL SIDE
TOTAL FLOW RATE	KLB/HR	SENS.	.100	SENSI	.700
TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS	DEGF LB/FT3 6	140.0 1.2913 .4726 .9973 .3723	47.2* 62.4739 1.3297 1.0046 .3488	40.0 62.5352	53.2* 62.4200 1.2221 1.0037 .3506
TEMP, AVG & SKIN VISCOSITY, AVG & SI PRESSURE, IN & DES	KIN CP	93.6 .7411	65.9 1.0306	46 6	64.9 1.0440
PRESSURE DROP, TOT VELOCITY, CALC & MA	& ALLOWED PSI AX ALLOWED FT/S	.01	10.00	.01	10.00
FOULING RESISTANCE FILM COEFFICIENT	HR-FT2-F/BTU BTU/HR-FT2-F	1	90.88		0010
TOTAL HEAT DUTY REGET TEMP DIF, DEGFOVERALL COEFF REQUIRED COEFF	QUIRED MEGBTU/HR (LMTD= 32.0,F= IRED BTU/HR-FT2	.46,BYP		FF=1.00)	.009270 13.7 94.69 94.95
SHELLS IN SERIES PASSES, SHELL SHELL DIAMETER IN.	1 TUBE 4 E	FFECTIVE	E AREA	FT2/SHELL	7.1
BAFFLE TYPE HOSPACING, CENTRAL					4 30.00

	che433b(40).OUT	
SPACING, INLET IN. 4.309	CUT DISTANCE FROM CENTER, IN764	
SPACING, OUTLET IN. 4.309		
	IMPINGEMENT BAFFLE INCLUDED NO	
	TUBESHEET BLANK AREA, % .0	
FAIRS OF SEALING DEVICES I	TODESHEET BLANK AREA, 5	
	AN MEDITAL SELECTION OF THE CONTROL	
	MATERIAL ELECTROLYTIC COPPER	
•	EST MAX TUBE COUNT 36	
•	TUBE PITCH IN3125	
TUBE LGTH, EFF FT 1.436	TUBE OUTSIDE DIAM IN250	
TUBE LAYOUT DEG 60	TUBE INSIDE DIAM IN214	
PITCH RATIO 1.250	TUBE SURFACE RATIO, OUT/IN 1.184	
SHL NOZZ ID, IN&OUT 1.0 1.0	TUBE NOZZ ID, IN&OUT IN8 .8	
* CALCULATED ITEMHEAT BALANCE	CODE = 8	
□□Washington University ChE433 hea		3
Young model F302DY4P	9/23/ 3	,
Toung moder F302D14P		
	CASE 6	
SUPPLEMENTAR	Y RESULTS	
HT PARAMETERS SHELL TUBE		
WALL CORRECTION 1.036 .000	•	
PRANDTL NUMBER 9.4 5.0	·	
RYNLD NO, AVG 196. 213.	CROSSFLOW COEF BTU/HR-FT2-F 241.8	
RYNLD NO, IN BUN 178. 333.	WINDOW COEF BTU/HR-FT2-F 243.3	
RYNLD NO, OUT BUN 216. 119.		
FOULNG LAYER IN0014 .0014	SHELLSIDE FLOW, % OF TOTAL	
1002110 2111211 2111	HEAT TRANSFER X-FLOW 81.51	
THERMAL RESISTANCE, % OF TOTAL		
SHELL TUBE FOULING METAL		
38.98 58.89 2.06 .07		
PCT OVER DESIGN .28		
TOT FOUL RESIST .000217	TUBE PASSLANE BYPASS $F = .00$	
DIFF RESIST .000029		
	SHELLSIDE HEAT TRANSFER FACTORS	
DIAMETRAL CLEARANCES	TOTAL = (BETA) (GAMMA) (FIN) = $.639$	
BUNDLE TO SHELL IN5000	BETA (BAFF CUT FACTOR) = .920	
TUBE TO BAFFLE HOLE IN0284	GAMMA (TUBE ROW ENTRY EFCT) = .695	
	END (HT LOSS IN END ZONE) = .994	
SHELL NOZZLE DATA IN OUT	SHELL PRESSURE DROP, % OF TOTAL	
HT UNDR NOZ IN25		
HT OPP NOZ IN25		
VELOCITY FT/S .57 .57		
DENSITY LB/FT3 62.535 62.420		
NOZZ RHO*VSQ LB/FT-S2 20 20	OUTLET NOZZLE = 40.8	
BUND RHO*VSQ LB/FT-S2 13 13		
TUBE NOZZLE DATA IN OUT		
VELOCITY FT/S .15 .14		
DENSITY LB/FT3 61.291 62.474	WET = 165.	
PRESS. DROP % 1.8 1.1		
	t exchanger experiment E0002 P 14	4
Young model F302DY4P	9/23/ 3	
y	5,20, 0	

					CASE /
SIZE 4- 18 TYPE BE					
		COLD S	HELL SIDE		
		Tube		Shel	1
		SENSI	BLE LIQ	SENS	IBLE LIQ
TOTAL FLOW RATE	KLB/HR		.100		.800
101112 12011 14112	1122, 1111	TN	OTIT	TN	OIIT
	DECE	140 0	46.2*	40.0	E1 6+
TEMPERATURE	DEGF	140.0	40.3"	40.0	JI.0"
DENSITY					
VISCOSITY	CP	.4726	1.3473	1.4791	1.2486
SPECIFIC HEAT					
THERMAL COND.	BTU/HR-FT-F	.3723	.3485	.3466	.3501
MOLAR MASS	LB/LBMOL		18.02		18.02
THERMAL COND. MOLAR MASS					
TEMP, AVG & SKIN	DEGF	93.2	64.4	45.8	63.4
VISCOSITY, AVG & S					
PRESSURE, IN & DES					
INDUCATION A DEC	1011	30.00	100.00	30.00	100.00
PRESSURE DROP, TOT	י ג אוו.השדה ספו	г 01	10 00	0.2	10 00
VELOCITY, CALC & M	MAX ALLOWED FI,	5 .10	10.00	.13	10.00
			0010		0.001.0
FOULING RESISTANCE					
FILM COEFFICIENT					61.86
TOTAL HEAT DUTY RE					.009361
EFF TEMP DIF, DEGE	(LMTD= 31.1, E	F = .46, BYPA	ASS= .93, BAI	FF=1.00)	13.3
OVERALL COEFF REQU	JIRED BTU/HR-H	FT2-F			98.41
CLEAN & FOULED COE	FF BTU/HR-F	FT2-F	100.65	5	98.12
SHELLS IN SERIES	1 PARALLEL 1	TOTAL EFF	' AREA	FT2	7.1
PASSES, SHELL					
SHELL DIAMETER IN.					
	0.020	12111 01121		, 1121111 111	
BAFFLE TYPE H	IORZ SEGMENTI.	CROSS PAS	SES PER SHI	T.T. PASS	Д
SPACING, CENTRAL					
SPACING, INLET		CUI DISIA	NCE FROM CI	ENIER, IN.	. / 64
SPACING, OUTLET					
BAFFLE THICKNESS	IN125	IMPINGEME	INT BAFFLE	INCLUDED	NO
PAIRS OF SEALING D	EVICES 1	TUBESHEET	BLANK AREA	A, %	.0
TUBE TYPE	PLAIN	MATERIAL	E]	LECTROLYTI	C COPPER
NO. OF TUBES/SHELI	76	EST MAX I	UBE COUNT		36
TUBE LGTH, OVERALI	FT 1.500	TUBE PITO	CH	IN.	.3125
TUBE LGTH, EFF					
TUBE LAYOUT					
PITCH RATIO					
SHL NOZZ ID, IN&OU					
SUT MOAA IN' IMGO(	) I I U I U	TODE NOZZ	ער י TN&OO.	T TIN •	. 0 . 0
+ 03101113000 TTT		- CODE - ^			
* CALCULATED ITE					T0000 - 1-
□□Washington Unive		eat exchang	ger experime	ent	
Young model F302DY	74P				9/23/ 3
					CASE 7
S U P P L E	M E N T A	R Y F	R E S U	L T S	

HT PARAMETERS	SHELL TUB	F	SHET	LSIDE PERFO	RMANCE	
WALL CORRECTION				L VEL,X-FLO		1 0
PRANDTL NUMBER				L VEL, WINDO		
RYNLD NO, AVG				LOW COEF		
RYNLD NO, AVG						
			INDOM	COEF	BTU/HR-FTZ-	-F 204.0
RYNLD NO, OUT BUN			0		° 05 5053	
FOULNG LAYER IN.	.0014 .001			LSIDE FLOW, RANSFER X-F		
THERMAL RESISTANCE	% OF TOTAL			O BAFFLE LE		
SHELL TUBE FOU				ROSSFLOW		
37.05 60.75 2						
PCT OVER DESIGN TOT FOUL RESIST	3	7 6	ALLTE	NACCIANE DVD	LANAGE E	- 13.60
			OBF P	ASSLANE BYP	ASS F	= .00
DIFF RESIST			CHET	TOTOE HEAD		A CHOD C
DIAMETRAL CLEARA BUNDLE TO SHELL				LSIDE HEAT		
DIAMETRAL CLEARA	NCES	T.(		= (BETA) (GAM		
				(BAFF CUT F		
TUBE TO BAFFLE HOL				•	•	
BAFFLE TO SHELL	IN10	00 E1	ND	(HT LOSS IN	END ZONE)	= .994
SHELL NOZZLE DAT	A IN O	ידוד	SHEI	.I. PRESSIIRE	DROP % OF	т∩тат.
HT UNDR NOZ IN.			INDOW		DROI, 0 OI	= 8.9
HT OPP NOZ IN.				NE		= 4.4
VELOCITY FT/S						= 3.7
DENSITY LB/FT3						= 41.9
NOZZ RHO*VSQ LB/FT				' NOZZLE		= 41.9
BUND RHO*VSQ LB/FT			011111	ПОДДЦЕ		- 41.2
DOND IMIO VSQ ID/II	52 10	10				
TUBE NOZZLE DATA	IN C	UT	WEIG	HT PER SHEL	L, LB	
VELOCITY FT/S	.15 .	14 DI	RY	MI FER SHEL	=	150.
DENSITY LB/FT3	61.291 62.4	82 W	ET		=	165.
PRESS. DROP %	1.8 1	.1				
□□Washington Unive	rsity ChE433	heat e	xchan	ger experim	ent	E0002 P 16
Young model F302DY	4 P					9/23/ 3
						CASE 8
SIZE 4- 18 TYPE BE	M, MULTI-PASS	FLOW,	SEGM	ENTAL BAFFL	ES, RATING	
		]	HOT I	UBE SIDE	COLD SH	HELL SIDE
			Tube	:	Shell	L
			SENS	IBLE LIQ	SENSI	IBLE LIQ
TOTAL FLOW RATE	KLB/HR			.100		.900
			IN	OUT	IN	OUT
TEMPERATURE	DEGF	1	40.0	45.6*	40.0	50.4*
DENSITY	LB/FT3	61.	2913	62.4879	62.5352	62.4452
	CP			1.3611		
SPECIFIC HEAT	BTU/LB-F		9973	1.0049	1.0058	1.0041
THERMAL COND.	BTU/HR-FT-F	•	3723	.3483	.3466	.3497
MOLAR MASS	LB/LBMOL			18.02		18.02
TEMP, AVG & SKIN				63.1		
VISCOSITY, AVG & S				1.0691		
PRESSURE, IN & DES	IGN PSIA	51	U.UU	165.00	50.00	165.00

		che433b(40			
PRESSURE DROP, TOT & ALLO	OWED PSI	.01	10.00	.02	10.00
VELOCITY, CALC & MAX ALLO	OWED FT/	s .10	10.00	.14	10.00
FOULING RESISTANCE HF	R-FT2-F/B	TU .00	010	.0	0010
		-F 191			32.43
TOTAL HEAT DUTY REQUIRED					.009432
EFF TEMP DIF, DEGF (LMTI	0 = 30.3, F =	= .46,BYPAS	S= .93, BAF	F=1.00)	13.0
OVERALL COEFF REQUIRED	BTU/HR-F	T2-F			101.30
CLEAN & FOULED COEFF			103.64		100.93
SHELLS IN SERIES 1 PARAI	LLEL 1	TOTAL EFF	AREA	FT2	7.1
PASSES, SHELL 1 TUBE	4	EFFECTIVE	AREA	FT2/SHELL	7.1
SHELL DIAMETER IN.					
BAFFLE TYPE HORZ SE	EGMENTL	CROSS PASS	ES PER SHE	LL PASS	4
CDACING CENTRAL IN	1 200	DAFFIF CIIM	DCT CUEI	T T D	30 00
SPACING, INLET IN.	4.309	CUT DISTAN	CE FROM CF	NTER. IN.	. 764
SPACING OUTLET IN	4 309	001 2101111.	02 11:011 02	,	• , 0 1
SPACING, CENTRAL IN. SPACING, INLET IN. SPACING, OUTLET IN. BAFFLE THICKNESS IN.	125	TMPTNGEMEN	T BAFFI.F T	NCLUDED	NO
PAIRS OF SEALING DEVICES	1	TILLINGELEN	BINNK VDEV	9	.0
	1	TODESHEET	DUANN ANDA	., •	• 0
		MATERIAL			
NO. OF TUBES/SHELL	/6	EST MAX TU	BE COUNT		36
TUBE LGTH, OVERALL FT TUBE LGTH, EFF FT	1.500	TUBE PITCH		IN.	.3125
TUBE LGTH, EFF FT	1.436	TUBE OUTSI	DE DIAM	IN.	
TUBE LAYOUT DEG	60	TUBE INSID	E DIAM	IN.	.214
PITCH RATIO SHL NOZZ ID, IN&OUT 1.0	1.250	TUBE SURFA	CE RATIO,	OUT/IN	1.184
SHL NOZZ ID, IN&OUT 1.0	1.0	TUBE NOZZ	ID, IN&OUT	IN.	.8 .8
* CALCULATED ITEMHEAT					
* CALCULATED ITEMHEAT			r experime	ent	
* CALCULATED ITEMHEAT			r experime	nt	9/23/ 3
* CALCULATED ITEMHEAT	ChE433 he	at exchange	_		9/23/ 3
* CALCULATED ITEMHEAT	ChE433 he	at exchange	_		
* CALCULATED ITEMHEAT	ChE433 he	at exchange	E S U	L T S	9/23/ 3 CASE 8
* CALCULATED ITEMHEAT	ChE433 he	at exchange	E S U	L T S	9/23/ 3 CASE 8
* CALCULATED ITEMHEAT	ChE433 he	at exchange	E S U	L T S	9/23/ 3 CASE 8
* CALCULATED ITEMHEAT	ChE433 he	at exchange	E S U	L T S	9/23/ 3 CASE 8
* CALCULATED ITEMHEAT	ChE433 he	at exchange	E S U	L T S	9/23/ 3 CASE 8
* CALCULATED ITEMHEAT	ChE433 he	at exchange	E S U	L T S	9/23/ 3 CASE 8
* CALCULATED ITEMHEAT	ChE433 he	at exchange	E S U	L T S	9/23/ 3 CASE 8
* CALCULATED ITEMHEAT	ChE433 he	at exchange  R Y R  SHELLS  NOMINAL  NOMINAL  CROSSFLO  WINDOW C  SHELLS	E S U  IDE PERFOR  VEL, X-FLOW  VEL, WINDOW  W COEF E  OEF E	L T S  MANCE  FT/S  FT/S  TU/HR-FT2-  TU/HR-FT2-  % OF TOTAL	9/23/3 CASE 8 .12 .23 F 283.5 F 285.3
* CALCULATED ITEMHEAT	TUBE .000 5.0 211. 333. 1160014	at exchange  R Y R  SHELLS  NOMINAL  NOMINAL  CROSSFLO  WINDOW C  SHELLS	E S U  IDE PERFOR  VEL, X-FLOW  VEL, WINDOW  W COEF E  OEF E	L T S  MANCE  FT/S  FT/S  TU/HR-FT2-  TU/HR-FT2-  % OF TOTAL	9/23/3 CASE 8 .12 .23 F 283.5 F 285.3
* CALCULATED ITEMHEAT  DDWashington University ( Young model F302DY4P  S U P P L E M E N  HT PARAMETERS SHELL  WALL CORRECTION 1.033  PRANDTL NUMBER 9.6  RYNLD NO, AVG 248.  RYNLD NO, IN BUN 229.  RYNLD NO, OUT BUN 267.  FOULNG LAYER IN0014  THERMAL RESISTANCE, % OF	TUBE .000 5.0 211. 333. 1160014	at exchange  R Y R  SHELLS  NOMINAL  NOMINAL  CROSSFLO  WINDOW C  SHELLS  HEAT TRA  TUBE TO	E S U  IDE PERFOR  VEL, X-FLOW  VEL, WINDOW  W COEF E  OEF E  IDE FLOW,  NSFER X-FI  BAFFLE LEA	L T S  MANCE  FT/S  FT/S  TU/HR-FT2-  TU/HR-FT2-  % OF TOTAL  OW  KAGE A	9/23/3 CASE 8  .12 .23 F 283.5 F 285.3  81.54 = 3.45
* CALCULATED ITEMHEAT  DDWashington University ( Young model F302DY4P  S U P P L E M E N  HT PARAMETERS SHELL  WALL CORRECTION 1.033  PRANDTL NUMBER 9.6  RYNLD NO, AVG 248.  RYNLD NO, IN BUN 229.  RYNLD NO, OUT BUN 267.  FOULNG LAYER IN0014  THERMAL RESISTANCE, % OF	TUBE .000 5.0 211. 333. 1160014	at exchange  R Y R  SHELLS  NOMINAL  NOMINAL  CROSSFLO  WINDOW C  SHELLS  HEAT TRA  TUBE TO	E S U  IDE PERFOR  VEL, X-FLOW  VEL, WINDOW  W COEF E  OEF E  IDE FLOW,  NSFER X-FI  BAFFLE LEA	L T S  MANCE  FT/S  FT/S  TU/HR-FT2-  TU/HR-FT2-  % OF TOTAL  OW  KAGE A	9/23/3 CASE 8  .12 .23 F 283.5 F 285.3  81.54 = 3.45
* CALCULATED ITEMHEAT  DDWashington University ( Young model F302DY4P  S U P P L E M E N  HT PARAMETERS SHELL  WALL CORRECTION 1.033  PRANDTL NUMBER 9.6  RYNLD NO, AVG 248.  RYNLD NO, IN BUN 229.  RYNLD NO, OUT BUN 267.  FOULNG LAYER IN0014  THERMAL RESISTANCE, % OF	TUBE .000 5.0 211. 333. 1160014	at exchange  R Y R  SHELLS  NOMINAL  NOMINAL  CROSSFLO  WINDOW C  SHELLS  HEAT TRA  TUBE TO	E S U  IDE PERFOR  VEL, X-FLOW  VEL, WINDOW  W COEF E  OEF E  IDE FLOW,  NSFER X-FI  BAFFLE LEA	L T S  MANCE  FT/S  FT/S  TU/HR-FT2-  TU/HR-FT2-  % OF TOTAL  OW  KAGE A	9/23/3 CASE 8  .12 .23 F 283.5 F 285.3  81.54 = 3.45
* CALCULATED ITEMHEAT  DDWashington University ( Young model F302DY4P  S U P P L E M E N  HT PARAMETERS SHELL  WALL CORRECTION 1.033  PRANDTL NUMBER 9.6  RYNLD NO, AVG 248.  RYNLD NO, IN BUN 229.  RYNLD NO, OUT BUN 267.  FOULNG LAYER IN0014  THERMAL RESISTANCE, % OF  SHELL TUBE FOULING N 35.34 62.40 2.19  PCT OVER DESIGN  TOT FOUL RESIST	TUBE .000 5.0 211. 333. 1160014  TOTAL METAL .0736 .000217	at exchange  R Y R  SHELLS  NOMINAL  NOMINAL  CROSSFLO  WINDOW C  SHELLS  HEAT TRA  TUBE TO	E S U  IDE PERFOR  VEL, X-FLOW  VEL, WINDOW  W COEF E  OEF E  IDE FLOW,  NSFER X-FI  BAFFLE LEA	L T S  MANCE  FT/S  FT/S  TU/HR-FT2-  TU/HR-FT2-  % OF TOTAL  OW  KAGE A	9/23/3 CASE 8 .12 .23 F 283.5 F 285.3 81.54 = 3.45
* CALCULATED ITEMHEAT  DUMASHINGTON University Of Young model F302DY4P  S U P P L E M E N  HT PARAMETERS SHELL  WALL CORRECTION 1.033  PRANDTL NUMBER 9.6  RYNLD NO, AVG 248.  RYNLD NO, IN BUN 229.  RYNLD NO, OUT BUN 267.  FOULNG LAYER IN0014  THERMAL RESISTANCE, % OF	TUBE .000 5.0 211. 333. 1160014  TOTAL METAL .0736 .000217	AT EXCHANGE  R Y R  SHELLS  NOMINAL  NOMINAL  CROSSFLO  WINDOW C  SHELLS  HEAT TRA  TUBE TO  MAIN CRO  BUNDLE T  BAFFLE T  TUBE PAS	E S U  IDE PERFORVEL, X-FLOW  VEL, WINDOW  W COEF E  IDE FLOW,  NSFER X-FI  BAFFLE LEA  SSFLOW  O SHELL BY O SHELL LE  SLANE BYPA	L T S  MANCE  FT/S  FT/S  TU/HR-FT2-  TU/HR-FT2-  OW  KAGE A  B PASS C  AKAGE E  SS F	9/23/3 CASE 8 .12 .23 F 283.5 F 285.3 .8 .81.54 = 3.45 = 66.07 = 14.78 = 15.70 = .00
* CALCULATED ITEMHEAT  COMMASSINGTON University Company Young model F302DY4P  S U P P L E M E M  HT PARAMETERS SHELL WALL CORRECTION 1.033 PRANDTL NUMBER 9.6 RYNLD NO, AVG 248. RYNLD NO, IN BUN 229. RYNLD NO,OUT BUN 267. FOULNG LAYER IN0014  THERMAL RESISTANCE, % OF SHELL TUBE FOULING M 35.34 62.40 2.19 PCT OVER DESIGN TOT FOUL RESIST DIFF RESIST	TUBE .000 5.0 211. 333. 1160014  TOTAL METAL .0736 .000217000036	AT EXCHANGE  R Y R  SHELLS  NOMINAL  NOMINAL  CROSSFLO  WINDOW C  SHELLS  HEAT TRA  TUBE TO  MAIN CRO  BUNDLE T  BAFFLE T  TUBE PAS	E S U  IDE PERFORVEL, X-FLOW  VEL, WINDOW  W COEF E  IDE FLOW,  NSFER X-FI  BAFFLE LEA  SSFLOW  O SHELL BY O SHELL LE  SLANE BYPA	L T S  MANCE  FT/S  FT/S  TU/HR-FT2-  TU/HR-FT2-  % OF TOTAL  OW  KAGE A	9/23/3 CASE 8 .12 .23 F 283.5 F 285.3 .8 .81.54 = 3.45 = 66.07 = 14.78 = 15.70 = .00
* CALCULATED ITEMHEAT  DDWashington University ( Young model F302DY4P  S U P P L E M E N  HT PARAMETERS SHELL  WALL CORRECTION 1.033  PRANDTL NUMBER 9.6  RYNLD NO, AVG 248.  RYNLD NO, IN BUN 229.  RYNLD NO, OUT BUN 267.  FOULNG LAYER IN0014  THERMAL RESISTANCE, % OF SHELL TUBE FOULING N 35.34 62.40 2.19  PCT OVER DESIGN  TOT FOUL RESIST	TUBE .000 5.0 211. 333. 1160014  TOTAL METAL .0736 .000217000036	AT EXCHANGE  R Y R  SHELLS  NOMINAL  NOMINAL  CROSSFLO  WINDOW C  SHELLS  HEAT TRA  TUBE TO  MAIN CRO  BUNDLE T  BAFFLE T  TUBE PAS  SHELLS  TOTAL = (	E S U  IDE PERFOF VEL, X-FLOW VEL, WINDOW W COEF E  IDE FLOW, NSFER X-FI BAFFLE LEA SSFLOW O SHELL BY O SHELL LE SLANE BYPA  IDE HEAT T BETA) (GAMM	L T S  MANCE  FT/S  FT/S  TU/HR-FT2-  VOF TOTAL  OW  KAGE A  B  PASS C  AKAGE E  SS F	9/23/3 CASE 8  .12 .23 F 283.5 F 285.3  81.54 = 3.45 = 66.07 = 14.78 = 15.70 = .00  ACTORS = .666

TUBE TO BAFFLE HOLD	E IN0284	GAMMA	(TUBE ROW EN	NTRY EFCT)	= .724 = .994
SHELL NOZZLE DATA HT UNDR NOZ IN. HT OPP NOZ IN. VELOCITY FT/S DENSITY LB/FT3 NOZZ RHO*VSQ LB/FT- BUND RHO*VSQ LB/FT-	.25 .25 .73 .73 62.535 62.445 -s2 33 33	WINDOW END ZO CROSS INLET	NE FLOW NOZZLE		TOTAL = 8.9 = 4.1 = 3.6 = 42.0 = 41.4
TUBE NOZZLE DATA VELOCITY FT/S DENSITY LB/FT3 PRESS. DROP %  UNIVERSELY UNIVERSELY UNIVERSELY	61.291 62.488 1.7 1.1 rsity ChE433 heat	WET		=	150. 165. E0002 P 18 9/23/ 3 CASE 9
SIZE 4- 18 TYPE BEN		HOT T	ENTAL BAFFLE UBE SIDE IBLE LIQ .200 OUT	COLD SH	IELL SIDE
TOTAL FLOW RATE	KLB/HR		.200		.200
TEMPERATURE DENSITY	DEGF LB/FT3	140.0 51.2913	82.9* 62.1061	40.0 62.5352	96.9* 61.9324
VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS	CP BTU/LB-F BTU/HR-FT-F	.4726 .9973 .3723	.8367 1.0001 .3589	1.4791 1.0058 .3466	.7152 .9989 .3625
MOLAR MASS	LB/LBMOL		18.02		18.02
TEMP, AVG & SKIN VISCOSITY, AVG & SI PRESSURE, IN & DES	KIN CP	111.5 .6150		68.4 .9977	91.8 .7561
PRESSURE DROP, TOT VELOCITY, CALC & MA	& ALLOWED PSI AX ALLOWED FT/S	.02	10.00	.00	10.00
FOULING RESISTANCE FILM COEFFICIENT	BTU/HR-FT2-F	· 1	97.38		00010
TOTAL HEAT DUTY RECEPT TEMP DIF, DEGFOVERALL COEFF REQUIRED COEFF	(LMTD= 43.0,F= IRED BTU/HR-FT2	.55,BYP.			.011396 21.8 73.26 73.43
SHELLS IN SERIES : PASSES, SHELL : SHELL DIAMETER IN.	l TUBE 4 E	EFFECTIV	E AREA		7.1
BAFFLE TYPE HOSPACING, CENTRAL SPACING, INLET	IN. 4.309 E	BAFFLE C	UT, PCT SHEI	LL I.D.	30.00

	he433b(40).OUT
SPACING, OUTLET IN. 4.309	
	APINGEMENT BAFFLE INCLUDED NO
PAIRS OF SEALING DEVICES 1 TO	JBESHEET BLANK AREA, % .0
TUBE TYPE PLAIN MA	ATERIAL ELECTROLYTIC COPPER
NO. OF TUBES/SHELL 76 ES	ST MAX TUBE COUNT 36
TUBE LGTH, OVERALL FT 1.500 TO	JBE PITCH IN3125
TUBE LGTH, EFF FT 1.436 TO	JBE OUTSIDE DIAM IN250
TUBE LAYOUT DEG 60 TO	JBE INSIDE DIAM IN214
PITCH RATIO 1.250 TO	JBE SURFACE RATIO, OUT/IN 1.184
SHL NOZZ ID, IN&OUT 1.0 1.0 TO	JBE NOZZ ID, IN&OUT IN8 .8
* CALCULATED ITEMHEAT BALANCE CO	DDE = 8
□□Washington University ChE433 heat	exchanger experiment E0002 P 19
Young model F302DY4P	9/23/ 3
	CASE 9
SUPPLEMENTAR	Y RESULTS
HT PARAMETERS SHELL TUBE	SHELLSIDE PERFORMANCE
WALL CORRECTION 1.040 .000	NOMINAL VEL, X-FLOW FT/S .03
PRANDTL NUMBER 6.8 4.1	NOMINAL VEL, WINDOW FT/S .05
RYNLD NO, AVG 74. 512.	CROSSFLOW COEF BTU/HR-FT2-F 135.1
RYNLD NO, IN BUN 50. 667.	WINDOW COEF BTU/HR-FT2-F 132.1
RYNLD NO, OUT BUN 103. 377.	210, mx 112 1 102.1
FOULNG LAYER IN0014 .0014	SHELLSIDE FLOW, % OF TOTAL
TOOLING LITTLIK INOOTT .OOTT	HEAT TRANSFER X-FLOW 79.56
THERMAL RESISTANCE, % OF TOTAL	TUBE TO BAFFLE LEAKAGE A = 2.53
SHELL TUBE FOULING METAL	MAIN CROSSFLOW B = 68.09
54.31 44.05 1.59 .05	BUNDLE TO SHELL BYPASS C = 10.96
PCT OVER DESIGN .23	BAFFLE TO SHELL LEAKAGE E = 18.42
TOT FOUL RESIST .000217	TUBE PASSLANE BYPASS F = .00
DIFF RESIST .000217	TODE TASSUANE DITASS F00
DIFF RESIST	SHELLSIDE HEAT TRANSFER FACTORS
DIAMETRAL CLEARANCES	TOTAL = (BETA) (GAMMA) (FIN) = .598
BUNDLE TO SHELL IN5000	BETA (BAFF CUT FACTOR) = .920
TUBE TO BAFFLE HOLE IN0284	GAMMA (TUBE ROW ENTRY EFCT) = .650
	END (HT LOSS IN END ZONE) = .998
DAFFIE TO SHELL IN1000	END (III LOSS IN END ZONE)990
SHELL NOZZLE DATA IN OUT	SHELL PRESSURE DROP, % OF TOTAL
HT UNDR NOZ IN25	WINDOW = 10.0
	END ZONE = 8.2
VELOCITY FT/S .16 .16	
DENSITY LB/FT3 62.535 61.932	
NOZZ RHO*VSQ LB/FT-S2 1 1	
BUND RHO*VSQ LB/FT-S2 1 1 BUND RHO*VSQ LB/FT-S2 1 1	OUTLET NOZZLE = 35.9
BOND KHO, A20 TR\11.25 I I	
MIDE NORTE DAMA TA COM	MEICHE DED CHELL ID
TUBE NOZZLE DATA IN OUT VELOCITY FT/S .30 .29	
DENSITY LB/FT3 61.291 62.106	WET = 165.
PRESS. DROP % 4.0 2.5	70000 7 00
	exchanger experiment E0002 P 20
Young model F302DY4P	9/23/ 3
	CASE 10

		che433b(	40).OUT		
SIZE 4- 18 TYPE BE	M, MULTI-PASS F	LOW, SEGME	ENTAL BAFFL	ES, RATING	
		HOT TU	JBE SIDE	COLD SH	HELL SIDE
		Tube		Shell	-
		SENSI	BLE LIQ	SENSI	BLE LIQ
TOTAL FLOW RATE	KLB/HR		.200 OUT 72.6*		.300
		IN	OUT	IN	OUT
TEMPERATURE	DEGF	140.0	72.6*	40.0	84.7*
DENSITY	LB/f"I'3	61.2913	62.2231	62.5352	62.0844
VISCOSITY	CP	.4726	.9467	1.4791	.8191
SPECIFIC HEAT	BTU/LB-F	.9973	1.0012	1.0058	.9999
THERMAL COND.		.3723	.3561	.3466	.3593
MOLAR MASS	LB/LBMOL		18.02		18.02
TEMP, AVG & SKIN VISCOSITY, AVG & S	DEGF		85.4	62.4	84.6
VISCOSITY, AVG & S	SKIN CP	.6477	.8131	1.0793	.8205
PRESSURE, IN & DES	SIGN PSIA	50.00	165.00	50.00	165.00
11.20001.2, 11. 4 52.0		00.00	100,00	00.00	100.00
PRESSURE DROP, TOT	. & ALLOWED PSI	.02	10.00	.00	10.00
VELOCITY, CALC & M	MAX ALLOWED FT/	s .19	10.00	.05	10.00
FOULING RESISTANCE					00010
FILM COEFFICIENT					54.87
					010451
TOTAL HEAT DUTY RE					.013451
EFF TEMP DIF, DEGE	(LMTD= 43.0,F	= .59,BYP <i>I</i>	ASS= .93,BA	FF=1.00)	
OVERALL COEFF REQU	JIRED BTU/HR-F	T2-F		_	79.55
CLEAN & FOULED COE	FF BTU/HR-F	T2-F	80.63	2	79.19
SHELLS IN SERIES	1 PARALLEL 1	TOTAL EFF	F AREA	FT2	7.1
PASSES, SHELL	1 TUBE 4	EFFECTIVE	E AREA	FT2/SHELL	7.1
SHELL DIAMETER IN.	3.820	TEMA SHEI	LL TYPE E	; REAR HE	EAD FXTS
BAFFLE TYPE	IORZ SEGMENTL	CROSS PAS	SSES PER SH	ELL PASS	4
SPACING, CENTRAL	IN. 4.309	BAFFLE CU	JT, PCT SHE	LL I.D.	30.00
SPACING, INLET	IN. 4.309	CUT DISTA	ANCE FROM C	ENTER, IN.	.764
SPACING, OUTLET	IN. 4.309				
BAFFLE THICKNESS	IN125		ENT BAFFLE		NO
PAIRS OF SEALING D	EVICES 1	TUBESHEET	BLANK ARE	A, %	.0
	DIATM				CODDED
TUBE TYPE			E:		
NO. OF TUBES/SHELI			TUBE COUNT		36
TUBE LGTH, OVERALI				IN.	.3125
TUBE LAYOUT					.250
TUBE LAYOUT					.214
PITCH RATIO			FACE RATIO,		
SHL NOZZ ID, IN&OU	1.0 1.0	TORE NOZZ	דווי, TN%OO,	T TIN •	.0 .0
* CALCULATED ITE	MHEAT BALANCE	CODE = 8			
□□Washington Unive			ger experim	ent	E0002 P 21
Young model F302DY	_		, <u></u>	-	9/23/ 3
					CASE 10
SUPPLE	M E N T A	R Y F	R E S U	L T S	<del></del>
<del>-</del>	=	-		-	

HT PARAMETERS WALL CORRECTION		TUBE	SHELI	POINE LEKEN	RMANCE	
			NOMINA	L VEL,X-FLO	W FT/S	.04
PRANDTL NUMBER				L VEL, WINDO		
RYNLD NO, AVG						
RYNLD NO, IN BUN						
RYNLD NO, OUT BUN				COLL	DIO/IIIC IIZ	1 100.1
FOULNG LAYER IN.				ICIDE EIOM	°	т
FOOLING LATER IN.	.0014					
				RANSFER X-F		
THERMAL RESISTANCE						
SHELL TUBE FOU						
50.56 47.67 1						
PCT OVER DESIGN						
TOT FOUL RESIST				ASSLANE BYP	ASS F	= .00
DIFF RESIST	(	000058				
			SHELI	LSIDE HEAT	TRANSFER F	ACTORS
DIAMETRAL CLEARA	ANCES		TOTAL =	=(BETA)(GAM	MA) (FIN)	= .598
BUNDLE TO SHELL	IN.	.5000	BETA	(BAFF CUT F	'ACTOR)	= .920
TUBE TO BAFFLE HOI	LE IN.	.0284	GAMMA	(TUBE ROW E	NTRY EFCT)	= .650
BAFFLE TO SHELL						
SHELL NOZZLE DAT						
HT UNDR NOZ IN. HT OPP NOZ IN. VELOCITY FT/S DENSITY LB/FT3 NOZZ RHO*VSQ LB/FT	.25		WINDOW			= 9.5
HT OPP NOZ IN.	.25		END ZOI	NE		= 6.5
VELOCITY FT/S	.24	.25	CROSS I	FLOW		= 5.1
DENSITY LB/FT3	62.535	62.084	INLET 1	NOZZLE		= 40.9
NOZZ RHO*VSO LB/FT	7-S2 3	3	OUTLET	NOZZLE		= 37.9
BUND RHO*VSQ LB/F1	7-S2 2	2				
TUBE NOZZLE DATA	A IN	OUT	WEIGH	HT PER SHEL	L. LB	
VELOCITY FT/S	3.0	29	DRY			150
VELOCITY FT/S			DRY WET		=	150. 165
DENSITY LB/FT3	61.291	62.223	DRY WET		=	150. 165.
DENSITY LB/FT3 PRESS. DROP %	61.291	62.223	MET		=	100.
DENSITY LB/FT3 PRESS. DROP %  UNive	61.291 3.8 ersity Chl	62.223	MET		= = nent	E0002 P 22
DENSITY LB/FT3 PRESS. DROP %	61.291 3.8 ersity Chl	62.223	MET		= = ment	E0002 P 22 9/23/ 3
DENSITY LB/FT3 PRESS. DROP %  Univeryoung model F302DY	61.291 3.8 ersity Chl	62.223 2.4 E433 hea	t exchang	ger experim	= = ment	E0002 P 22 9/23/ 3 CASE 11
DENSITY LB/FT3 PRESS. DROP %  UNive	61.291 3.8 ersity Chl	62.223 2.4 E433 hea	wEI it exchand	ger experim ENTAL BAFFL	= = ment .ES, RATING	E0002 P 22 9/23/ 3 CASE 11
DENSITY LB/FT3 PRESS. DROP %  Univeryoung model F302DY	61.291 3.8 ersity Chl	62.223 2.4 E433 hea	wET exchanged to the control of the	ger experim	= = ment ES, RATING COLD S	E0002 P 22 9/23/ 3 CASE 11
DENSITY LB/FT3 PRESS. DROP %  Univeryoung model F302DY	61.291 3.8 ersity Chl	62.223 2.4 E433 hea	WET  at exchange  OW, SEGMI  HOT TO  Tube	ger experim ENTAL BAFFL UBE SIDE	= = nent ES, RATING COLD S Shel	E0002 P 22 9/23/ 3 CASE 11 HELL SIDE
DENSITY LB/FT3 PRESS. DROP %  University Uni	61.291 3.8 ersity Chi 74P EM, MULTI-	62.223 2.4 E433 hea -PASS FI	OW, SEGMI HOT TO Tube SENS	ger experim ENTAL BAFFL UBE SIDE IBLE LIQ	= = nent ES, RATING COLD S Shel SENS	E0002 P 22 9/23/ 3 CASE 11 HELL SIDE 1 IBLE LIQ
DENSITY LB/FT3 PRESS. DROP %  Univeryoung model F302DY	61.291 3.8 ersity Chi 74P EM, MULTI-	62.223 2.4 E433 hea -PASS FI	OW, SEGMI HOT TO Tube SENS:	ger experim ENTAL BAFFL UBE SIDE IBLE LIQ .200	= = nent .ES, RATING COLD S Shel SENS	E0002 P 22 9/23/ 3 CASE 11 HELL SIDE 1 IBLE LIQ .400
DENSITY LB/FT3 PRESS. DROP %  Univeryoung model F302DY  SIZE 4- 18 TYPE BE  TOTAL FLOW RATE	61.291 3.8 ersity Chi (4P EM, MULTI- KLB/HR	62.223 2.4 E433 hea	OW, SEGMI HOT TU Tube SENS:	ger experim ENTAL BAFFL UBE SIDE IBLE LIQ .200 OUT	= = = = = = = = = = = = = = = = = = =	E0002 P 22 9/23/ 3 CASE 11 HELL SIDE 1 IBLE LIQ .400 OUT
DENSITY LB/FT3 PRESS. DROP %  University Uni	61.291 3.8 ersity Chi (4P EM, MULTI- KLB/HR	62.223 2.4 E433 hea	OW, SEGMI HOT TU Tube SENS:	ger experim ENTAL BAFFL UBE SIDE IBLE LIQ .200 OUT	= = = = = = = = = = = = = = = = = = =	E0002 P 22 9/23/ 3 CASE 11 HELL SIDE 1 IBLE LIQ .400 OUT
DENSITY LB/FT3 PRESS. DROP %  Univeryoung model F302DY  SIZE 4- 18 TYPE BE  TOTAL FLOW RATE	61.291 3.8 ersity Chi 44P EM, MULTI- KLB/HR DEGF	62.223 2.4 E433 hea	OW, SEGME HOT TUBE SENS:  IN 140.0	ger experim ENTAL BAFFL UBE SIDE IBLE LIQ .200 OUT 66.3*	= = = = = = = = = = = = = = = = = = =	E0002 P 22 9/23/ 3 CASE 11 HELL SIDE 1 IBLE LIQ .400 OUT 76.7*
DENSITY LB/FT3 PRESS. DROP %  UNIVERSE DROP %  SIZE 4- 18 TYPE BE  TOTAL FLOW RATE  TEMPERATURE	61.291 3.8 ersity Chi 44P EM, MULTI- KLB/HR DEGF LB/FT3	62.223 2.4 E433 hea -PASS FI	OW, SEGMI HOT TU Tube SENS: IN 140.0 61.2913	ger experim ENTAL BAFFL UBE SIDE IBLE LIQ .200 OUT 66.3*	= = = = = = = = = = = = = = = = = = =	E0002 P 22 9/23/ 3 CASE 11 HELL SIDE 1 IBLE LIQ .400 OUT 76.7* 62.1781
DENSITY LB/FT3 PRESS. DROP %  Univeryoung model F302DY  SIZE 4- 18 TYPE BE  TOTAL FLOW RATE  TEMPERATURE DENSITY	61.291 3.8 ersity Chi 74P EM, MULTI- KLB/HR DEGF LB/FT3 CP	62.223 2.4 E433 hea -PASS FI	OW, SEGMI HOT TU Tube SENSI IN 140.0 61.2913	ger experim ENTAL BAFFL UBE SIDE  IBLE LIQ .200 OUT 66.3* 62.2904 1.0251	= = = = = = = = = = = = = = = = = = =	E0002 P 22 9/23/ 3 CASE 11 HELL SIDE 1 IBLE LIQ .400 OUT 76.7* 62.1781 .9010
DENSITY LB/FT3 PRESS. DROP %  Universal Washington University Washington Washington University Washington Washington University Washington	61.291 3.8 ersity Chi 74P EM, MULTI- KLB/HR DEGF LB/FT3 CP BTU/LB-I	62.223 2.4 E433 hea -PASS FI	Tube SENS:  IN 140.0 61.2913 .4726	ger experim ENTAL BAFFL UBE SIDE  IBLE LIQ .200 OUT 66.3* 62.2904 1.0251 1.0020	= = = = = = = = = = = = = = = = = = =	E0002 P 22 9/23/ 3 CASE 11 HELL SIDE 1 IBLE LIQ .400 OUT 76.7* 62.1781 .9010 1.0007
DENSITY LB/FT3 PRESS. DROP %  Univeryoung model F302DY  SIZE 4- 18 TYPE BE  TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY	61.291 3.8 ersity Chi 4P EM, MULTI- KLB/HR DEGF LB/FT3 CP BTU/LB-I BTU/HR-I	62.223 2.4 E433 hea -PASS FI FT-F	Tube SENS:  IN 140.0 61.2913 .4726	ger experim ENTAL BAFFL UBE SIDE  IBLE LIQ .200 OUT 66.3* 62.2904 1.0251 1.0020	= = = = = = = = = = = = = = = = = = =	E0002 P 22 9/23/ 3 CASE 11 HELL SIDE 1 IBLE LIQ .400 OUT 76.7* 62.1781 .9010 1.0007
DENSITY LB/FT3 PRESS. DROP %  University Uni	61.291 3.8 ersity Chi 4P EM, MULTI- KLB/HR DEGF LB/FT3 CP BTU/LB-I BTU/HR-I	62.223 2.4 E433 hea -PASS FI FT-F	IN 140.0 61.2913 .4726 .9973 .3723	ger experimental BAFFLUBE SIDE  IBLE LIQ .200 OUT 66.3* 62.2904 1.0251 1.0020 .3543	= = = = = = = = = = = = = = = = = = =	E0002 P 22 9/23/ 3 CASE 11 HELL SIDE 1 IBLE LIQ .400 OUT 76.7* 62.1781 .9010 1.0007 .3572
DENSITY LB/FT3 PRESS. DROP %  University Uni	61.291 3.8 ersity Chi 44P EM, MULTI- KLB/HR DEGF LB/FT3 CP BTU/LB-I BTU/HR-I LB/LBMO	62.223 2.4 E433 hea -PASS FI FT-F	.OW, SEGMI HOT TU Tube SENS: IN 140.0 61.2913 .4726 .9973 .3723	ger experim  ENTAL BAFFL  UBE SIDE  IBLE LIQ .200 OUT 66.3* 62.2904 1.0251 1.0020 .3543 18.02	= = = = = = = = = = = = = = = = = = =	E0002 P 22 9/23/ 3 CASE 11 HELL SIDE 1 IBLE LIQ .400 OUT 76.7* 62.1781 .9010 1.0007 .3572 18.02
DENSITY LB/FT3 PRESS. DROP %  Universal Washington University Washington	61.291 3.8 ersity Chi 44P EM, MULTI- KLB/HR DEGF LB/FT3 CP BTU/LB-I BTU/HR-I LB/LBMOI	62.223 2.4 E433 hea -PASS FI FT-F	IN 140.0 61.2913 .4726 .9973 .3723	ger experim ENTAL BAFFL UBE SIDE  IBLE LIQ .200 OUT 66.3* 62.2904 1.0251 1.0020 .3543 18.02	= = = = = = = = = = = = = = = = = = =	E0002 P 22 9/23/ 3 CASE 11 HELL SIDE 1 IBLE LIQ .400 OUT 76.7* 62.1781 .9010 1.0007 .3572 18.02
DENSITY LB/FT3 PRESS. DROP %  Univeryoung model F302DY  SIZE 4- 18 TYPE BE  TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS  TEMP, AVG & SKIN	61.291 3.8 ersity Chi 74P EM, MULTI- KLB/HR DEGF LB/FT3 CP BTU/LB-I BTU/HR-I LB/LBMOD	62.223 2.4 E433 hea -PASS FI FT-F	IN 140.0 61.2913 .4726 .9973 .3723	ger experim ENTAL BAFFL UBE SIDE  IBLE LIQ .200 OUT 66.3* 62.2904 1.0251 1.0020 .3543 18.02	= = = = = = = = = = = = = = = = = = =	E0002 P 22 9/23/ 3 CASE 11 HELL SIDE 1 IBLE LIQ .400 OUT 76.7* 62.1781 .9010 1.0007 .3572 18.02
DENSITY LB/FT3 PRESS. DROP %  DWashington Univeryoung model F302DY  SIZE 4- 18 TYPE BE  TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS  TEMP, AVG & SKIN VISCOSITY, AVG & S	61.291 3.8 ersity Chi 74P EM, MULTI- KLB/HR DEGF LB/FT3 CP BTU/LB-I BTU/HR-I LB/LBMOD	62.223 2.4 E433 hea -PASS FI FT-F	IN 140.0 61.2913 .4726 .9973 .3723	ger experim ENTAL BAFFL UBE SIDE  IBLE LIQ .200 OUT 66.3* 62.2904 1.0251 1.0020 .3543 18.02 80.2 .8635	= = = = = = = = = = = = = = = = = = =	E0002 P 22 9/23/ 3 CASE 11 HELL SIDE 1 IBLE LIQ .400 OUT 76.7* 62.1781 .9010 1.0007 .3572 18.02

	che433b(40).OUT	
VELOCITY, CALC & MAX ALLOWED FT/S	.19 10.00 .07	10.00
FOULING RESISTANCE HR-FT2-F/BTU	.00010	.00010
FILM COEFFICIENT BTU/HR-FT2-H	F 196.61	179.08
TOTAL HEAT DUTY REQUIRED MEGBTU/HR		.014712
EFF TEMP DIF, DEGF (LMTD= 42.2,F=		24.3
OVERALL COEFF REQUIRED BTU/HR-FT2	2-F	84.58
OVERALL COEFF REQUIRED BTU/HR-FT2 CLEAN & FOULED COEFF BTU/HR-FT2	2-F 86.71	84.98
0 1 D.D 1		7 1
SHELLS IN SERIES 1 PARALLEL 1	TOTAL EFF AREA FTZ	7.1
PASSES, SHELL 1 TUBE 4 F		
SHELL DIAMETER IN. 3.820	TEMA SHELL TYPE E ; REAR	HEAD FXTS
BAFFLE TYPE HORZ SEGMENTL (	CROSS PASSES PER SHELL PASS	4
SPACING, CENTRAL IN. 4.309	BAFFLE CUT, PCT SHELL I.D.	30.00
SPACING, INLET IN. 4.309	CUT DISTANCE FROM CENTER, IN	.764
SPACING, OUTLET IN. 4.309	,,	
BAFFLE THICKNESS IN125	IMPINGEMENT BAFFLE INCLUDED	NO
PAIRS OF SEALING DEVICES 1	TUBESHEET BLANK AREA, %	. 0
	,	
	MATERIAL ELECTROLYT	
NO. OF TUBES/SHELL 76 TUBE LGTH, OVERALL FT 1.500	EST MAX TUBE COUNT	36
TUBE LGTH, OVERALL FT 1.500	TUBE PITCH IN.	.3125
TUBE LGTH, EFF FT 1.436	TUBE OUTSIDE DIAM IN.	.250
TUBE LAYOUT DEG 60	TUBE INSIDE DIAM IN.	.214
PITCH RATIO 1.250	TUBE SURFACE RATIO, OUT/IN	1.184
SHL NOZZ ID, IN&OUT 1.0 1.0	TUBE NOZZ ID, IN&OUT IN.	.8 .8
+ G11 G11 1 T T T T T T T T T T T T T T T	2007	
* CALCULATED ITEMHEAT BALANCE (		E0000 D 03
□□Washington University ChE433 heat Young model F302DY4P	t exchanger experiment	9/23/ 3
roung moder roughlar		9/23/ 3 CASE 11
S U P P L E M E N T A R	Y RESILTS	
HT PARAMETERS SHELL TUBE		
WALL CORRECTION 1.038 .000	NOMINAL VEL, X-FLOW FT/S	.05
PRANDTL NUMBER 7.9 4.4	NOMINAL VEL, WINDOW FT/S	.10
RYNLD NO, AVG 132. 471.		2-F 179.8
RYNLD NO, IN BUN 102. 667.	WINDOW COEF BTU/HR-FT	2-F 180.8
RYNLD NO, OUT BUN 167. 307.		
FOULNG LAYER IN0014 .0014	SHELLSIDE FLOW, % OF TOT	AL
	HEAT TRANSFER X-FLOW	81.32
THERMAL RESISTANCE, % OF TOTAL	TUBE TO BAFFLE LEAKAGE	A = 2.78
SHELL TUBE FOULING METAL		
46.92 51.17 1.84 .06	BUNDLE TO SHELL BYPASS	C = 11.72
PCT OVER DESIGN .47 TOT FOUL RESIST .000217	BAFFLE TO SHELL LEAKAGE	E = 16.47
TOT FOUL RESIST .000217	TUBE PASSLANE BYPASS	F = .00
DIFF RESIST .000056		
	SHELLSIDE HEAT TRANSFER	
DIAMETRAL CLEARANCES	TOTAL = (BETA) (GAMMA) (FIN)	= .606
BUNDLE TO SHELL IN5000	BETA (BAFF CUT FACTOR)	
TUBE TO BAFFLE HOLE IN0284	GAMMA (TUBE ROW ENTRY EFCT	.658

		che433b(			
BAFFLE TO SHELL	IN1000	END	(HT LOSS IN	END ZONE)	= .994
SHELL NOZZLE DATA	A TNI OIIT	CHETI	r ppeccipe i		TOTAT
HT UNDR NOZ IN.			L PRESSURE I	DROP, 5 OF	= 9.2
HT OPP NOZ IN.			ALE:		
					= 5.6 = 4.6
VELOCITY FT/S			FLOW		
DENSITY LB/FT3					= 41.5
NOZZ RHO*VSQ LB/FT			NOZZLE		= 39.1
BUND RHO*VSQ LB/FT	-S2 4 4				
TUBE NOZZLE DATA	IN OUT	WEIGH	HT PER SHEL	L, LB	
VELOCITY FT/S					150.
DENSITY LB/FT3				=	165.
PRESS. DROP %					
□□Washington Unive		at exchand	ger experim	ent	E0002 P 24
Young model F302DY		20 011011011	901 01119011111	0110	9/23/ 3
roung moder rough					CASE 12
SIZE 4- 18 TYPE BEI	M, MULTI-PASS FI	LOW, SEGME	ENTAL BAFFLI	ES, RATING	
			JBE SIDE		
		Tube		Shell	
		SENSI	IBLE LIQ	SENS	IBLE LIQ
TOTAL FLOW RATE	KLB/HR		.200		.500
	·		OUT		OUT
TEMPERATURE	DEGF				
	LB/FT3				
			1.0846		
SPECIFIC HEAT			1.0025		
THERMAL COND.					
MOLAR MASS		. 3 / 2 3	18.02	•3100	18.02
TEMP, AVG & SKIN			76.4	55.5	75.5
VISCOSITY, AVG & SI	KIN CP	.6845	.9042	1.1831	.9144
PRESSURE, IN & DES	IGN PSIA	50.00	165.00	50.00	165.00
PRESSURE DROP, TOT	s Allowed Dat	0.2	10 00	.01	10 00
VELOCITY, CALC & MA				.08	
VELOCITI, CALC & MA	AX ALLOWED FI/L	.19	10.00	.00	10.00
FOULING RESISTANCE	HR-FT2-F/B7	ru .(	00010	. (	00010
FILM COEFFICIENT					02.78
TOTAL HEAT DUTY REG	OUIRED MEGBTU/HE	3			.015580
EFF TEMP DIF, DEGF	(LMTD= 41.1,F=	= .63,BYPA	ASS= .93,BA		
OVERALL COEFF REQUI			•	,	89.72
CLEAN & FOULED COE			91.9	2	89.92
SHELLS IN SERIES	1 PARALLEL 1	TOTAL EFF	F AREA	FT2	7.1
PASSES, SHELL					
SHELL DIAMETER IN.					
BAFFLE TYPE H					
SPACING, CENTRAL	IN. 4.309	BAFFLE CU	UT, PCT SHE	LL I.D.	30.00
SPACING, INLET	IN. 4.309	CUT DISTA	ANCE FROM C	ENTER, IN.	.764
SPACING, OUTLET	IN. 4.309				

	C	ne433b(40).001	
BAFFLE THICKNESS IN.	125 I	MPINGEMENT BAFFLE INCLUDED	NO
PAIRS OF SEALING DEVICES		JBESHEET BLANK AREA, %	.0
IMINO OI OBMBINO DEVICEO			• •
TUBE TYPE PI	LAIN M	ATERIAL ELECTROLYTI	C COPPER
NO. OF TUBES/SHELL	76 E	ST MAX TUBE COUNT	36
TUBE LGTH, OVERALL FT 1.	500 T	JBE PITCH IN.	.3125
TUBE LGTH, EFF FT 1.	436 T	JBE OUTSIDE DIAM IN.	.250
TUBE LAYOUT DEG	60 T	JBE INSIDE DIAM IN.	.214
PITCH RATIO 1.	.250 Т	JBE SURFACE RATIO, OUT/IN	1.184
SHL NOZZ ID, IN&OUT 1.0			.8 .8
SHL NOZZ ID, IN&OUT 1.0	1.0 1	JDE NOZZ ID, IN&OUT IN.	.0 .0
* CALCULATED ITEMHEAT BA	ALANCE C	ODE = 8	
□□Washington University ChE4	133 heat	exchanger experiment	E0002 P 25
<del>-</del>	100 11000	ononangor onporamono	
Young model F302DY4P			9/23/ 3
			CASE 12
SUPPLEMENT	AR	Y RESULTS	
HT PARAMETERS SHELL	шппп	CHELLCIDE DEDECOMANCE	
	TUBE	SHELLSIDE PERFORMANCE	
	.000	NOMINAL VEL, X-FLOW FT/S	.07
PRANDTL NUMBER 8.2	4.6	NOMINAL VEL, WINDOW FT/S	.13
RYNLD NO, AVG 159.		CROSSFLOW COEF BTU/HR-FT2	-F 203 6
	667		
	667.	WINDOW COEF BTU/HR-FT2	-F 204.8
RYNLD NO, OUT BUN 195.	291.		
FOULNG LAYER IN0014 .	0014	SHELLSIDE FLOW, % OF TOTA	L
		HEAT TRANSFER X-FLOW	81.40
MURDMAL DEGLOCANICE O OF MOR			
THERMAL RESISTANCE, % OF TOT		TUBE TO BAFFLE LEAKAGE A	
SHELL TUBE FOULING META	ΑL	MAIN CROSSFLOW B	= 68.25
43.85 54.14 1.95 .0	) 6	BUNDLE TO SHELL BYPASS C	= 12.55
	.23	BAFFLE TO SHELL LEAKAGE E	
	00217	TUBE PASSLANE BYPASS F	= .00
DIFF RESIST .00	0025		
		SHELLSIDE HEAT TRANSFER F	ACTORS
DIAMETRAL CLEARANCES		TOTAL = (BETA) (GAMMA) (FIN)	= 620
	.5000		
		BETA (BAFF CUT FACTOR)	
TUBE TO BAFFLE HOLE IN.	.0284	GAMMA (TUBE ROW ENTRY EFCT)	= .673
BAFFLE TO SHELL IN.	.1000	END (HT LOSS IN END ZONE)	= .994
CUDIT NORRID DAMA IN	OTTE		m
SHELL NOZZLE DATA IN		SHELL PRESSURE DROP, % OF	
HT UNDR NOZ IN25		WINDOW	= 9.0
HT OPP NOZ IN25		END ZONE	= 5.1
		CROSS FLOW	= 4.3
DENSITY LB/FT3 62.535 6			= 41.8
NOZZ RHO*VSQ LB/FT-S2 10	10	OUTLET NOZZLE	= 39.8
BUND RHO*VSQ LB/FT-S2 7	7		
~ .			
MIDE MORRIE DATE	0	METONE DED OVER	
TUBE NOZZLE DATA IN	OUT	WEIGHT PER SHELL, LB	
VELOCITY FT/S .30	.29	DRY =	150.
DENSITY LB/FT3 61.291 6	52.335	WET =	165.
	2.3		•
1 VEOD . DEOL 9 3.0	۷. ۷		
	1001	1	T0000 - 01
$\square\square$ Washington University ChE4	133 heat	exchanger experiment	E0002 P 26
	133 heat	exchanger experiment	E0002 P 26 9/23/ 3
$\square\square$ Washington University ChE4	133 heat	exchanger experiment	

SIZE 4- 18 TYPE BEM, MULTI-PASS FLOW, SEGMENTAL BAFFLES, RATING

Young model F302DY4P 9/23/ 3 CASE 13			che433b( HOT TU Tube SENSI		COLD SI Shell SENS:	HELL SIDE L IBLE LIO
MOLAR MASS LB/LBMOL 18.02 .3466 .3545 MOLAR MASS LB/LBMOL 18.02 .18.02  TEMP, AVG & SKIN DEGF 99.4 73.4 53.5 72.4 VISCOSITY, AVG & SKIN CP .6959 .9378 1.2175 .9491 PRESSURE, IN & DESIGN PSIA 50.00 165.00 50.00 165.00  PRESSURE DROP, TOT & ALLOWED PSI .02 10.00 .01 10.00 VELOCITY, CALC & MAX ALLOWED FT/S .19 10.00 .10 10.00 FOULING RESISTANCE HR-FT2-F/BTU .00010 .00010 FILM COEFFICIENT ETU/HR-FT2-F 196.73 225.36  TOTAL HEAT DUTY REQUIRED MEGETU/HR .0016202 EFF TEMP DIF, DEGF (LMTD= 40.1,F= .65,BYFASS= .93,BAFF=1.00) 24.1 OVERALL COEFF REQUIRED BTU/HR-FT2-F 96.31 94.08  SHELLS IN SERIES 1 PARALLEL 1 TOTAL EFF AREA FT2 7.1 PASSES, SHELL 1 TUBE 4 EFFECTIVE AREA FT2/SHELL 7.1 SHELL DIAMETER IN. 3.820 TEMA SHELL TYPE E ; REAR HEAD FXTS  BAFFLE TYPE HORZ SEGMENTL CROSS PASSES PER SHELL PASS 4 SPACING, CENTRAL IN. 4.309 BAFFLE CUT, PCT SHELL I.D. 30.00 SPACING, INLET IN. 4.309 BAFFLE CUT, PCT SHELL I.D. 30.00 SPACING, INLET IN. 4.309 BAFFLE THICKNESS IN125 IMPINGEMENT BAFFLE INCLUDED NO SPACING, OUTLET IN. 4.309 BAFFLE THICKNESS IN125 IMPINGEMENT BAFFLE INCLUDED NO PAIRS OF SEALING DEVICES 1 TUBESHEET BLANK AREA, % .0  TUBE TYPE PLAIN MATERIAL ELECTROLYTIC COPPER NO. OF TUBES/SHELL FT 1.500 TUBE SHEAL BASK A.0  TUBE TYPE PLAIN MATERIAL ELECTROLYTIC COPPER NO. OF TUBES/SHELL FT 1.500 TUBE INSIDE DIAM IN2104 PITCH RATIO 1.250 TUBE SURFACE RATIO, OUT/IN 1.184 SHL NOZZ ID, IN&OUT 1.0 1.0 TUBE NOZZ ID, IN&OUT IN8 .8  * CALCULATED ITEM-HEAT BALANCE CODE = 8  IDWASHINGTON University ChE433 heat exchanger experiment E0002 F 2 Young model F302DY4P 20003	TOTAL FLOW RATE	KLB/HR		.200		.600
MOLAR MASS LB/LBMOL 18.02 .3466 .3545 MOLAR MASS LB/LBMOL 18.02 .18.02  TEMP, AVG & SKIN DEGF 99.4 73.4 53.5 72.4 VISCOSITY, AVG & SKIN CP .6959 .9378 1.2175 .9491 PRESSURE, IN & DESIGN PSIA 50.00 165.00 50.00 165.00  PRESSURE DROP, TOT & ALLOWED PSI .02 10.00 .01 10.00 VELOCITY, CALC & MAX ALLOWED FT/S .19 10.00 .10 10.00 FOULING RESISTANCE HR-FT2-F/BTU .00010 .00010 FILM COEFFICIENT ETU/HR-FT2-F 196.73 225.36  TOTAL HEAT DUTY REQUIRED MEGETU/HR .0016202 EFF TEMP DIF, DEGF (LMTD= 40.1,F= .65,BYFASS= .93,BAFF=1.00) 24.1 OVERALL COEFF REQUIRED BTU/HR-FT2-F 96.31 94.08  SHELLS IN SERIES 1 PARALLEL 1 TOTAL EFF AREA FT2 7.1 PASSES, SHELL 1 TUBE 4 EFFECTIVE AREA FT2/SHELL 7.1 SHELL DIAMETER IN. 3.820 TEMA SHELL TYPE E ; REAR HEAD FXTS  BAFFLE TYPE HORZ SEGMENTL CROSS PASSES PER SHELL PASS 4 SPACING, CENTRAL IN. 4.309 BAFFLE CUT, PCT SHELL I.D. 30.00 SPACING, INLET IN. 4.309 BAFFLE CUT, PCT SHELL I.D. 30.00 SPACING, INLET IN. 4.309 BAFFLE THICKNESS IN125 IMPINGEMENT BAFFLE INCLUDED NO SPACING, OUTLET IN. 4.309 BAFFLE THICKNESS IN125 IMPINGEMENT BAFFLE INCLUDED NO PAIRS OF SEALING DEVICES 1 TUBESHEET BLANK AREA, % .0  TUBE TYPE PLAIN MATERIAL ELECTROLYTIC COPPER NO. OF TUBES/SHELL FT 1.500 TUBE SHEAL BASK A.0  TUBE TYPE PLAIN MATERIAL ELECTROLYTIC COPPER NO. OF TUBES/SHELL FT 1.500 TUBE INSIDE DIAM IN2104 PITCH RATIO 1.250 TUBE SURFACE RATIO, OUT/IN 1.184 SHL NOZZ ID, IN&OUT 1.0 1.0 TUBE NOZZ ID, IN&OUT IN8 .8  * CALCULATED ITEM-HEAT BALANCE CODE = 8  IDWASHINGTON University ChE433 heat exchanger experiment E0002 F 2 Young model F302DY4P 20003	DENSITY	DEGF LB/FT3	IN 140.0 61.2913	OUT 58.9* 62.3655	IN 40.0 62.5352	OUT 66.9* 62.2843
TEMP, AVG & SKIN DEGF 99.4 73.4 53.5 72.4 VISCOSITY, AVG & SKIN CP .6959 .9378 1.2175 .9491 PRESSURE, IN & DESIGN PSIA 50.00 165.00 50.00 165.00 165.00    PRESSURE DROP, TOT & ALLOWED PSI .02 10.00 .01 10.00 VELOCITY, CALC & MAX ALLOWED FT/S .19 10.00 .10 10.00    FOULING RESISTANCE HR-FT2-F/BTU .00010 .00010   FILM COEFFICIENT BTU/HR-FT2-F 196.73 225.36    TOTAL HEAT DUTY REQUIRED MEGBTU/HR .016.73 225.36    TOTAL HEAT DUTY REQUIRED BTU/HR-FT2-F 93.93 .93 .93 .94 .08    CLEAN & FOULED COEFF BTU/HR-FT2-F 96.31 94.08    SHELLS IN SERIES 1 PARALLEL 1 TOTAL EFF AREA FT2 7.1   SHELL SIN SERIES 1 PARALLEL 1 TOTAL EFF AREA FT2 7.1   SHELL DIAMETER IN. 3.820 TEMA SHELL TYPE E ; REAR HEAD FXTS    BAFFLE TYPE HORZ SEGMENTL CROSS PASSES PER SHELL PASS 4   SPACING, CENTRAL IN. 4.309 BAFFLE CUT, PCT SHELL I.D. 30.00   SPACING, INLET IN. 4.309 BAFFLE CUT, PCT SHELL I.D. 30.00   SPACING, INLET IN. 4.309 BAFFLE CUT, PCT SHELL I.D. 30.00   SPACING, OUTLET IN. 4.309 BAFFLE THICKNESS IN764   SPACING, OUTLET IN. 4.309 BAFFLE THICKNESS IN125   IMPINGEMENT BAFFLE INCLUDED NO   PAIRS OF SEALING DEVICES 1 TUBESHEET BLANK AREA, % .0    TUBE TYPE PLAIN MATERIAL ELECTROLYTIC COPPER   NO. OF TUBES/SHELL 76 EST MAX TUBE COUNT 36   TUBE LGTH, OVERALL FT 1.500 TUBE PITCH IN3125   TUBE LGTH, OVERALL FT 1.500 TUBE PITCH IN3125   TUBE LGTH, OVERALL FT 1.500 TUBE PITCH IN3125   TUBE LGTH, EFF FT 1.436 TUBE OUTSIDE DIAM IN254   PITCH RATIO 1.250 TUBE SURFACE RATIO, OUT/IN 1.184   SHL NOZZ ID, IN&OUT 1.0 1.0 TUBE NOZZ ID, IN&OUT IN8   * CALCULATED ITEM-HEAT BALANCE CODE = 8    DWASHINGTON University Che433 heat exchanger experiment E0002 P 2   Young model F302DY4P    * CALCULATED ITEM-HEAT BALANCE CODE = 8    DWASHINGTON University Che433 heat exchanger experiment E0002 P 2   Young model F302DY4P    * CALCULATED ITEM-HEAT BALANCE CODE = 8    DWASHINGTON University Che433 heat exchanger experiment E0002 P 2   Young model F302DY4P	SPECIFIC HEAT THERMAL COND.	BTU/HR-FT-F	.3723	.3522 18.02	.3466	.3545 18.02
FOULING RESISTANCE HR-FT2-F/BTU .00010 .00010 FILM COEFFICIENT BTU/HR-FT2-F 196.73 .225.36  TOTAL HEAT DUTY REQUIRED MEGBTU/HR .016202 EFF TEMP DIF, DEGF (LMTD= 40.1, F= .65, BYPASS= .93, BAFF=1.00) .24.1 OVERALL COEFF REQUIRED BTU/HR-FT2-F .93.93 CLEAN & FOULED COEFF BTU/HR-FT2-F .96.31 .94.08  SHELLS IN SERIES 1 PARALLEL 1 TOTAL EFF AREA FT2 .7.1 PASSES, SHELL 1 TUBE 4 EFFECTIVE AREA FT2/SHELL 7.1 SHELL DIAMETER IN. 3.820 TEMA SHELL TYPE E ; REAR HEAD FXTS  BAFFLE TYPE HORZ SEGMENTL CROSS PASSES PER SHELL PASS 4 SPACING, CENTRAL IN. 4.309 BAFFLE CUT, PCT SHELL I.D. 30.00 SPACING, INLET IN. 4.309 CUT DISTANCE FROM CENTER, IN764 SPACING, OUTLET IN. 4.309 BAFFLE THICKNESS IN125 IMPINGEMENT BAFFLE INCLUDED NO PAIRS OF SEALING DEVICES 1 TUBESHEET BLANK AREA, % .0  TUBE TYPE PLAIN MATERIAL ELECTROLYTIC COPPER NO. OF TUBES/SHELL 76 EST MAX TUBE COUNT 36 TUBE LGTH, OVERALL FT 1.500 TUBE PITCH IN3125 TUBE LGTH, EFF FT 1.436 TUBE OUTSIDE DIAM IN250 TUBE LAYOUT DEG 60 TUBE INSIDE DIAM IN214 PITCH RATIO 1.250 TUBE SURFACE RATIO, OUT/IN 1.184 SHL NOZZ ID, IN&OUT 1.0 1.0 TUBE NOZZ ID, IN&OUT IN8 .8  * CALCULATED ITEMHEAT BALANCE CODE = 8  CHARACTER AND STANDARD STANDARD SURFACE RATIO, OUT/IN 1.184  * CALCULATED ITEMHEAT BALANCE CODE = 8  CHARACTER AND STANDARD SURFACE RATIO, OUT/IN 1.184  * CALCULATED ITEMHEAT BALANCE CODE = 8  CHARACTER AND STANDARD SURFACE RATIO, OUT/IN 1.184  * CALCULATED ITEMHEAT BALANCE CODE = 8  CHARACTER AND STANDARD SURFACE RATIO, OUT/IN 1.184  * CALCULATED ITEMHEAT BALANCE CODE = 8  CHARACTER AND STANDARD SURFACE RATIO, OUT/IN 1.184  * CALCULATED ITEMHEAT BALANCE CODE = 8  CHARACTER AND STANDARD SURFACE RATIO, OUT/IN 1.184  * CALCULATED ITEMHEAT BALANCE CODE = 8  CHARACTER AND SURFACE RATIO, OUT/IN 1.184  * CALCULATED ITEMHEAT BALANCE CODE = 8  CHARACTER AND SURFACE RATIO, OUT/IN 1.184  * CALCULATED ITEMHEAT BALANCE CODE = 8  CHARACTER AND SURFACE RATIO, OUT/IN 1.184  * CALCULATED ITEMHEAT BALANCE CODE = 8  CHARACTER AND SURFACE RATIO, OUT/IN 1.184  * CALCULAT	VISCOSITY, AVG & S	KIN CP	994	73 4	53 5	72 4
TOTAL HEAT DUTY REQUIRED MEGBTU/HR  EFF TEMP DIF, DEGF (LMTD= 40.1,F= .65,BYPASS= .93,BAFF=1.00)  CLEAN & FOULED COEFF BTU/HR-FT2-F  PASSES, SHELL 1 TUBE 4 EFFECTIVE AREA FT2/SHELL 7.1  SHELLS IN SERIES 1 PARALLEL 1 TOTAL EFF AREA FT2/SHELL 7.1  SHELL DIAMETER IN. 3.820 TEMA SHELL TYPE E; REAR HEAD FXTS  BAFFLE TYPE HORZ SEGMENTL CROSS PASSES PER SHELL PASS 4  SPACING, CENTRAL IN. 4.309 BAFFLE CUT, PCT SHELL I.D. 30.00  SPACING, INLET IN. 4.309 CUT DISTANCE FROM CENTER, IN764  SPACING, OUTLET IN. 4.309  BAFFLE THICKNESS IN125 IMPINGEMENT BAFFLE INCLUDED NO PAIRS OF SEALING DEVICES 1 TUBESHEET BLANK AREA, % .0  TUBE TYPE PLAIN MATERIAL ELECTROLYTIC COPPER NO. OF TUBES/SHELL FT 1.500 TUBE PITCH IN3125  TUBE LGTH, OVERALL FT 1.500 TUBE PITCH IN3125  TUBE LGTH, EFF FT 1.436 TUBE OUTSIDE DIAM IN250  TUBE LAYOUT DEG 60 TUBE INSIDE DIAM IN214  PITCH RATIO 1.250 TUBE SURFACE RATIO, OUT/IN 1.184  SHL NOZZ ID, INGOUT 1.0 1.0 TUBE NOZZ ID, INGOUT IN8 .8  * CALCULATED ITEMHEAT BALANCE CODE = 8  COMBASHINGTON UNIVERSITY CHE433 heat exchanger experiment E0002 P 2  Young model F302DY4P 9/23/3 CASE 13	PRESSURE DROP, TOT VELOCITY, CALC & M	& ALLOWED PSI AX ALLOWED FT/	.02 /s .19	10.00	.01	10.00
TOTAL HEAT DUTY REQUIRED MEGBTU/HR  EFF TEMP DIF, DEGF (LMTD= 40.1,F= .65,BYPASS= .93,BAFF=1.00)  24.1  OVERALL COEFF REQUIRED BTU/HR-FT2-F  CLEAN & FOULED COEFF BTU/HR-FT2-F  SHELLS IN SERIES 1 PARALLEL 1 TOTAL EFF AREA FT2  SHELLS IN SERIES 1 PARALLEL 1 TOTAL EFF AREA FT2  SHELL DIAMETER IN. 3.820 TEMA SHELL TYPE E ; REAR HEAD FXTS  BAFFLE TYPE HORZ SEGMENTL CROSS PASSES PER SHELL PASS 4  SPACING, CENTRAL IN. 4.309 BAFFLE CUT, PCT SHELL I.D. 30.00  SPACING, INLET IN. 4.309 BAFFLE CUT, PCT SHELL I.D. 30.00  SPACING, OUTLET IN. 4.309  BAFFLE THICKNESS IN125 IMPINGEMENT BAFFLE INCLUDED NO PAIRS OF SEALING DEVICES 1 TUBESHEET BLANK AREA, % .0  TUBE TYPE PLAIN MATERIAL ELECTROLYTIC COPPER  NO. OF TUBES/SHELL 76 EST MAX TUBE COUNT 36  TUBE LGTH, OVERALL FT 1.500 TUBE PITCH IN3125  TUBE LGTH, OVERALL FT 1.500 TUBE PITCH IN214  PITCH RATIO 1.250 TUBE SURFACE RATIO, OUT/IN 1.184  SHL NOZZ ID, IN&OUT 1.0 1.0 TUBE NOZZ ID, IN&OUT IN. 8  * CALCULATED ITEMHEAT BALANCE CODE = 8  COMMASHINGTON University ChE433 heat exchanger experiment E0002 P 2  Young model F302DY4P  9/23/3  CASE 13	FOULING RESISTANCE	BTU/HR-FT2	2-F 19	96.73	22	
BAFFLE TYPE HORZ SEGMENTL CROSS PASSES PER SHELL PASS 4 SPACING, CENTRAL IN. 4.309 BAFFLE CUT, PCT SHELL I.D. 30.00 SPACING, INLET IN. 4.309 CUT DISTANCE FROM CENTER, IN764 SPACING, OUTLET IN. 4.309 BAFFLE THICKNESS IN125 IMPINGEMENT BAFFLE INCLUDED NO PAIRS OF SEALING DEVICES 1 TUBESHEET BLANK AREA, % .0  TUBE TYPE PLAIN MATERIAL ELECTROLYTIC COPPER NO. OF TUBES/SHELL 76 EST MAX TUBE COUNT 36 TUBE LGTH, OVERALL FT 1.500 TUBE PITCH IN3125 TUBE LGTH, EFF FT 1.436 TUBE OUTSIDE DIAM IN250 TUBE LAYOUT DEG 60 TUBE INSIDE DIAM IN250 TUBE LAYOUT DEG 60 TUBE SURFACE RATIO, OUT/IN 1.184 SHL NOZZ ID, IN&OUT 1.0 1.0 TUBE NOZZ ID, IN&OUT IN8 .8  * CALCULATED ITEMHEAT BALANCE CODE = 8  □□Washington University ChE433 heat exchanger experiment E0002 P 2 Young model F302DY4P  9/23/3 CASE 13		QUIRED MEGBTU/F (LMTD= 40.1,F IRED BTU/HR-F	HR F= .65,BYP <i>I</i> FT2-F	ASS= .93,BA	FF=1.00)	
SPACING, CENTRAL IN. 4.309 BAFFLE CUT, PCT SHELL I.D. 30.00 SPACING, INLET IN. 4.309 CUT DISTANCE FROM CENTER, IN764 SPACING, OUTLET IN. 4.309 BAFFLE THICKNESS IN125 IMPINGEMENT BAFFLE INCLUDED NO PAIRS OF SEALING DEVICES 1 TUBESHEET BLANK AREA, % .0  TUBE TYPE PLAIN MATERIAL ELECTROLYTIC COPPER NO. OF TUBES/SHELL 76 EST MAX TUBE COUNT 36 TUBE LGTH, OVERALL FT 1.500 TUBE PITCH IN3125 TUBE LGTH, EFF FT 1.436 TUBE OUTSIDE DIAM IN250 TUBE LAYOUT DEG 60 TUBE INSIDE DIAM IN214 PITCH RATIO 1.250 TUBE SURFACE RATIO, OUT/IN 1.184 SHL NOZZ ID, IN&OUT 1.0 1.0 TUBE NOZZ ID, IN&OUT IN8 .8  * CALCULATED ITEMHEAT BALANCE CODE = 8	SHELLS IN SERIES PASSES, SHELL SHELL DIAMETER IN.	1 PARALLEL 1 1 TUBE 4 3.820	TOTAL EFF EFFECTIVE TEMA SHEI	F AREA E AREA LL TYPE E	FT2 FT2/SHELL ; REAR HI	7.1 7.1 EAD FXTS
BAFFLE THICKNESS IN125 IMPINGEMENT BAFFLE INCLUDED NO PAIRS OF SEALING DEVICES 1 TUBESHEET BLANK AREA, % .0  TUBE TYPE PLAIN MATERIAL ELECTROLYTIC COPPER NO. OF TUBES/SHELL 76 EST MAX TUBE COUNT 36 TUBE LGTH, OVERALL FT 1.500 TUBE PITCH IN3125 TUBE LGTH, EFF FT 1.436 TUBE OUTSIDE DIAM IN250 TUBE LAYOUT DEG 60 TUBE INSIDE DIAM IN214 PITCH RATIO 1.250 TUBE SURFACE RATIO, OUT/IN 1.184 SHL NOZZ ID, IN&OUT 1.0 1.0 TUBE NOZZ ID, IN&OUT IN8 .8  * CALCULATED ITEMHEAT BALANCE CODE = 8  \[ \text{\text{Washington University Che433 heat exchanger experiment}}  \text{E0002 P 2} \\  \text{Young model F302DY4P}   \text{9/23/3} \\ \text{CASE 13}	SPACING, CENTRAL SPACING, INLET	IN. 4.309 IN. 4.309				20.00
NO. OF TUBES/SHELL 76 EST MAX TUBE COUNT 36  TUBE LGTH, OVERALL FT 1.500 TUBE PITCH IN3125  TUBE LGTH, EFF FT 1.436 TUBE OUTSIDE DIAM IN250  TUBE LAYOUT DEG 60 TUBE INSIDE DIAM IN214  PITCH RATIO 1.250 TUBE SURFACE RATIO, OUT/IN 1.184  SHL NOZZ ID, IN&OUT 1.0 1.0 TUBE NOZZ ID, IN&OUT IN8 .8  * CALCULATED ITEMHEAT BALANCE CODE = 8  \[ \text{\text{\text{CALCULATED ITEMHEAT BALANCE CODE}} = 8  \[ \text{\text{\text{\text{\text{\text{CALCULATED ITEMHEAT BALANCE CODE}}} = 8  \[ \text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\te	BAFFLE THICKNESS	IN125				
TUBE LGTH, EFF FT 1.436 TUBE OUTSIDE DIAM IN250  TUBE LAYOUT DEG 60 TUBE INSIDE DIAM IN214  PITCH RATIO 1.250 TUBE SURFACE RATIO, OUT/IN 1.184  SHL NOZZ ID, IN&OUT 1.0 1.0 TUBE NOZZ ID, IN&OUT IN8 .8  * CALCULATED ITEMHEAT BALANCE CODE = 8  DDWashington University ChE433 heat exchanger experiment E0002 P 2  Young model F302DY4P 9/23/3  CASE 13	NO. OF TUBES/SHELL	76	EST MAX T	TUBE COUNT		36
* CALCULATED ITEMHEAT BALANCE CODE = 8  UNAShington University ChE433 heat exchanger experiment E0002 P 2  Young model F302DY4P 9/23/3  CASE 13	TUBE LGTH, EFF TUBE LAYOUT	FT 1.436 DEG 60	TUBE OUTS	SIDE DIAM IDE DIAM	IN. IN.	.250 .214
	* CALCULATED ITE DDWashington University Young model F302DY	MHEAT BALANCE rsity ChE433 he 4P	E CODE = 8 eat exchang	ger experim	ent	E0002 P 27 9/23/ 3

HT PARAMETERS SHELL TUBE SHELLSIDE PERFORMANCE

WALL CORRECTION 1.035	.000	NOMINAL VI	EL,X-FLOW	FT/S	.08
PRANDTL NUMBER 8.4	4.6	NOMINAL VI	EL.WINDOW	FT/S	.15
RYNLD NO, AVG 186. RYNLD NO, IN BUN 153. RYNLD NO, OUT BUN 222.	453	CROSSET.OW	COEF BT	- די און / ווי	-F 226 2
NINED NO, AVO 100.	455.	CRODDILOW	CODI DI	U/IIN I I Z	T 220.2
RYNLD NO, IN BUN 153.	667.	MINDOM CO	₹F. B.I.	.0/HK-E.I.7-	-F 221.1
RYNLD NO, OUT BUN 222.	279.				
FOULNG LAYER IN0014	.0014	SHELLSI	DE FLOW, %	OF TOTAL	: 
FOULNG LAYER IN0014		HEAT TRANS	SFER X-FLO	W	81.47
THERMAL RESISTANCE, % OF	ТТТ	TIBE TO B	ΔΕΕΤ.Ε. Τ.ΕΔΚ	ACE A	= 3 12
SHELL TUBE FOULING 41.28 56.61 2.04	MDDDI	MAIN CDOC		D	- (7 55
SHELL TUBE FOULING	METAL	MAIN CROS	2 F LOW	В	= 67.55
41.28 56.61 2.04	. 0 7	BUNDLE TO	SHELL BYP	ASS C	= 13.29
PCT OVER DESIGN	.16	BAFFLE TO	SHELL LEA	KAGE E	= 16.04
TOT FOUL RESIST	.000217	TUBE PASS	LANE BYPAS	S F	= .00
DIFF RESIST	.000017				
PCT OVER DESIGN TOT FOUL RESIST DIFF RESIST	.000017	CHELLCI	DE HEAT TR	ANCEED E7	CTODC
		SHELLSII	DE REAL IN	ANSEER EA	ACTONS
DIAMETRAL CLEARANCES BUNDLE TO SHELL IN.		TOTAL = (B)	ETA) (GAMMA	r) (E.TN)	= .633
BUNDLE TO SHELL IN.	.5000	BETA (BA	FF CUT FAC	TOR)	= .920
TUBE TO BAFFLE HOLE IN.	.0284	GAMMA (TU	BE ROW ENT	RY EFCT)	= .689
BAFFLE TO SHELL IN.	.1000	END (HT	LOSS IN E	ND ZONE)	= .994
		,		,	
SHELL NOZZLE DATA	TNI OIIM	CHELL D	DECCIOE DO	OD % OF	шоша т
HT UNDR NOZ IN	25	WINDOW			= 8.9
HT OPP NOZ IN	25	END ZONE			= 4.8
VELOCITY FT/S .	49 .49	CROSS FLO	N		= 4.0
HT UNDR NOZ IN. HT OPP NOZ IN. VELOCITY FT/S DENSITY LB/FT3 62.5 NOZZ RHO*VSQ LB/FT-S2	35 62.284	INLET NOZ	ZLE		= 42.0
NO77 PHO*VSO IB/ET-S2	1/1 1/1		 771 F		- 10 3
BUND RHO*VSQ LB/FT-S2	10 10	OOTHET NO.	27111		- 40.5
BUND RHO^VSQ LB/FT-SZ	10 10				
TUBE NOZZLE DATA	IN OUT	WEIGHT :	PER SHELL,	LB	
TUBE NOZZLE DATA VELOCITY FT/S .	IN OUT 30 .29	WEIGHT :		=	150.
VELOCITY FT/S .	30 .29	DRY		=	150. 165.
VELOCITY FT/S . DENSITY LB/FT3 61.2	30 .29 91 62.366	DRY			150. 165.
VELOCITY FT/S . DENSITY LB/FT3 61.2 PRESS. DROP % 3	30 .29 91 62.366 .5 2.2	DRY WET		=	165.
VELOCITY FT/S . DENSITY LB/FT3 61.2 PRESS. DROP % 3  UNiversity	30 .29 91 62.366 .5 2.2	DRY WET		=	165. E0002 P 28
VELOCITY FT/S . DENSITY LB/FT3 61.2 PRESS. DROP % 3	30 .29 91 62.366 .5 2.2	DRY WET		=	165.
VELOCITY FT/S . DENSITY LB/FT3 61.2 PRESS. DROP % 3  UNiversity	30 .29 91 62.366 .5 2.2	DRY WET		=	165. E0002 P 28
VELOCITY FT/S . DENSITY LB/FT3 61.2 PRESS. DROP % 3 □□Washington University Young model F302DY4P	30 .29 91 62.366 .5 2.2 ChE433 heat	DRY WET exchanger	experimen	= = it	165. E0002 P 28 9/23/ 3 CASE 14
VELOCITY FT/S . DENSITY LB/FT3 61.2 PRESS. DROP % 3  UNiversity	30 .29 91 62.366 .5 2.2 ChE433 heat	DRY WET exchanger W, SEGMENT	experimen AL BAFFLES	= = at , RATING	165. E0002 P 28 9/23/ 3 CASE 14
VELOCITY FT/S . DENSITY LB/FT3 61.2 PRESS. DROP % 3 □□Washington University Young model F302DY4P	30 .29 91 62.366 .5 2.2 ChE433 heat	DRY WET exchanger W, SEGMENTE HOT TUBE	experimen AL BAFFLES SIDE	= = at , RATING COLD SE	165.  E0002 P 28  9/23/ 3  CASE 14  HELL SIDE
VELOCITY FT/S . DENSITY LB/FT3 61.2 PRESS. DROP % 3 □□Washington University Young model F302DY4P	30 .29 91 62.366 .5 2.2 ChE433 heat	DRY WET exchanger W, SEGMENT; HOT TUBE Tube	experimen AL BAFFLES SIDE	= = at , RATING COLD SH Shell	165.  E0002 P 28 9/23/ 3 CASE 14  HELL SIDE
VELOCITY FT/S . DENSITY LB/FT3 61.2 PRESS. DROP % 3 □□Washington University Young model F302DY4P  SIZE 4- 18 TYPE BEM, MUL	30 .29 91 62.366 .5 2.2 ChE433 heat	DRY WET exchanger W, SEGMENT HOT TUBE Tube SENSIBL	experimen AL BAFFLES SIDE E LIQ	= = at , RATING COLD SH Shell	165.  E0002 P 28 9/23/ 3 CASE 14  HELL SIDE L IBLE LIQ
VELOCITY FT/S . DENSITY LB/FT3 61.2 PRESS. DROP % 3 □□Washington University Young model F302DY4P	30 .29 91 62.366 .5 2.2 ChE433 heat	DRY WET exchanger W, SEGMENT; HOT TUBE Tube	experimen AL BAFFLES SIDE E LIQ	= = at , RATING COLD SH Shell	165.  E0002 P 28 9/23/ 3 CASE 14  HELL SIDE
VELOCITY FT/S . DENSITY LB/FT3 61.2 PRESS. DROP % 3 □□Washington University Young model F302DY4P  SIZE 4- 18 TYPE BEM, MUL	30 .29 91 62.366 .5 2.2 ChE433 heat	DRY WET exchanger W, SEGMENT HOT TUBE Tube SENSIBL	experimen AL BAFFLES SIDE E LIQ	= = at , RATING COLD SH Shell	165.  E0002 P 28 9/23/ 3 CASE 14  HELL SIDE L IBLE LIQ
VELOCITY FT/S . DENSITY LB/FT3 61.2 PRESS. DROP % 3  Washington University Young model F302DY4P  SIZE 4- 18 TYPE BEM, MUL  TOTAL FLOW RATE KLB/H	30 .29 91 62.366 .5 2.2 ChE433 heat TI-PASS FLO	DRY WET  exchanger  W, SEGMENT: HOT TUBE Tube SENSIBLE 1	experimen AL BAFFLES SIDE E LIQ DO OUT	= = = = = = = = = = = = = = = = = = =	165.  E0002 P 28 9/23/ 3 CASE 14  HELL SIDE L IBLE LIQ .700 OUT
VELOCITY FT/S .  DENSITY LB/FT3 61.2  PRESS. DROP % 3  DWashington University  Young model F302DY4P  SIZE 4- 18 TYPE BEM, MUL  TOTAL FLOW RATE KLB/H  TEMPERATURE DEGF	30 .29 91 62.366 .5 2.2 ChE433 heat TI-PASS FLO	DRY WET  exchanger  W, SEGMENT HOT TUBE Tube SENSIBLE .20 IN 140.0	experiment AL BAFFLES SIDE E LIQ DO OUT 56.5*	= = = = = = = = = = = = = = = = = = =	165.  E0002 P 28 9/23/3 CASE 14  HELL SIDE L IBLE LIQ .700 OUT 63.7*
VELOCITY FT/S . DENSITY LB/FT3 61.2 PRESS. DROP % 3 □□Washington University Young model F302DY4P  SIZE 4- 18 TYPE BEM, MUL  TOTAL FLOW RATE KLB/H  TEMPERATURE DEGF DENSITY LB/FT	30 .29 91 62.366 .5 2.2 ChE433 heat TI-PASS FLO	DRY WET  exchanger  W, SEGMENT HOT TUBE Tube SENSIBLE .20 IN 140.0 1.2913 63	experiment AL BAFFLES SIDE E LIQ 00 OUT 56.5* 2.3885	= = = = = = = = = = = = = = = = = = =	165.  E0002 P 28 9/23/ 3 CASE 14  HELL SIDE L IBLE LIQ .700 OUT 63.7* 62.3171
VELOCITY FT/S . DENSITY LB/FT3 61.2 PRESS. DROP % 3 □□Washington University Young model F302DY4P  SIZE 4- 18 TYPE BEM, MUL  TOTAL FLOW RATE KLB/H  TEMPERATURE DEGF DENSITY LB/FT VISCOSITY CP	30 .29 91 62.366 .5 2.2 ChE433 heat TI-PASS FLO	DRY WET  exchanger  W, SEGMENT HOT TUBE Tube SENSIBLE .20 IN 140.0 1.2913 63 .4726	experiment AL BAFFLES SIDE E LIQ 00 OUT 56.5* 2.3885 1.1672	= = = = = = = = = = = = = = = = = = =	165.  E0002 P 28 9/23/ 3 CASE 14  HELL SIDE L IBLE LIQ .700 OUT 63.7* 62.3171 1.0601
VELOCITY FT/S  DENSITY LB/FT3 61.2  PRESS. DROP % 3  □Washington University  Young model F302DY4P  SIZE 4- 18 TYPE BEM, MUL  TOTAL FLOW RATE KLB/H  TEMPERATURE DEGF  DENSITY LB/FT  VISCOSITY CP  SPECIFIC HEAT BTU/L	30 .29 91 62.366 .5 2.2 ChE433 heat TI-PASS FLO R 3 6 B-F	DRY WET  exchanger  W, SEGMENT; HOT TUBE Tube SENSIBL; .2 IN 140.0 1.2913 64726 .9973	experiment AL BAFFLES SIDE E LIQ OO OUT 56.5* 2.3885 1.1672 1.0033	= = = = = = = = = = = = = = = = = = =	165.  E0002 P 28 9/23/3 CASE 14  HELL SIDE LIBLE LIQ .700 OUT 63.7* 62.3171 1.0601 1.0023
VELOCITY FT/S . DENSITY LB/FT3 61.2 PRESS. DROP % 3 □□Washington University Young model F302DY4P  SIZE 4- 18 TYPE BEM, MUL  TOTAL FLOW RATE KLB/H  TEMPERATURE DEGF DENSITY LB/FT VISCOSITY CP SPECIFIC HEAT BTU/L THERMAL COND. BTU/H	30 .29 91 62.366 .5 2.2 ChE433 heat TI-PASS FLO R 3 6 B-F R-FT-F	DRY WET  exchanger  W, SEGMENT; HOT TUBE Tube SENSIBL; .2 IN 140.0 1.2913 64726 .9973	experiment AL BAFFLES SIDE E LIQ 00 OUT 56.5* 2.3885 1.1672	= = = = = = = = = = = = = = = = = = =	165.  E0002 P 28 9/23/3 CASE 14  HELL SIDE L IBLE LIQ .700 OUT 63.7* 62.3171 1.0601 1.0023 .3536
VELOCITY FT/S . DENSITY LB/FT3 61.2 PRESS. DROP % 3 □□Washington University Young model F302DY4P  SIZE 4- 18 TYPE BEM, MUL  TOTAL FLOW RATE KLB/H  TEMPERATURE DEGF DENSITY LB/FT VISCOSITY CP SPECIFIC HEAT BTU/L THERMAL COND. BTU/H	30 .29 91 62.366 .5 2.2 ChE433 heat TI-PASS FLO R 3 6 B-F R-FT-F	DRY WET  exchanger  W, SEGMENT; HOT TUBE Tube SENSIBL; .2 IN 140.0 1.2913 64726 .9973	experiment AL BAFFLES SIDE E LIQ OO OUT 56.5* 2.3885 1.1672 1.0033	= = = = = = = = = = = = = = = = = = =	165.  E0002 P 28 9/23/3 CASE 14  HELL SIDE LIBLE LIQ .700 OUT 63.7* 62.3171 1.0601 1.0023
VELOCITY FT/S  DENSITY LB/FT3 61.2  PRESS. DROP % 3  □ Washington University  Young model F302DY4P  SIZE 4- 18 TYPE BEM, MUL  TOTAL FLOW RATE KLB/H  TEMPERATURE DEGF  DENSITY LB/FT  VISCOSITY CP  SPECIFIC HEAT BTU/L  THERMAL COND. BTU/H	30 .29 91 62.366 .5 2.2 ChE433 heat TI-PASS FLO R 3 6 B-F R-FT-F	DRY WET  exchanger  W, SEGMENT; HOT TUBE Tube SENSIBL; .2 IN 140.0 1.2913 64726 .9973	experiment AL BAFFLES SIDE E LIQ OO OUT 56.5* 2.3885 1.1672 1.0033 .3515	= = = = = = = = = = = = = = = = = = =	165.  E0002 P 28 9/23/3 CASE 14  HELL SIDE L IBLE LIQ .700 OUT 63.7* 62.3171 1.0601 1.0023 .3536
VELOCITY FT/S  DENSITY LB/FT3 61.2  PRESS. DROP % 3  □Washington University  Young model F302DY4P  SIZE 4- 18 TYPE BEM, MUL  TOTAL FLOW RATE KLB/H  TEMPERATURE DEGF  DENSITY LB/FT  VISCOSITY CP  SPECIFIC HEAT BTU/L  THERMAL COND. BTU/H  MOLAR MASS LB/LB	30 .29 91 62.366 .5 2.2 ChE433 heat TI-PASS FLO R 3 6 B-F R-FT-F MOL	DRY WET  exchanger  W, SEGMENT HOT TUBE Tube SENSIBLE .20 IN 140.0 1.2913 6: .4726 .9973 .3723	experiment AL BAFFLES SIDE E LIQ 00 OUT 56.5* 2.3885 1.1672 1.0033 .3515 18.02	= = = = = = = = = = = = = = = = = = =	165.  E0002 P 28 9/23/3 CASE 14  HELL SIDE L IBLE LIQ .700 OUT 63.7* 62.3171 1.0601 1.0023 .3536 18.02
VELOCITY FT/S  DENSITY LB/FT3 61.2  PRESS. DROP % 3  □□Washington University  Young model F302DY4P  SIZE 4- 18 TYPE BEM, MUL  TOTAL FLOW RATE KLB/H  TEMPERATURE DEGF  DENSITY LB/FT  VISCOSITY CP  SPECIFIC HEAT BTU/L  THERMAL COND. BTU/H  MOLAR MASS LB/LB  TEMP, AVG & SKIN D	30 .29 91 62.366 .5 2.2 ChE433 heat TI-PASS FLO  R  3 6 B-F R-FT-F MOL EGF	DRY WET  exchanger  W, SEGMENT HOT TUBE Tube SENSIBLE IN 140.0 1.2913 6: .4726 .9973 .3723	experiment AL BAFFLES SIDE E LIQ 00 OUT 56.5* 2.3885 1.1672 1.0033 .3515 18.02 71.0	= = = = = = = = = = = = = = = = = = =	165.  E0002 P 28 9/23/3 CASE 14  HELL SIDE L IBLE LIQ .700 OUT 63.7* 62.3171 1.0601 1.0023 .3536 18.02 70.0
VELOCITY FT/S  DENSITY LB/FT3 61.2  PRESS. DROP % 3  □□Washington University  Young model F302DY4P  SIZE 4- 18 TYPE BEM, MUL  TOTAL FLOW RATE KLB/H  TEMPERATURE DEGF  DENSITY LB/FT  VISCOSITY CP  SPECIFIC HEAT BTU/L  THERMAL COND. BTU/H  MOLAR MASS LB/LB  TEMP, AVG & SKIN D  VISCOSITY, AVG & SKIN C	30 .29 91 62.366 .5 2.2 ChE433 heat TI-PASS FLO  R  3 6 B-F R-FT-F MOL EGF P	DRY WET  exchanger  W, SEGMENT HOT TUBE Tube SENSIBLE .20 IN 140.0 1.2913 6: .4726 .9973 .3723	experiment AL BAFFLES SIDE E LIQ 00     OUT	= = = = = = = = = = = = = = = = = = =	165.  E0002 P 28 9/23/3 CASE 14  HELL SIDE L IBLE LIQ .700 OUT 63.7* 62.3171 1.0601 1.0023 .3536 18.02 70.0 .9786
VELOCITY FT/S  DENSITY LB/FT3 61.2  PRESS. DROP % 3  □□Washington University  Young model F302DY4P  SIZE 4- 18 TYPE BEM, MUL  TOTAL FLOW RATE KLB/H  TEMPERATURE DEGF  DENSITY LB/FT  VISCOSITY CP  SPECIFIC HEAT BTU/L  THERMAL COND. BTU/H  MOLAR MASS LB/LB  TEMP, AVG & SKIN D	30 .29 91 62.366 .5 2.2 ChE433 heat TI-PASS FLO  R  3 6 B-F R-FT-F MOL EGF P	DRY WET  exchanger  W, SEGMENT HOT TUBE Tube SENSIBLE IN 140.0 1.2913 6: .4726 .9973 .3723	experiment AL BAFFLES SIDE E LIQ 00     OUT	= = = = = = = = = = = = = = = = = = =	165.  E0002 P 28 9/23/3 CASE 14  HELL SIDE L IBLE LIQ .700 OUT 63.7* 62.3171 1.0601 1.0023 .3536 18.02 70.0 .9786
VELOCITY FT/S  DENSITY LB/FT3 61.2  PRESS. DROP % 3  □ Washington University  Young model F302DY4P  SIZE 4- 18 TYPE BEM, MUL  TOTAL FLOW RATE KLB/H  TEMPERATURE DEGF  DENSITY LB/FT  VISCOSITY CP  SPECIFIC HEAT BTU/L  THERMAL COND. BTU/H  MOLAR MASS LB/LB  TEMP, AVG & SKIN D  VISCOSITY, AVG & SKIN C  PRESSURE, IN & DESIGN P	30 .29 91 62.366 .5 2.2 ChE433 heat TI-PASS FLO  R  3 6 B-F R-FT-F MOL EGF P SIA	DRY WET  exchanger  W, SEGMENT HOT TUBE Tube SENSIBLI .2 IN 140.0 1.2913 63 .4726 .9973 .3723  98.3 .7047 50.00	experiment AL BAFFLES SIDE E LIQ 00     OUT	= = = = = = = = = = = = = = = = = = =	165.  E0002 P 28 9/23/3 CASE 14  HELL SIDE LIBLE LIQ .700 OUT 63.7* 62.3171 1.0601 1.0023 .3536 18.02 70.0 .9786 165.00
VELOCITY FT/S  DENSITY LB/FT3 61.2  PRESS. DROP % 3  □□Washington University  Young model F302DY4P  SIZE 4- 18 TYPE BEM, MUL  TOTAL FLOW RATE KLB/H  TEMPERATURE DEGF  DENSITY LB/FT  VISCOSITY CP  SPECIFIC HEAT BTU/L  THERMAL COND. BTU/H  MOLAR MASS LB/LB  TEMP, AVG & SKIN D  VISCOSITY, AVG & SKIN C	30 .29 91 62.366 .5 2.2 ChE433 heat TI-PASS FLO  R  3 6 B-F R-FT-F MOL EGF P SIA	DRY WET  exchanger  W, SEGMENT HOT TUBE Tube SENSIBLI .2 IN 140.0 1.2913 63 .4726 .9973 .3723  98.3 .7047 50.00	experiment AL BAFFLES SIDE E LIQ 00     OUT	= = = = = = = = = = = = = = = = = = =	165.  E0002 P 28 9/23/3 CASE 14  HELL SIDE L IBLE LIQ .700 OUT 63.7* 62.3171 1.0601 1.0023 .3536 18.02 70.0 .9786
VELOCITY FT/S  DENSITY LB/FT3 61.2  PRESS. DROP % 3  □ Washington University  Young model F302DY4P  SIZE 4- 18 TYPE BEM, MUL  TOTAL FLOW RATE KLB/H  TEMPERATURE DEGF  DENSITY LB/FT  VISCOSITY CP  SPECIFIC HEAT BTU/L  THERMAL COND. BTU/H  MOLAR MASS LB/LB  TEMP, AVG & SKIN D  VISCOSITY, AVG & SKIN C  PRESSURE, IN & DESIGN P	30 .29 91 62.366 .5 2.2 ChE433 heat TI-PASS FLO  R  3 6 B-F R-FT-F MOL EGF P SIA OWED PSI	DRY WET  exchanger  W, SEGMENTA HOT TUBE Tube SENSIBLI .2 IN 140.0 1.2913 63 .4726 .9973 .3723 98.3 .7047 50.00 .02	experiment AL BAFFLES SIDE E LIQ 00 OUT 56.5* 2.3885 1.1672 1.0033 .3515 18.02 71.0 .9662 165.00	= = = = = = = = = = = = = = = = = = =	165.  E0002 P 28 9/23/3 CASE 14  HELL SIDE LIBLE LIQ .700 OUT 63.7* 62.3171 1.0601 1.0023 .3536 18.02 70.0 .9786 165.00

FOULING RESISTANCE HR-FT2-F/E FILM COEFFICIENT BTU/HR-FT2		.00010 247.22
TOTAL HEAT DUTY REQUIRED MEGBTU/F EFF TEMP DIF, DEGF (LMTD= 39.1, F OVERALL COEFF REQUIRED BTU/HR-F CLEAN & FOULED COEFF BTU/HR-F	F= .65,BYPASS= .93,BAFF=1.00)	.016677 23.8 97.90 97.67
SHELLS IN SERIES 1 PARALLEL 1 PASSES, SHELL 1 TUBE 4 SHELL DIAMETER IN. 3.820	EFFECTIVE AREA FT2/SHELI	7.1
BAFFLE TYPE HORZ SEGMENTL SPACING, CENTRAL IN. 4.309 SPACING, INLET IN. 4.309 SPACING, OUTLET IN. 4.309 BAFFLE THICKNESS IN125	BAFFLE CUT, PCT SHELL I.D. CUT DISTANCE FROM CENTER, IN.	30.00
PAIRS OF SEALING DEVICES 1		
TUBE TYPE PLAIN  NO. OF TUBES/SHELL 76  TUBE LGTH, OVERALL FT 1.500  TUBE LGTH, EFF FT 1.436  TUBE LAYOUT DEG 60  PITCH RATIO 1.250  SHL NOZZ ID, IN&OUT 1.0	TUBE PITCH IN.  TUBE OUTSIDE DIAM IN.  TUBE INSIDE DIAM IN.  TUBE SURFACE RATIO, OUT/IN	36 .3125 .250 .214 1.184
* CALCULATED ITEMHEAT BALANCE UNWashington University ChE433 he Young model F302DY4P	eat exchanger experiment	9/23/ 3
S II D D I. F M F N T A	R V R F S II I. T S	CASE 14
S U P P L E M E N T A  HT PARAMETERS SHELL TUBE WALL CORRECTION 1.034 .000 PRANDTL NUMBER 8.6 4.7	SHELLSIDE PERFORMANCE NOMINAL VEL,X-FLOW FT/S	.09
HT PARAMETERS SHELL TUBE WALL CORRECTION 1.034 .000 PRANDTL NUMBER 8.6 4.7 RYNLD NO, AVG 212. 447. RYNLD NO, IN BUN 178. 667. RYNLD NO,OUT BUN 249. 270.	SHELLSIDE PERFORMANCE NOMINAL VEL,X-FLOW FT/S NOMINAL VEL,WINDOW FT/S CROSSFLOW COEF BTU/HR-FT2 WINDOW COEF BTU/HR-FT2	.09 .18 2-F 248.2 2-F 249.8
HT PARAMETERS SHELL TUBE WALL CORRECTION 1.034 .000 PRANDTL NUMBER 8.6 4.7 RYNLD NO, AVG 212. 447. RYNLD NO, IN BUN 178. 667. RYNLD NO,OUT BUN 249. 270. FOULNG LAYER IN0014 .0014 THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL 39.06 58.75 2.12 .07	SHELLSIDE PERFORMANCE NOMINAL VEL, X-FLOW FT/S NOMINAL VEL, WINDOW FT/S CROSSFLOW COEF BTU/HR-FT2 WINDOW COEF BTU/HR-FT2 SHELLSIDE FLOW, % OF TOTA HEAT TRANSFER X-FLOW TUBE TO BAFFLE LEAKAGE MAIN CROSSFLOW BUNDLE TO SHELL BYPASS	.09 .18 2-F 248.2 2-F 249.8 AL 81.54 A = 3.26 B = 66.93 C = 13.96
HT PARAMETERS SHELL TUBE WALL CORRECTION 1.034 .000 PRANDTL NUMBER 8.6 4.7 RYNLD NO, AVG 212. 447. RYNLD NO, IN BUN 178. 667. RYNLD NO,OUT BUN 249. 270. FOULNG LAYER IN0014 .0014 THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL	SHELLSIDE PERFORMANCE NOMINAL VEL, X-FLOW FT/S NOMINAL VEL, WINDOW FT/S CROSSFLOW COEF BTU/HR-FT2 WINDOW COEF BTU/HR-FT2 SHELLSIDE FLOW, % OF TOTA HEAT TRANSFER X-FLOW TUBE TO BAFFLE LEAKAGE A MAIN CROSSFLOW BUNDLE TO SHELL BYPASS CO BAFFLE TO SHELL LEAKAGE F TUBE PASSLANE BYPASS F	.09 .18 2-F 248.2 2-F 249.8 AL 81.54 A = 3.26 B = 66.93 C = 13.96 E = 15.86 F = .00

SHELL NOZZLE DAT HT UNDR NOZ IN. HT OPP NOZ IN. VELOCITY FT/S DENSITY LB/FT3 NOZZ RHO*VSQ LB/FT BUND RHO*VSQ LB/FT	.25 .57 .57 62.535 62.317 -s2 20 20	WINDOW END ZON CROSS E INLET N	NE FLOW NOZZLE		= 8.9 = 4.5 = 3.8 = 42.2
TUBE NOZZLE DATA VELOCITY FT/S DENSITY LB/FT3 PRESS. DROP %  UWashington Unive Young model F302DY	61.291 62.388 3.5 2.2 rsity ChE433 heat	DRY WET		=	E0002 P 30 9/23/ 3
SIZE 4- 18 TYPE BE	M, MULTI-PASS FLO	HOT TU	ENTAL BAFFLE JBE SIDE IBLE LIQ	COLD SE	HELL SIDE
TOTAL FLOW RATE	KLB/HR	SENSI	.200	SENSI	.800
		IN	.200 OUT	IN	OUT
TEMPERATURE	DEGF	140.0	54.7*	40.0	61.2*
DENSITY	LB/FT3 6				
VISCOSITY				1.4791	
SPECIFIC HEAT	BTU/LB-F	.9973	1.0035	1.0058	1.0026
THERMAL COND.	BTU/HR-FT-F	.3723	.3510	.3466	.3529
MOLAR MASS	LB/LBMOL		18.02		18.02
TEMP, AVG & SKIN	DEGF				
VISCOSITY, AVG & S	KIN CP	.7117	.9907	1.2670	1.0040
PRESSURE, IN & DES	IGN PSIA	50.00	165.00	50.00	165.00
PRESSURE DROP, TOT	C ALLOWED DOL	0.2	10 00	0.1	10.00
VELOCITY, CALC & M	AX ALLOWED FT/S	.19	10.00	.12	
FOULING RESISTANCE FILM COEFFICIENT	HR-FT2-F/BTU	.(	00010	. (	00010
FILM COEFFICIENT					58.41
	OUTDED MECDEU/UD				017042
TOTAL HEAT DUTY RE EFF TEMP DIF, DEGF		CC DVD7	NGG- 02 DAT	3E-1 00)	.017043
OVERALL COEFF REQU			ASS93, BAI	F-1.00)	101.19
CLEAN & FOULED COE			102 47	-	
CLEAN & FOOTED COE	FF BTU/HR-FT2	:-r	103.46	)	100.80
SHELLS IN SERIES	1 PARALLEL 1 T	OTAL EFF	F AREA	FT2	7.1
PASSES, SHELL	1 TUBE 4 E	EFFECTIVE	E AREA	FT2/SHELL	7.1
SHELL DIAMETER IN.					
BAFFLE TYPE H	OD7 SECMENTET C	ים פפ חזים	ממבס סבס מווי	מסגם דד	Л
SPACING, CENTRAL					
SPACING, CENTRAL SPACING, INLET	IN 4.309 E	יחד חדפשי	NCE EDOM CE	את בס דעו יר דיהי	761
SPACING, OUTLET	TN 4.309 C	OI DISIF	THOE PROPERTY	114 T TT/, TIV.	. / 04
BAFFLE THICKNESS	TN 105 7	MDTNICENT	י סזטטאס חואק	ואכו ווספס	NO
PULLUD INTCINESS	11v TCJ 1		ייי העננות ד	עהמטייי	110

SHELLSIDE HEAT TRANSFER FACTORS DIAMETRAL CLEARANCES TOTAL = (BETA) (GAMMA) (FIN) = .661DIAMETRAL CLEARANCES

BUNDLE TO SHELL

IN. .5000

BETA (BAFF CUT FACTOR) = .920

TUBE TO BAFFLE HOLE IN. .0284

GAMMA (TUBE ROW ENTRY EFCT) = .719

BAFFLE TO SHELL

IN. .1000

END (HT LOSS IN END ZONE) = .994

SHELL NOZZLE DATA IN OUT SHELL PRESSURE DROP, % OF TOTAL HT UNDR NOZ IN. .25 WINDOW = 8 HT OPP NOZ IN. .25 END ZONE = 4 VELOCITY FT/S .65 .65 CROSS FLOW = 3 4.2 DENSITY LB/FT3 62.535 62.342 INLET NOZZLE NOZZ RHO*VSQ LB/FT-S2 26 26 OUTLET NOZZLE BUND RHO*VSQ LB/FT-S2 18 18

TUBE NOZZLE DATA IN OUT WEIGHT PER SHELL, LB VELOCITY FT/S .30 .29 DRY 150. DENSITY LB/FT3 61.291 62.406 WET 165. PRESS. DROP % 3.4 2.1

□□Washington University ChE433 heat exchanger experiment E0002 P 32 Young model F302DY4P 9/23/ 3 CASE 16

SIZE 4- 18 TYPE BEM, MULTI-PASS FLOW, SEGMENTAL BAFFLES, RATING HOT TUBE SIDE COLD SHELL SIDE

			40).OUT		
				Shell	
		SENSI	BLE LIQ	SENS	IBLE LIQ
TOTAL FLOW RATE	KLB/HR		- 200		900
TOTAL FLOW RATE	1122/ 1111	TNI	OTIT	TM	OIIT
	DUCE	1.40.0	E2 2+	10 0	E0 2+
TEMPERATURE					
DENSITY					
VISCOSITY	CP	.4726	1.2202	1.4791	1.1262
SPECIFIC HEAT	BTU/LB-F	.9973	1.0037	1.0058	1.0029
THERMAL COND.					
MOLAR MASS			18.02		18.02
MOLAR MASS	LB/ LBMOL		10.02		
TEMP, AVG & SKIN	DEGF				
VISCOSITY, AVG & S	SKIN CP	.7170	1.0120	1.2855	1.0263
PRESSURE, IN & DES					
INDSOND, IN & DEL	JION ISIA	30.00	103.00	30.00	103.00
PRESSURE DROP, TO	r & ALLOWED PSI	.02	10.00	.02	10.00
VELOCITY, CALC & N	MAX ALLOWED FT/	'S .19	10.00	.14	10.00
FOULING RESISTANCE	E HR-FT2-F/E	BTU .(	00010	. (	00010
FILM COEFFICIENT	BTU/HR-FT2	2-F 19	97.02	28	89.32
TOTAL HEAT DUTY RE	-				.017322
EFF TEMP DIF, DEGI	F (LMTD= $37.4$ , F	r = .67, BYPA	ASS= .93,BA	FF=1.00)	23.5
OVERALL COEFF REQU	JIRED BTU/HR-F	TT2-F			103.28
CLEAN & FOULED COR			106 4	6	
CHEIN & LOOPED COL	DIO/III I	12 1	100.1	O	100.02
SHELLS IN SERIES	1 PARALLEL 1	TOTAL EF	F AREA	FT2	7.1
PASSES, SHELL					
SHELL DIAMETER IN			LL TYPE E		
SHELL DIAMETER IN.	. 3.020	THIM SILLI	111111111111111111111111111111111111111	, IVEAIV III	EAD FAID
BAFFLE TYPE I	HORZ SEGMENTL	CROSS PAS	SSES PER SHI	ELL PASS	4
BAFFLE TYPE F					
SPACING, CENTRAL	IN. 4.309	BAFFLE CU	JT, PCT SHE	LL I.D.	30.00
SPACING, CENTRAL SPACING, INLET	IN. 4.309 IN. 4.309	BAFFLE CU		LL I.D.	30.00
SPACING, CENTRAL SPACING, INLET SPACING, OUTLET	IN. 4.309 IN. 4.309 IN. 4.309	BAFFLE CUCUT DISTA	JT, PCT SHE: ANCE FROM C	LL I.D. ENTER, IN.	30.00 .764
SPACING, CENTRAL SPACING, INLET SPACING, OUTLET BAFFLE THICKNESS	IN. 4.309 IN. 4.309 IN. 4.309 IN125	BAFFLE CUCUT DISTA	JT, PCT SHE	LL I.D. ENTER, IN.	30.00 .764
SPACING, CENTRAL SPACING, INLET SPACING, OUTLET	IN. 4.309 IN. 4.309 IN. 4.309 IN125	BAFFLE CUCUT DISTA	JT, PCT SHE: ANCE FROM C	LL I.D. ENTER, IN.	30.00 .764 NO
SPACING, CENTRAL SPACING, INLET SPACING, OUTLET BAFFLE THICKNESS PAIRS OF SEALING I	IN. 4.309 IN. 4.309 IN. 4.309 IN125 DEVICES 1	BAFFLE CUCUT DISTA	JT, PCT SHE ANCE FROM CI ENT BAFFLE :	LL I.D. ENTER, IN. INCLUDED	30.00 .764 NO .0
SPACING, CENTRAL SPACING, INLET SPACING, OUTLET BAFFLE THICKNESS PAIRS OF SEALING I	IN. 4.309 IN. 4.309 IN. 4.309 IN125 DEVICES 1	BAFFLE CUCUT DISTAINED IMPINGEMENTUBESHEED	JT, PCT SHE: ANCE FROM CI ENT BAFFLE : F BLANK ARE	LL I.D. ENTER, IN. INCLUDED	30.00 .764 NO .0
SPACING, CENTRAL SPACING, INLET SPACING, OUTLET BAFFLE THICKNESS PAIRS OF SEALING ITUBE TYPE NO. OF TUBES/SHELI	IN. 4.309 IN. 4.309 IN. 4.309 IN125 DEVICES 1 PLAIN 76	BAFFLE CUCUT DISTALL IMPINGEMENTUBESHEED MATERIAL EST MAX 1	JT, PCT SHE ANCE FROM CI ENT BAFFLE :	LL I.D. ENTER, IN. INCLUDED A, % LECTROLYTIC	30.00 .764 NO .0 C COPPER 36
SPACING, CENTRAL SPACING, INLET SPACING, OUTLET BAFFLE THICKNESS PAIRS OF SEALING I	IN. 4.309 IN. 4.309 IN. 4.309 IN125 DEVICES 1 PLAIN 76	BAFFLE CUCUT DISTALL IMPINGEMENTUBESHEED MATERIAL EST MAX 1	JT, PCT SHE: ANCE FROM CI ENT BAFFLE: BLANK ARE: E: TUBE COUNT	LL I.D. ENTER, IN. INCLUDED A, % LECTROLYTIC	30.00 .764 NO .0
SPACING, CENTRAL SPACING, INLET SPACING, OUTLET BAFFLE THICKNESS PAIRS OF SEALING I TUBE TYPE NO. OF TUBES/SHELI TUBE LGTH, OVERALI	IN. 4.309 IN. 4.309 IN. 4.309 IN125 DEVICES 1  PLAIN 76 L FT 1.500	BAFFLE CUCUT DISTALL IMPINGEMENTUBESHEET MATERIAL EST MAX TUBE PITC	JT, PCT SHE: ANCE FROM CI ENT BAFFLE : BLANK ARE: TUBE COUNT	LL I.D. ENTER, IN. INCLUDED A, % LECTROLYTIC IN.	30.00 .764 NO .0 C COPPER 36 .3125
SPACING, CENTRAL SPACING, INLET SPACING, OUTLET BAFFLE THICKNESS PAIRS OF SEALING I  TUBE TYPE NO. OF TUBES/SHELI TUBE LGTH, OVERALI TUBE LGTH, EFF	IN. 4.309 IN. 4.309 IN. 4.309 IN125 DEVICES 1  PLAIN 76 L FT 1.500 FT 1.436	BAFFLE CUCUT DISTALL IMPINGEMENTUBESHEET MATERIAL EST MAX TUBE PITCUBE OUTS	JT, PCT SHE: ANCE FROM CI ENT BAFFLE : F BLANK ARE: FUBE COUNT CH SIDE DIAM	LL I.D. ENTER, IN. INCLUDED A, % LECTROLYTIC IN. IN.	30.00 .764 NO .0 C COPPER 36 .3125 .250
SPACING, CENTRAL SPACING, INLET SPACING, OUTLET BAFFLE THICKNESS PAIRS OF SEALING I  TUBE TYPE NO. OF TUBES/SHELI TUBE LGTH, OVERALI TUBE LGTH, EFF TUBE LAYOUT	IN. 4.309 IN. 4.309 IN. 4.309 IN125 DEVICES 1  PLAIN 76 FT 1.500 FT 1.436 DEG 60	BAFFLE CUCUT DISTALL IMPINGEMENTUBESHEET MATERIAL EST MAX TUBE PITO TUBE OUTS TUBE INST	JT, PCT SHE: ANCE FROM CI ENT BAFFLE : BLANK ARE: CUBE COUNT CH SIDE DIAM IDE DIAM	LL I.D. ENTER, IN. INCLUDED A, % LECTROLYTIC IN. IN. IN.	30.00 .764 NO .0 C COPPER 36 .3125 .250 .214
SPACING, CENTRAL SPACING, INLET SPACING, OUTLET BAFFLE THICKNESS PAIRS OF SEALING I  TUBE TYPE NO. OF TUBES/SHELI TUBE LGTH, OVERALI TUBE LGTH, EFF TUBE LAYOUT PITCH RATIO	IN. 4.309 IN. 4.309 IN125 DEVICES 1  PLAIN 76 FT 1.500 FT 1.436 DEG 60 1.250	BAFFLE CUCUT DISTALL IMPINGEMENTUBESHEES  MATERIAL EST MAX STUBE PITCUBE OUTS TUBE INSSTUBE SURE	UT, PCT SHEE ANCE FROM CO ENT BAFFLE ENT BLANK ARE FUBE COUNT CH SIDE DIAM IDE DIAM FACE RATIO,	LL I.D. ENTER, IN. INCLUDED A, % LECTROLYTIC IN. IN. IN. OUT/IN	30.00 .764 NO .0 C COPPER 36 .3125 .250 .214 1.184
SPACING, CENTRAL SPACING, INLET SPACING, OUTLET BAFFLE THICKNESS PAIRS OF SEALING I  TUBE TYPE NO. OF TUBES/SHELI TUBE LGTH, OVERALI TUBE LGTH, EFF TUBE LAYOUT	IN. 4.309 IN. 4.309 IN125 DEVICES 1  PLAIN 76 FT 1.500 FT 1.436 DEG 60 1.250	BAFFLE CUCUT DISTALL IMPINGEMENTUBESHEES  MATERIAL EST MAX STUBE PITCUBE OUTS TUBE INSSTUBE SURE	UT, PCT SHEE ANCE FROM CO ENT BAFFLE ENT BLANK ARE FUBE COUNT CH SIDE DIAM IDE DIAM FACE RATIO,	LL I.D. ENTER, IN. INCLUDED A, % LECTROLYTIC IN. IN. IN. OUT/IN	30.00 .764 NO .0 C COPPER 36 .3125 .250 .214 1.184
SPACING, CENTRAL SPACING, INLET SPACING, OUTLET BAFFLE THICKNESS PAIRS OF SEALING I  TUBE TYPE NO. OF TUBES/SHELI TUBE LGTH, OVERALI TUBE LGTH, EFF TUBE LAYOUT PITCH RATIO SHL NOZZ ID, IN&OU	IN. 4.309 IN. 4.309 IN. 4.309 IN125 DEVICES 1  PLAIN 76 L FT 1.500 FT 1.436 DEG 60 1.250 JT 1.0 1.0	BAFFLE CUCUT DISTAL  IMPINGEME TUBESHEET  MATERIAL EST MAX TUBE PITO TUBE OUTS TUBE INST	UT, PCT SHEE ANCE FROM CO ENT BAFFLE ENT BLANK ARE FUBE COUNT CH SIDE DIAM IDE DIAM FACE RATIO,	LL I.D. ENTER, IN. INCLUDED A, % LECTROLYTIC IN. IN. IN. OUT/IN	30.00 .764 NO .0 C COPPER 36 .3125 .250 .214 1.184
SPACING, CENTRAL SPACING, INLET SPACING, OUTLET BAFFLE THICKNESS PAIRS OF SEALING I  TUBE TYPE NO. OF TUBES/SHELI TUBE LGTH, OVERALI TUBE LGTH, EFF TUBE LAYOUT PITCH RATIO SHL NOZZ ID, IN&OU  * CALCULATED ITE	IN. 4.309 IN. 4.309 IN. 4.309 IN125 DEVICES 1  PLAIN 76 L FT 1.500 FT 1.436 DEG 60 1.250 JT 1.0 1.0	BAFFLE CUCUT DISTAL  IMPINGEME TUBESHEET  MATERIAL EST MAX TUBE PITO TUBE OUTS TUBE INST	JT, PCT SHE: ANCE FROM CI ENT BAFFLE : BLANK ARE: TUBE COUNT CH SIDE DIAM IDE DIAM FACE RATIO, Z ID, IN&OUT	LL I.D. ENTER, IN. INCLUDED A, % LECTROLYTIC IN. IN. IN. OUT/IN I IN.	30.00 .764 NO .0 C COPPER 36 .3125 .250 .214 1.184
SPACING, CENTRAL SPACING, INLET SPACING, OUTLET BAFFLE THICKNESS PAIRS OF SEALING I  TUBE TYPE NO. OF TUBES/SHELI TUBE LGTH, OVERALI TUBE LGTH, EFF TUBE LAYOUT PITCH RATIO SHL NOZZ ID, IN&OU  * CALCULATED ITE GOWASHINGTON UNIVERSALI *** ** ** ** ** ** ** ** ** ** ** ** *	IN. 4.309 IN. 4.309 IN. 4.309 IN125 DEVICES 1  PLAIN 76 FT 1.500 FT 1.436 DEG 60 1.250 JT 1.0 1.0  EMHEAT BALANCE ersity ChE433 he	BAFFLE CUCUT DISTAL  IMPINGEME TUBESHEET  MATERIAL EST MAX TUBE PITO TUBE OUTS TUBE INST	JT, PCT SHE: ANCE FROM CI ENT BAFFLE : BLANK ARE: TUBE COUNT CH SIDE DIAM IDE DIAM FACE RATIO, Z ID, IN&OUT	LL I.D. ENTER, IN. INCLUDED A, % LECTROLYTIC IN. IN. IN. OUT/IN I IN.	30.00 .764 NO .0 C COPPER 36 .3125 .250 .214 1.184 .8 .8
SPACING, CENTRAL SPACING, INLET SPACING, OUTLET BAFFLE THICKNESS PAIRS OF SEALING I  TUBE TYPE NO. OF TUBES/SHELI TUBE LGTH, OVERALI TUBE LGTH, EFF TUBE LAYOUT PITCH RATIO SHL NOZZ ID, IN&OU  * CALCULATED ITE	IN. 4.309 IN. 4.309 IN. 4.309 IN125 DEVICES 1  PLAIN 76 FT 1.500 FT 1.436 DEG 60 1.250 JT 1.0 1.0  EMHEAT BALANCE ersity ChE433 he	BAFFLE CUCUT DISTAL  IMPINGEME TUBESHEET  MATERIAL EST MAX TUBE PITO TUBE OUTS TUBE INST	JT, PCT SHE: ANCE FROM CI ENT BAFFLE : BLANK ARE: TUBE COUNT CH SIDE DIAM IDE DIAM FACE RATIO, Z ID, IN&OUT	LL I.D. ENTER, IN. INCLUDED A, % LECTROLYTIC IN. IN. IN. OUT/IN I IN.	30.00 .764 NO .0 C COPPER 36 .3125 .250 .214 1.184 .8 .8
SPACING, CENTRAL SPACING, INLET SPACING, OUTLET BAFFLE THICKNESS PAIRS OF SEALING I  TUBE TYPE NO. OF TUBES/SHELI TUBE LGTH, OVERALI TUBE LGTH, EFF TUBE LAYOUT PITCH RATIO SHL NOZZ ID, IN&OU  * CALCULATED ITE GOWASHINGTON UNIVERSALI *** ** ** ** ** ** ** ** ** ** ** ** *	IN. 4.309 IN. 4.309 IN. 4.309 IN125 DEVICES 1  PLAIN 76 FT 1.500 FT 1.436 DEG 60 1.250 JT 1.0 1.0  EMHEAT BALANCE ersity ChE433 he	BAFFLE CUCUT DISTAL  IMPINGEME TUBESHEET  MATERIAL EST MAX TUBE PITO TUBE OUTS TUBE INST	JT, PCT SHE: ANCE FROM CI ENT BAFFLE : BLANK ARE: TUBE COUNT CH SIDE DIAM IDE DIAM FACE RATIO, Z ID, IN&OUT	LL I.D. ENTER, IN. INCLUDED A, % LECTROLYTIC IN. IN. IN. OUT/IN I IN.	30.00 .764 NO .0 C COPPER 36 .3125 .250 .214 1.184 .8 .8
SPACING, CENTRAL SPACING, INLET SPACING, OUTLET BAFFLE THICKNESS PAIRS OF SEALING I  TUBE TYPE NO. OF TUBES/SHELI TUBE LGTH, OVERALI TUBE LGTH, EFF TUBE LAYOUT PITCH RATIO SHL NOZZ ID, IN&OU  * CALCULATED ITE GOWASHINGTON UNIVERSALI *** ** ** ** ** ** ** ** ** ** ** ** *	IN. 4.309 IN. 4.309 IN. 4.309 IN. 125 DEVICES 1  PLAIN To 76 To FT 1.500 FT 1.436 DEG 60 1.250 JT 1.0 1.0  EMHEAT BALANCE ersity ChE433 here	BAFFLE CUCUT DISTAL  IMPINGEME TUBESHEET  MATERIAL EST MAX TUBE PITO TUBE OUTS TUBE INST TUBE SURE TUBE NOZZ	JT, PCT SHE: ANCE FROM CI ENT BAFFLE: F BLANK ARE: FUBE COUNT CH SIDE DIAM IDE DIAM FACE RATIO, Z ID, IN&OU'	LL I.D. ENTER, IN. INCLUDED A, %  LECTROLYTIC IN. IN. OUT/IN I IN. ent	30.00 .764 NO .0 C COPPER 36 .3125 .250 .214 1.184 .8 .8
SPACING, CENTRAL SPACING, INLET SPACING, OUTLET BAFFLE THICKNESS PAIRS OF SEALING INTUBE TYPE NO. OF TUBES/SHELITUBE LGTH, OVERALITUBE LGTH, EFF TUBE LAYOUT PITCH RATIO SHL NOZZ ID, IN&OUT * CALCULATED ITE Washington University oung model F302D	IN. 4.309 IN. 4.309 IN. 4.309 IN. 125 DEVICES 1  PLAIN To 76 To FT 1.500 FT 1.436 DEG 60 1.250 JT 1.0 1.0  EMHEAT BALANCE ersity ChE433 here	BAFFLE CUCUT DISTAL  IMPINGEMENTUBESHEET  MATERIAL EST MAX TOBE PITO TUBE OUTS TUBE INST TUBE SURF TUBE NOZZ	JT, PCT SHE: ANCE FROM CI ENT BAFFLE: F BLANK ARE: FUBE COUNT CH SIDE DIAM IDE DIAM FACE RATIO, Z ID, IN&OU'	LL I.D. ENTER, IN. INCLUDED A, %  LECTROLYTIC IN. IN. OUT/IN I IN. ent	30.00 .764 NO .0 C COPPER 36 .3125 .250 .214 1.184 .8 .8
SPACING, CENTRAL SPACING, INLET SPACING, OUTLET BAFFLE THICKNESS PAIRS OF SEALING INTUBE TYPE NO. OF TUBES/SHELITUBE LGTH, OVERALITUBE LGTH, EFF TUBE LAYOUT PITCH RATIO SHL NOZZ ID, IN&OUT * CALCULATED ITE Washington University oung model F302D	IN. 4.309 IN. 4.309 IN. 4.309 IN125 DEVICES 1  PLAIN 76 L FT 1.500 FT 1.436 DEG 60 1.250 JT 1.0 1.0  EMHEAT BALANCE ersity ChE433 he 44P  M E N T A	BAFFLE CUCUT DISTAL  IMPINGEME TUBESHEET  MATERIAL EST MAX TUBE PITO TUBE OUTS TUBE INST TUBE SURE TUBE NOZZ  CODE = 8 eat exchange  R Y E	JT, PCT SHE: ANCE FROM CI ENT BAFFLE: F BLANK ARE: FUBE COUNT CH SIDE DIAM IDE DIAM FACE RATIO, Z ID, IN&OU'	LL I.D. ENTER, IN. INCLUDED A, % LECTROLYTIC IN. IN. OUT/IN I IN. ent L T S	30.00 .764 NO .0 C COPPER 36 .3125 .250 .214 1.184 .8 .8
SPACING, CENTRAL SPACING, INLET SPACING, OUTLET BAFFLE THICKNESS PAIRS OF SEALING I  TUBE TYPE NO. OF TUBES/SHELI TUBE LGTH, OVERALI TUBE LGTH, EFF TUBE LAYOUT PITCH RATIO SHL NOZZ ID, IN&OU  * CALCULATED ITE \[ \text{\text{\text{Washington Unive}}}\) Young model F302DY  S U P P L E	IN. 4.309 IN. 4.309 IN. 4.309 IN. 125 DEVICES 1  PLAIN 76 FT 1.500 FT 1.436 DEG 60 1.250 JT 1.0 1.0  EMHEAT BALANCE PERSITY ChE433 here 74P  M E N T A  SHELL TUBE	BAFFLE CUCUT DISTAL  IMPINGEME TUBESHEET  MATERIAL EST MAX TUBE PITO TUBE OUTS TUBE INST TUBE NOZZ  CODE = 8 eat exchange  R Y F	JT, PCT SHE: ANCE FROM CI ENT BAFFLE: BLANK ARE: TUBE COUNT CH SIDE DIAM IDE DIAM FACE RATIO, Z ID, IN&OUT	LL I.D. ENTER, IN. INCLUDED A, % LECTROLYTIC IN. IN. OUT/IN I IN. ent L T S RMANCE	30.00 .764 NO .0 C COPPER 36 .3125 .250 .214 1.184 .8 .8

			cne433b(			
PRANDTL NUMBER	8.9	4.8	NOMINAI	L VEL, WINDO	W FT/S	.23
RYNLD NO, AVG			CROSSFI	LOW COEF	BTU/HR-FT2	-F 290.5
RYNLD NO, IN BUN	229	667	WINDOM	COEE	BTII/HR-FT2	-F 292 3
DVNID NO OUT DIN	301	250	WINDOW		D10/1110 112	1 232.0
RYNLD NO, OUT BUN	301.	200.	OHET T	CIDE FION	0 00 000	<del>-</del>
FOULNG LAYER IN.	.0014	.0014	SHELL	SIDE FLOW,	% OF TOTA.	Li
				RANSFER X-F	LOW	81.54
THERMAL RESISTANCE	, % OF T	OTAL	TUBE TO	BAFFLE LE	AKAGE A	= 3.52
SHELL TUBE FOU	LING ME	TAL	MAIN CF	ROSSFLOW	В	= 65.71
35.41 62.27 2	.25	.07	BUNDLE	TO SHELL B	YPASS C	= 15.12
PCT OVER DESIGN		.33	BAFFLE	TO SHELL L	EAKAGE E	= 15.64
PCT OVER DESIGN TOT FOUL RESIST		000217	TUBE PA	ASSLANE BYP	ASS F	= .00
DIFF RESIST						
			CHETT	SIDE HEAT	TONICEED E	л СПОВС
DIAMETRAL CLEARA BUNDLE TO SHELL	MODO		SUFTI	OLDE VEWI	IKANSEEK E	ACIORS
DIAMETRAL CLEARA	INCES	= 0 0 0	TOTAL =	=(BETA)(GAM	MA) (FIN)	= .6/5
BUNDLE TO SHELL	IN.	.5000	BETA	(BAFF CUT F.	ACTOR)	= .920
TUBE TO BAFFLE HOL						
BAFFLE TO SHELL	IN.	.1000	END	(HT LOSS IN		
SHELL NOZZLE DAT	'A IN	OUT	SHELI	PRESSURE	DROP, % OF	TOTAL = 8.9 = 4.0 = 3.5 = 42.4 = 41.3
HT UNDR NOZ IN.	.25		WINDOW			= 8.9
HT OPP NOZ IN.	. 25		END ZON	JF.		= 4.0
VELOCITY FT/S				 TI.OW		= 3.5
DENSITY LB/FT3				IOVIE		- 42.4
				NORRER		- 42.4
NOZZ RHO*VSQ LB/FT			OOLTEL	NOZZLŁ		= 41.3
BUND RHO*VSQ LB/FT	'-S2 22	22				
TUBE NOZZLE DATA	IN	OUT	WEIGH	IT PER SHEL	L, LB	
TUBE NOZZLE DATA VELOCITY FT/S	.30	.29	DRY	IT PER SHEL	L, LB =	
VELOCITY FT/S	.30	.29	DRY	HT PER SHEL	L, LB	150.
TUBE NOZZLE DATA VELOCITY FT/S DENSITY LB/FT3 PRESS. DROP %	.30 61.291	.29 62.419	DRY	HT PER SHEL	L, LB =	150.
VELOCITY FT/S DENSITY LB/FT3 PRESS. DROP %	.30 61.291 3.4	.29 62.419 2.1	DRY WET	IT PER SHEL	L, LB = = =	150. 165.
VELOCITY FT/S DENSITY LB/FT3 PRESS. DROP % □□Washington Unive	.30 61.291 3.4 ersity Ch	.29 62.419 2.1	DRY WET	IT PER SHEL	L, LB = = =	150. 165. E0002 P 34
VELOCITY FT/S DENSITY LB/FT3 PRESS. DROP %	.30 61.291 3.4 ersity Ch	.29 62.419 2.1	DRY WET	IT PER SHEL	L, LB = = =	150. 165. E0002 P 34 9/23/ 3
VELOCITY FT/S DENSITY LB/FT3 PRESS. DROP % □□Washington Unive Young model F302DY	.30 61.291 3.4 ersity Ch	.29 62.419 2.1 E433 heat	DRY WET exchang	HT PER SHEL	L, LB = = =	150. 165. E0002 P 34 9/23/ 3 CASE 17
VELOCITY FT/S DENSITY LB/FT3 PRESS. DROP % □□Washington Unive	.30 61.291 3.4 ersity Ch	.29 62.419 2.1 E433 heat	DRY WET  exchang	HT PER SHEL ger experim	L, LB = = = ent ES, RATING	150. 165. E0002 P 34 9/23/ 3 CASE 17
VELOCITY FT/S DENSITY LB/FT3 PRESS. DROP % □□Washington Unive Young model F302DY	.30 61.291 3.4 ersity Ch	.29 62.419 2.1 E433 heat	DRY WET  exchang  W, SEGME HOT TU	HT PER SHEL Jer experim ENTAL BAFFL JBE SIDE	L, LB = = = ent  ES, RATING COLD S:	150. 165. E0002 P 34 9/23/ 3 CASE 17
VELOCITY FT/S DENSITY LB/FT3 PRESS. DROP % □□Washington Unive Young model F302DY	.30 61.291 3.4 ersity Ch	.29 62.419 2.1 E433 heat	DRY WET  exchang  W, SEGME HOT TU	HT PER SHEL Jer experim ENTAL BAFFL JBE SIDE	L, LB = = = ent  ES, RATING COLD S:	150. 165. E0002 P 34 9/23/ 3 CASE 17
VELOCITY FT/S DENSITY LB/FT3 PRESS. DROP % □□Washington Unive Young model F302DY SIZE 4- 18 TYPE BE	.30 61.291 3.4 ersity Ch 4P	.29 62.419 2.1 E433 heat	DRY WET  exchang  W, SEGME HOT TU	ger experim  ENTAL BAFFL  JBE SIDE	L, LB = = = ent  ES, RATING COLD S:	150. 165. E0002 P 34 9/23/ 3 CASE 17 HELL SIDE 1 IBLE LIQ
VELOCITY FT/S DENSITY LB/FT3 PRESS. DROP % □□Washington Unive Young model F302DY	.30 61.291 3.4 ersity Ch 4P	.29 62.419 2.1 E433 heat	DRY WET  exchang  W, SEGME HOT TU	HT PER SHEL Jer experim ENTAL BAFFL JBE SIDE	L, LB = = = ent  ES, RATING COLD S:	150. 165. E0002 P 34 9/23/ 3 CASE 17
VELOCITY FT/S DENSITY LB/FT3 PRESS. DROP % □□Washington Unive Young model F302DY SIZE 4- 18 TYPE BE	.30 61.291 3.4 ersity Ch 4P	.29 62.419 2.1 E433 heat	DRY WET  exchang  W, SEGME HOT TU	ger experim  ENTAL BAFFL  JBE SIDE	L, LB = = = ent  ES, RATING COLD S:	150. 165. E0002 P 34 9/23/ 3 CASE 17 HELL SIDE 1 IBLE LIQ
VELOCITY FT/S DENSITY LB/FT3 PRESS. DROP % □□Washington Unive Young model F302DY SIZE 4- 18 TYPE BE	.30 61.291 3.4 ersity Ch 4P	.29 62.419 2.1 E433 heat	DRY WET  exchang  W, SEGME HOT TU Tube SENSI	ger experim  ENTAL BAFFLE  JBE SIDE  EBLE LIQ  .300  OUT	L, LB  =  =  ent  ES, RATING COLD S. Shel SENS  IN	150. 165. E0002 P 34 9/23/ 3 CASE 17 HELL SIDE 1 IBLE LIQ .200 OUT
VELOCITY FT/S DENSITY LB/FT3 PRESS. DROP %  UNIVERSE WASHINGTON Univeryoung model F302DY  SIZE 4- 18 TYPE BE  TOTAL FLOW RATE	.30 61.291 3.4 ersity Ch 44P M, MULTI	.29 62.419 2.1 E433 heat	DRY WET  E exchange  OW, SEGME HOT TU Tube SENSI  IN 140.0	ger experim  ENTAL BAFFLE  JBE SIDE  EBLE LIQ  .300  OUT	ES, RATING COLD S: Shel. SENS IN 40.0	150. 165. E0002 P 34 9/23/ 3 CASE 17 HELL SIDE 1 IBLE LIQ .200 OUT 106.5*
VELOCITY FT/S DENSITY LB/FT3 PRESS. DROP % □□Washington Unive Young model F302DY SIZE 4- 18 TYPE BE TOTAL FLOW RATE TEMPERATURE DENSITY	.30 61.291 3.4 ersity Ch 44P M, MULTI KLB/HR DEGF	.29 62.419 2.1 E433 heat	DRY WET  E exchange  OW, SEGME HOT TU Tube SENSI  IN 140.0 51.2913	ger experim  ENTAL BAFFL  JBE SIDE  BLE LIQ  .300  OUT  95.5* 61.9502	ent  ES, RATING COLD S: Shel. SENS  IN 40.0 62.5352	150. 165. E0002 P 34 9/23/ 3 CASE 17 HELL SIDE 1 IBLE LIQ .200 OUT 106.5* 61.8032
VELOCITY FT/S DENSITY LB/FT3 PRESS. DROP %  Washington Univeryoung model F302DY SIZE 4- 18 TYPE BE TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY	.30 61.291 3.4 ersity Ch 4P KM, MULTI KLB/HR DEGF LB/FT3 CP	.29 62.419 2.1 E433 heat	DRY WET  E exchang  OW, SEGME HOT TU TUBE SENSI  IN 140.0 51.2913 .4726	ger experim  ENTAL BAFFL  JBE SIDE  EBLE LIQ  .300  OUT  95.5* 61.9502  .7259	ES, RATING COLD S: Shel. SENS IN 40.0 62.5352 1.4791	150. 165. E0002 P 34 9/23/ 3 CASE 17 HELL SIDE 1 IBLE LIQ .200 OUT 106.5* 61.8032 .6465
VELOCITY FT/S DENSITY LB/FT3 PRESS. DROP %  UNIVERSE WASHINGTON Univeryoung model F302DY  SIZE 4- 18 TYPE BE  TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT	.30 61.291 3.4 ersity Ch 4P  KLB/HR  DEGF LB/FT3 CP BTU/LB-	.29 62.419 2.1 E433 heat -PASS FLC	DRY WET  E exchange  OW, SEGME HOT TU TUDE SENSI  IN 140.0 51.2913 .4726 .9973	ger experim  ENTAL BAFFL  JBE SIDE  EBLE LIQ  .300  OUT  95.5* 61.9502  .7259  .9990	ES, RATING COLD S. Shel. SENS IN 40.0 62.5352 1.4791 1.0058	150. 165. E0002 P 34 9/23/3 CASE 17 HELL SIDE 1 IBLE LIQ .200 OUT 106.5* 61.8032 .6465 .9982
VELOCITY FT/S DENSITY LB/FT3 PRESS. DROP %  UNIVERSE DROP %  VOUNG model F302DY  SIZE 4- 18 TYPE BE  TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND.	.30 61.291 3.4 ersity Ch 4P EM, MULTI KLB/HR DEGF LB/FT3 CP BTU/LB- BTU/HR-	.29 62.419 2.1 E433 heat -PASS FLC	DRY WET  E exchang  OW, SEGME HOT TU TUBE SENSI  IN 140.0 51.2913 .4726	ger experim  ENTAL BAFFLE JBE SIDE  EBLE LIQ .300 OUT 95.5* 61.9502 .7259 .9990 .3621	ES, RATING COLD S: Shel. SENS IN 40.0 62.5352 1.4791	150. 165. E0002 P 34 9/23/ 3 CASE 17 HELL SIDE 1 IBLE LIQ .200 OUT 106.5* 61.8032 .6465 .9982 .3648
VELOCITY FT/S DENSITY LB/FT3 PRESS. DROP %  UNIVERSE DROP %  VOUNG model F302DY  SIZE 4- 18 TYPE BE  TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND.	.30 61.291 3.4 ersity Ch 4P  KLB/HR  DEGF LB/FT3 CP BTU/LB-	.29 62.419 2.1 E433 heat -PASS FLC	DRY WET  E exchange  OW, SEGME HOT TU Tube SENSI  IN 140.0 51.2913 .4726 .9973 .3723	ger experim  ENTAL BAFFLE JBE SIDE  EBLE LIQ .300 OUT 95.5* 61.9502 .7259 .9990 .3621 18.02	ES, RATING COLD S: Shel SENS IN 40.0 62.5352 1.4791 1.0058 .3466	150. 165. E0002 P 34 9/23/ 3 CASE 17 HELL SIDE 1 IBLE LIQ .200 OUT 106.5* 61.8032 .6465 .9982 .3648 18.02
VELOCITY FT/S DENSITY LB/FT3 PRESS. DROP %  UNIVERSITY UNIVERSE  Washington University  SIZE 4- 18 TYPE BE  TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS	.30 61.291 3.4 ersity Ch 4P EM, MULTI KLB/HR DEGF LB/FT3 CP BTU/LB- BTU/HR- LB/LBMC	.29 62.419 2.1 E433 heat -PASS FLC	DRY WET  E exchange  OW, SEGME HOT TU Tube SENSI  IN 140.0 51.2913 .4726 .9973 .3723	ger experim  ENTAL BAFFL  JBE SIDE  BLE LIQ  .300  OUT  95.5* 61.9502  .7259  .9990  .3621  18.02	ES, RATING COLD S: Shel SENS IN 40.0 62.5352 1.4791 1.0058 .3466	150. 165. E0002 P 34 9/23/ 3 CASE 17 HELL SIDE 1 IBLE LIQ .200 OUT 106.5* 61.8032 .6465 .9982 .3648 18.02
VELOCITY FT/S DENSITY LB/FT3 PRESS. DROP %  UWAShington Univeryoung model F302DY  SIZE 4- 18 TYPE BE  TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS  TEMP, AVG & SKIN	.30 61.291 3.4 ersity Ch 24P M, MULTI KLB/HR DEGF LB/FT3 CP BTU/LB- BTU/HR- LB/LBMC	.29 62.419 2.1 E433 heat -PASS FLC	DRY WET E exchange DW, SEGME HOT TU Tube SENSI IN 140.0 51.2913 .4726 .9973 .3723	ger experim  ENTAL BAFFL  JBE SIDE  BLE LIQ  .300  OUT  95.5* 61.9502  .7259  .9990  .3621  18.02	ES, RATING COLD S: Shel SENS IN 40.0 62.5352 1.4791 1.0058 .3466	150. 165. E0002 P 34 9/23/ 3 CASE 17 HELL SIDE 1 IBLE LIQ .200 OUT 106.5* 61.8032 .6465 .9982 .3648 18.02
VELOCITY FT/S DENSITY LB/FT3 PRESS. DROP %  UWAShington Univeryoung model F302DY  SIZE 4- 18 TYPE BE  TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS  TEMP, AVG & SKIN VISCOSITY, AVG & S	.30 61.291 3.4 ersity Ch 4P  M, MULTI  KLB/HR  DEGF LB/FT3 CP BTU/LB- BTU/HR- LB/LBMC  DEG  KKIN CP	.29 62.419 2.1 E433 heat -PASS FLC	DRY WET E exchange DW, SEGME HOT TU Tube SENSI IN 140.0 51.2913 .4726 .9973 .3723	Ger experim  ENTAL BAFFL  JBE SIDE  EBLE LIQ  .300  OUT  95.5* 61.9502  .7259  .9990  .3621  18.02   98.5  .7030	ES, RATING COLD S: Shel. SENS  IN 40.0 62.5352 1.4791 1.0058 .3466 73.3 .9394	150. 165. E0002 P 34 9/23/ 3 CASE 17 HELL SIDE 1 IBLE LIQ .200 OUT 106.5* 61.8032 .6465 .9982 .3648 18.02  97.7 .7086
VELOCITY FT/S DENSITY LB/FT3 PRESS. DROP %  UWAShington Univeryoung model F302DY  SIZE 4- 18 TYPE BE  TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS  TEMP, AVG & SKIN	.30 61.291 3.4 ersity Ch 4P  M, MULTI  KLB/HR  DEGF LB/FT3 CP BTU/LB- BTU/HR- LB/LBMC  DEG  KKIN CP	.29 62.419 2.1 E433 heat -PASS FLC	DRY WET E exchange DW, SEGME HOT TU Tube SENSI IN 140.0 51.2913 .4726 .9973 .3723	ger experim  ENTAL BAFFL  JBE SIDE  BLE LIQ  .300  OUT  95.5* 61.9502  .7259  .9990  .3621  18.02	ES, RATING COLD S: Shel. SENS  IN 40.0 62.5352 1.4791 1.0058 .3466 73.3 .9394	150. 165. E0002 P 34 9/23/ 3 CASE 17 HELL SIDE 1 IBLE LIQ .200 OUT 106.5* 61.8032 .6465 .9982 .3648 18.02  97.7 .7086
VELOCITY FT/S DENSITY LB/FT3 PRESS. DROP %  UWAShington Univeryoung model F302DY  SIZE 4- 18 TYPE BE  TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS  TEMP, AVG & SKIN VISCOSITY, AVG & S	.30 61.291 3.4 ersity Ch 4P  M, MULTI  KLB/HR  DEGF LB/FT3 CP BTU/LB- BTU/HR- LB/LBMC  DEG  KKIN CP	.29 62.419 2.1 E433 heat -PASS FLC	DRY WET E exchange DW, SEGME HOT TU Tube SENSI IN 140.0 51.2913 .4726 .9973 .3723	Ger experim  ENTAL BAFFL  JBE SIDE  EBLE LIQ  .300  OUT  95.5* 61.9502  .7259  .9990  .3621  18.02   98.5  .7030	ES, RATING COLD S: Shel. SENS  IN 40.0 62.5352 1.4791 1.0058 .3466 73.3 .9394	150. 165. E0002 P 34 9/23/ 3 CASE 17 HELL SIDE 1 IBLE LIQ .200 OUT 106.5* 61.8032 .6465 .9982 .3648 18.02  97.7 .7086
VELOCITY FT/S DENSITY LB/FT3 PRESS. DROP %  UNIVERSE DROP %  UNIVERSE DROP %  UNIVERSE DROP %  SIZE 4- 18 TYPE BE  TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS  TEMP, AVG & SKIN VISCOSITY, AVG & S PRESSURE, IN & DES	.30 61.291 3.4 ersity Ch 4P  EM, MULTI  KLB/HR  DEGF LB/FT3 CP BTU/LB- BTU/HR- LB/LBMC  DEG EKIN CP	.29 62.419 2.1 E433 heat -PASS FLC	DRY WET  E exchange  OW, SEGME HOT TU Tube SENSI  IN 140.0 61.2913 .4726 .9973 .3723  117.8 .5782 50.00	Ger experim  ENTAL BAFFL  JBE SIDE  EBLE LIQ  .300  OUT  95.5* 61.9502  .7259  .9990  .3621  18.02   98.5  .7030  165.00	ES, RATING COLD S: Shell SENS  IN 40.0 62.5352 1.4791 1.0058 .3466 73.3 .9394 50.00	150. 165. E0002 P 34 9/23/ 3 CASE 17 HELL SIDE 1 IBLE LIQ .200 OUT 106.5* 61.8032 .6465 .9982 .3648 18.02  97.7 .7086
VELOCITY FT/S DENSITY LB/FT3 PRESS. DROP %  UWAShington Univeryoung model F302DY  SIZE 4- 18 TYPE BE  TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS  TEMP, AVG & SKIN VISCOSITY, AVG & S	.30 61.291 3.4 ersity Ch 44P  EM, MULTI  KLB/HR  DEGF LB/FT3 CP BTU/LB- BTU/HR- LB/LBMC  DEG EKIN CP EIGN PSI	.29 62.419 2.1 E433 heat -PASS FLC	DRY WET  E exchange  OW, SEGME HOT TU Tube SENSI  IN 140.0 51.2913 .4726 .9973 .3723  117.8 .5782 50.00	Ger experim  ENTAL BAFFLE  JBE SIDE  EBLE LIQ  .300  OUT  95.5* 61.9502  .7259  .9990  .3621  18.02   98.5  .7030  165.00	ES, RATING COLD S: Shel SENS  IN 40.0 62.5352 1.4791 1.0058 .3466 73.3 .9394 50.00	150. 165. E0002 P 34 9/23/ 3 CASE 17 HELL SIDE 1 IBLE LIQ .200 OUT 106.5* 61.8032 .6465 .9982 .3648 18.02  97.7 .7086 165.00

	che433b(40).OUT	
FOULING RESISTANCE HR-FT2-F/B	TU .00010 .	.00010
FILM COEFFICIENT BTU/HR-FT2		134.13
		010016
TOTAL HEAT DUTY REQUIRED MEGBTU/H		.013316
EFF TEMP DIF, DEGF (LMTD= 43.6,F	= .63,BYPASS= .92,BAFF=1.00)	25.0
OVERALL COEFF REQUIRED BTU/HR-F	T2-F	74.57
CLEAN & FOULED COEFF BTU/HR-F		74.66
SHELLS IN SERIES 1 PARALLEL 1	TOTAL EFF AREA FT2	7.1
PASSES, SHELL 1 TUBE 4		
SHELL DIAMETER IN. 3.820	TEMA SHELL TYPE E ; REAR F	HEAD FXTS
BAFFLE TYPE HORZ SEGMENTL	CROSS PASSES PER SHELL PASS	4
SPACING, CENTRAL IN. 4.309	BAFFLE CUT, PCT SHELL I.D.	
SPACING, INLET IN. 4.309	CUT DISTANCE FROM CENTER, IN.	/ 64
SPACING, OUTLET IN. 4.309		
BAFFLE THICKNESS IN125	IMPINGEMENT BAFFLE INCLUDED	NO
PAIRS OF SEALING DEVICES 1	TUBESHEET BLANK AREA, %	.0
	·	
TUBE TYPE PLAIN	MATERIAL ELECTROLYTI	C CODDED
NO. OF TUBES/SHELL 76	EST MAX TUBE COUNT	
TUBE LGTH, OVERALL FT 1.500		.3125
TUBE LGTH, EFF FT 1.436	TUBE OUTSIDE DIAM IN.	.250
TUBE LAYOUT DEG 60	TUBE INSIDE DIAM IN.	.214
PITCH RATIO 1.250		
SHL NOZZ ID, IN&OUT 1.0 1.0		
SHL NOZZ ID, INWOOL I.O I.O	TOBE NOZZ ID, INGOUT IN.	. 0 . 0
* CALCULATED ITEMHEAT BALANCE		
* CALCULATED ITEMHEAT BALANCE	CODE = 8	E0002 P 35
□□Washington University ChE433 he	CODE = 8	
	CODE = 8	9/23/ 3
□□Washington University ChE433 he Young model F302DY4P	CODE = 8 at exchanger experiment	
□□Washington University ChE433 he Young model F302DY4P	CODE = 8	9/23/ 3
□□Washington University ChE433 he Young model F302DY4P  S U P P L E M E N T A	CODE = 8 at exchanger experiment  R Y R E S U L T S	9/23/ 3
□□Washington University ChE433 he Young model F302DY4P  S U P P L E M E N T A  HT PARAMETERS SHELL TUBE	CODE = 8 at exchanger experiment  R Y R E S U L T S  SHELLSIDE PERFORMANCE	9/23/ 3
□□Washington University ChE433 he Young model F302DY4P  S U P P L E M E N T A	CODE = 8 at exchanger experiment  R Y R E S U L T S  SHELLSIDE PERFORMANCE	9/23/ 3 CASE 17
University ChE433 he Young model F302DY4P  S U P P L E M E N T A  HT PARAMETERS SHELL TUBE WALL CORRECTION 1.040 .000	CODE = 8 at exchanger experiment  R Y R E S U L T S  SHELLSIDE PERFORMANCE NOMINAL VEL, X-FLOW FT/S	9/23/ 3 CASE 17
University ChE433 here Young model F302DY4P  S U P P L E M E N T A  HT PARAMETERS SHELL TUBE WALL CORRECTION 1.040 .0000 PRANDTL NUMBER 6.4 3.8	CODE = 8 eat exchanger experiment  R Y R E S U L T S  SHELLSIDE PERFORMANCE NOMINAL VEL, X-FLOW FT/S NOMINAL VEL, WINDOW FT/S	9/23/ 3 CASE 17 .03 .05
University ChE433 he Young model F302DY4P  S U P P L E M E N T A  HT PARAMETERS SHELL TUBE WALL CORRECTION 1.040 .000 PRANDTL NUMBER 6.4 3.8 RYNLD NO, AVG 79. 818.	CODE = 8 at exchanger experiment  R Y R E S U L T S  SHELLSIDE PERFORMANCE NOMINAL VEL, X-FLOW FT/S NOMINAL VEL, WINDOW FT/S CROSSFLOW COEF BTU/HR-FT2	9/23/ 3 CASE 17 .03 .05 2-F 135.6
University ChE433 he Young model F302DY4P  S U P P L E M E N T A  HT PARAMETERS SHELL TUBE WALL CORRECTION 1.040 .000 PRANDTL NUMBER 6.4 3.8 RYNLD NO, AVG 79. 818. RYNLD NO, IN BUN 50. 1000.	CODE = 8 at exchanger experiment  R Y R E S U L T S  SHELLSIDE PERFORMANCE NOMINAL VEL, X-FLOW FT/S NOMINAL VEL, WINDOW FT/S CROSSFLOW COEF BTU/HR-FT2 WINDOW COEF BTU/HR-FT2	9/23/ 3 CASE 17 .03 .05 2-F 135.6
University ChE433 he Young model F302DY4P  S U P P L E M E N T A  HT PARAMETERS SHELL TUBE WALL CORRECTION 1.040 .000 PRANDTL NUMBER 6.4 3.8 RYNLD NO, AVG 79. 818. RYNLD NO, IN BUN 50. 1000. RYNLD NO, OUT BUN 114. 651.	CODE = 8 at exchanger experiment  R Y R E S U L T S  SHELLSIDE PERFORMANCE NOMINAL VEL, X-FLOW FT/S NOMINAL VEL, WINDOW FT/S CROSSFLOW COEF BTU/HR-FT2 WINDOW COEF BTU/HR-FT2	9/23/3 CASE 17 .03 .05 2-F 135.6 2-F 132.5
Toung model F302DY4P  S U P P L E M E N T A  HT PARAMETERS SHELL TUBE WALL CORRECTION 1.040 .000 PRANDTL NUMBER 6.4 3.8 RYNLD NO, AVG 79. 818. RYNLD NO, IN BUN 50. 1000. RYNLD NO,OUT BUN 114. 651. FOULNG LAYER IN0014 .0014	CODE = 8 at exchanger experiment  R Y R E S U L T S  SHELLSIDE PERFORMANCE NOMINAL VEL, X-FLOW FT/S NOMINAL VEL, WINDOW FT/S CROSSFLOW COEF BTU/HR-FT2 WINDOW COEF BTU/HR-FT2 SHELLSIDE FLOW, % OF TOTA	9/23/3 CASE 17 .03 .05 2-F 135.6 2-F 132.5
Toung model F302DY4P  S U P P L E M E N T A  HT PARAMETERS SHELL TUBE WALL CORRECTION 1.040 .000 PRANDTL NUMBER 6.4 3.8 RYNLD NO, AVG 79. 818. RYNLD NO, IN BUN 50. 1000. RYNLD NO,OUT BUN 114. 651. FOULNG LAYER IN0014 .0014	CODE = 8 at exchanger experiment  R Y R E S U L T S  SHELLSIDE PERFORMANCE NOMINAL VEL, X-FLOW FT/S NOMINAL VEL, WINDOW FT/S CROSSFLOW COEF BTU/HR-FT2 WINDOW COEF BTU/HR-FT2	9/23/3 CASE 17 .03 .05 2-F 135.6 2-F 132.5
□□Washington University ChE433 he Young model F302DY4P  S U P P L E M E N T A  HT PARAMETERS SHELL TUBE WALL CORRECTION 1.040 .0000 PRANDTL NUMBER 6.4 3.8 RYNLD NO, AVG 79. 818. RYNLD NO, IN BUN 50. 1000. RYNLD NO, OUT BUN 114. 651. FOULNG LAYER IN0014 .0014	CODE = 8 at exchanger experiment  R Y R E S U L T S  SHELLSIDE PERFORMANCE NOMINAL VEL, X-FLOW FT/S NOMINAL VEL, WINDOW FT/S CROSSFLOW COEF BTU/HR-FT2 WINDOW COEF BTU/HR-FT2 SHELLSIDE FLOW, % OF TOTA	9/23/3 CASE 17 .03 .05 2-F 135.6 2-F 132.5
University ChE433 he Young model F302DY4P  S U P P L E M E N T A  HT PARAMETERS SHELL TUBE WALL CORRECTION 1.040 .000 PRANDTL NUMBER 6.4 3.8 RYNLD NO, AVG 79. 818. RYNLD NO, IN BUN 50. 1000. RYNLD NO, OUT BUN 114. 651. FOULNG LAYER IN0014 .0014  THERMAL RESISTANCE, % OF TOTAL	CODE = 8 at exchanger experiment  R Y R E S U L T S  SHELLSIDE PERFORMANCE NOMINAL VEL, X-FLOW FT/S NOMINAL VEL, WINDOW FT/S CROSSFLOW COEF BTU/HR-FT2 WINDOW COEF BTU/HR-FT2  SHELLSIDE FLOW, % OF TOTA HEAT TRANSFER X-FLOW TUBE TO BAFFLE LEAKAGE	9/23/3 CASE 17 .03 .05 2-F 135.6 2-F 132.5 AL 79.81 A = 2.55
University ChE433 he Young model F302DY4P  S U P P L E M E N T A  HT PARAMETERS SHELL TUBE WALL CORRECTION 1.040 .000 PRANDTL NUMBER 6.4 3.8 RYNLD NO, AVG 79. 818. RYNLD NO, IN BUN 50. 1000. RYNLD NO, OUT BUN 114. 651. FOULNG LAYER IN0014 .0014  THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL	CODE = 8 at exchanger experiment  R Y R E S U L T S  SHELLSIDE PERFORMANCE NOMINAL VEL, X-FLOW FT/S NOMINAL VEL, WINDOW FT/S CROSSFLOW COEF BTU/HR-FT2 WINDOW COEF BTU/HR-FT2  SHELLSIDE FLOW, % OF TOTA HEAT TRANSFER X-FLOW TUBE TO BAFFLE LEAKAGE MAIN CROSSFLOW	9/23/3 CASE 17 .03 .05 2-F 135.6 2-F 132.5 AL 79.81 A = 2.55 B = 68.32
□□Washington University ChE433 he Young model F302DY4P  S U P P L E M E N T A  HT PARAMETERS SHELL TUBE WALL CORRECTION 1.040 .000 PRANDTL NUMBER 6.4 3.8 RYNLD NO, AVG 79. 818. RYNLD NO, IN BUN 50. 1000. RYNLD NO, OUT BUN 114. 651. FOULNG LAYER IN0014 .0014  THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL 55.04 43.29 1.62 .05	CODE = 8 at exchanger experiment  R Y R E S U L T S  SHELLSIDE PERFORMANCE NOMINAL VEL, X-FLOW FT/S NOMINAL VEL, WINDOW FT/S CROSSFLOW COEF BTU/HR-FT2 WINDOW COEF BTU/HR-FT2  SHELLSIDE FLOW, % OF TOTA HEAT TRANSFER X-FLOW TUBE TO BAFFLE LEAKAGE MAIN CROSSFLOW BUNDLE TO SHELL BYPASS	9/23/3 CASE 17  .03 .05 2-F 135.6 2-F 132.5  AL 79.81 A = 2.55 B = 68.32 C = 10.98
□□Washington University ChE433 he Young model F302DY4P  S U P P L E M E N T A  HT PARAMETERS SHELL TUBE WALL CORRECTION 1.040 .000 PRANDTL NUMBER 6.4 3.8 RYNLD NO, AVG 79. 818. RYNLD NO, IN BUN 50. 1000. RYNLD NO, OUT BUN 114. 651. FOULNG LAYER IN0014 .0014  THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL 55.04 43.29 1.62 .05	CODE = 8 at exchanger experiment  R Y R E S U L T S  SHELLSIDE PERFORMANCE NOMINAL VEL, X-FLOW FT/S NOMINAL VEL, WINDOW FT/S CROSSFLOW COEF BTU/HR-FT2 WINDOW COEF BTU/HR-FT2  SHELLSIDE FLOW, % OF TOTA HEAT TRANSFER X-FLOW TUBE TO BAFFLE LEAKAGE MAIN CROSSFLOW BUNDLE TO SHELL BYPASS	9/23/3 CASE 17  .03 .05 2-F 135.6 2-F 132.5  AL 79.81 A = 2.55 B = 68.32 C = 10.98
□□Washington University ChE433 he Young model F302DY4P  S U P P L E M E N T A  HT PARAMETERS SHELL TUBE WALL CORRECTION 1.040 .000 PRANDTL NUMBER 6.4 3.8 RYNLD NO, AVG 79. 818. RYNLD NO, IN BUN 50. 1000. RYNLD NO,OUT BUN 114. 651. FOULNG LAYER IN0014 .0014  THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL 55.04 43.29 1.62 .05 PCT OVER DESIGN .12 TOT FOUL RESIST .000217	CODE = 8 at exchanger experiment  R Y R E S U L T S  SHELLSIDE PERFORMANCE NOMINAL VEL, X-FLOW FT/S NOMINAL VEL, WINDOW FT/S CROSSFLOW COEF BTU/HR-FT2 WINDOW COEF BTU/HR-FT2  SHELLSIDE FLOW, % OF TOTH HEAT TRANSFER X-FLOW TUBE TO BAFFLE LEAKAGE MAIN CROSSFLOW BUNDLE TO SHELL BYPASS BAFFLE TO SHELL LEAKAGE TUBE PASSLANE BYPASS	9/23/3 CASE 17  .03 .05 2-F 135.6 2-F 132.5  AL 79.81 A = 2.55 B = 68.32 C = 10.98
□□Washington University ChE433 he Young model F302DY4P  S U P P L E M E N T A  HT PARAMETERS SHELL TUBE WALL CORRECTION 1.040 .000 PRANDTL NUMBER 6.4 3.8 RYNLD NO, AVG 79. 818. RYNLD NO, IN BUN 50. 1000. RYNLD NO,OUT BUN 114. 651. FOULNG LAYER IN0014 .0014  THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL 55.04 43.29 1.62 .05 PCT OVER DESIGN .12 TOT FOUL RESIST .000217	CODE = 8 at exchanger experiment  R Y R E S U L T S  SHELLSIDE PERFORMANCE NOMINAL VEL, X-FLOW FT/S NOMINAL VEL, WINDOW FT/S CROSSFLOW COEF BTU/HR-FT2 WINDOW COEF BTU/HR-FT2  SHELLSIDE FLOW, % OF TOTH HEAT TRANSFER X-FLOW TUBE TO BAFFLE LEAKAGE MAIN CROSSFLOW BUNDLE TO SHELL BYPASS BAFFLE TO SHELL LEAKAGE TUBE PASSLANE BYPASS	9/23/3 CASE 17  .03 .05 2-F 135.6 2-F 132.5  AL 79.81 A = 2.55 B = 68.32 C = 10.98
□□Washington University ChE433 he Young model F302DY4P  S U P P L E M E N T A  HT PARAMETERS SHELL TUBE WALL CORRECTION 1.040 .000 PRANDTL NUMBER 6.4 3.8 RYNLD NO, AVG 79. 818. RYNLD NO, IN BUN 50. 1000. RYNLD NO,OUT BUN 114. 651. FOULNG LAYER IN0014 .0014  THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL 55.04 43.29 1.62 .05 PCT OVER DESIGN .12 TOT FOUL RESIST .000016	CODE = 8 at exchanger experiment  R Y R E S U L T S  SHELLSIDE PERFORMANCE NOMINAL VEL, X-FLOW FT/S NOMINAL VEL, WINDOW FT/S CROSSFLOW COEF BTU/HR-FT2 WINDOW COEF BTU/HR-FT2  SHELLSIDE FLOW, % OF TOTA HEAT TRANSFER X-FLOW TUBE TO BAFFLE LEAKAGE MAIN CROSSFLOW BUNDLE TO SHELL BYPASS BAFFLE TO SHELL LEAKAGE TUBE PASSLANE BYPASS  SHELLSIDE HEAT TRANSFER E	9/23/3 CASE 17  .03 .05 2-F 135.6 2-F 132.5  AL 79.81 A = 2.55 B = 68.32 C = 10.98 E = 18.15 F = .00
□□Washington University ChE433 he Young model F302DY4P  S U P P L E M E N T A  HT PARAMETERS SHELL TUBE WALL CORRECTION 1.040 .000 PRANDTL NUMBER 6.4 3.8 RYNLD NO, AVG 79. 818. RYNLD NO, IN BUN 50. 1000. RYNLD NO,OUT BUN 114. 651. FOULNG LAYER IN0014 .0014  THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL 55.04 43.29 1.62 .05 PCT OVER DESIGN .12 TOT FOUL RESIST .000016	CODE = 8 at exchanger experiment  R Y R E S U L T S  SHELLSIDE PERFORMANCE NOMINAL VEL, X-FLOW FT/S NOMINAL VEL, WINDOW FT/S CROSSFLOW COEF BTU/HR-FT2 WINDOW COEF BTU/HR-FT2  SHELLSIDE FLOW, % OF TOTA HEAT TRANSFER X-FLOW TUBE TO BAFFLE LEAKAGE MAIN CROSSFLOW BUNDLE TO SHELL BYPASS BAFFLE TO SHELL LEAKAGE TUBE PASSLANE BYPASS  SHELLSIDE HEAT TRANSFER E	9/23/3 CASE 17  .03 .05 2-F 135.6 2-F 132.5  AL 79.81 A = 2.55 B = 68.32 C = 10.98 E = 18.15 F = .00
□□Washington University ChE433 he Young model F302DY4P  S U P P L E M E N T A  HT PARAMETERS SHELL TUBE WALL CORRECTION 1.040 .000 PRANDTL NUMBER 6.4 3.8 RYNLD NO, AVG 79. 818. RYNLD NO, IN BUN 50. 1000. RYNLD NO, OUT BUN 114. 651. FOULNG LAYER IN0014 .0014  THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL 55.04 43.29 1.62 .05 PCT OVER DESIGN .12 TOT FOUL RESIST .0000217 DIFF RESIST .000016	CODE = 8 at exchanger experiment  R Y R E S U L T S  SHELLSIDE PERFORMANCE NOMINAL VEL, X-FLOW FT/S NOMINAL VEL, WINDOW FT/S CROSSFLOW COEF BTU/HR-FT2 WINDOW COEF BTU/HR-FT2  SHELLSIDE FLOW, % OF TOTA HEAT TRANSFER X-FLOW TUBE TO BAFFLE LEAKAGE MAIN CROSSFLOW BUNDLE TO SHELL BYPASS BAFFLE TO SHELL LEAKAGE TUBE PASSLANE BYPASS  SHELLSIDE HEAT TRANSFER F TOTAL = (BETA) (GAMMA) (FIN)	9/23/3 CASE 17  .03 .05 2-F 135.6 2-F 132.5  AL 79.81 A = 2.55 B = 68.32 C = 10.98 E = 18.15 F = .00  FACTORS = .598
□□Washington University ChE433 he Young model F302DY4P  S U P P L E M E N T A  HT PARAMETERS SHELL TUBE WALL CORRECTION 1.040 .000 PRANDTL NUMBER 6.4 3.8 RYNLD NO, AVG 79. 818. RYNLD NO, IN BUN 50. 1000. RYNLD NO,OUT BUN 114. 651. FOULNG LAYER IN0014 .0014  THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL 55.04 43.29 1.62 .05 PCT OVER DESIGN .12 TOT FOUL RESIST .000217 DIFF RESIST .000016	CODE = 8 at exchanger experiment  R Y R E S U L T S  SHELLSIDE PERFORMANCE NOMINAL VEL, X-FLOW FT/S NOMINAL VEL, WINDOW FT/S CROSSFLOW COEF BTU/HR-FT2 WINDOW COEF BTU/HR-FT2  SHELLSIDE FLOW, % OF TOTA HEAT TRANSFER X-FLOW TUBE TO BAFFLE LEAKAGE A MAIN CROSSFLOW BUNDLE TO SHELL BYPASS BAFFLE TO SHELL BYPASS BAFFLE TO SHELL LEAKAGE F TUBE PASSLANE BYPASS SHELLSIDE HEAT TRANSFER F TOTAL = (BETA) (GAMMA) (FIN) BETA (BAFF CUT FACTOR)	9/23/3 CASE 17  .03 .05 2-F 135.6 2-F 132.5  AL 79.81 A = 2.55 B = 68.32 C = 10.98 E = 18.15 F = .00  FACTORS = .598 = .920
□□Washington University ChE433 he Young model F302DY4P  S U P P L E M E N T A  HT PARAMETERS SHELL TUBE WALL CORRECTION 1.040 .000 PRANDTL NUMBER 6.4 3.8 RYNLD NO, AVG 79. 818. RYNLD NO, IN BUN 50. 1000. RYNLD NO,OUT BUN 114. 651. FOULNG LAYER IN0014 .0014  THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL 55.04 43.29 1.62 .05 PCT OVER DESIGN .12 TOT FOUL RESIST .000217 DIFF RESIST .000016  DIAMETRAL CLEARANCES BUNDLE TO SHELL IN5000 TUBE TO BAFFLE HOLE IN0284	CODE = 8 at exchanger experiment  R Y R E S U L T S  SHELLSIDE PERFORMANCE NOMINAL VEL, X-FLOW FT/S NOMINAL VEL, WINDOW FT/S CROSSFLOW COEF BTU/HR-FT2 WINDOW COEF BTU/HR-FT2  SHELLSIDE FLOW, % OF TOTA HEAT TRANSFER X-FLOW TUBE TO BAFFLE LEAKAGE A MAIN CROSSFLOW BUNDLE TO SHELL BYPASS BAFFLE TO SHELL BYPASS BAFFLE TO SHELL LEAKAGE B TUBE PASSLANE BYPASS SHELLSIDE HEAT TRANSFER B TOTAL = (BETA) (GAMMA) (FIN) BETA (BAFF CUT FACTOR) GAMMA (TUBE ROW ENTRY EFCT)	9/23/3 CASE 17  .03 .05 2-F 135.6 2-F 132.5  AL 79.81 A = 2.55 B = 68.32 C = 10.98 E = 18.15 F = .00  FACTORS = .598 = .920 = .650
□□Washington University ChE433 he Young model F302DY4P  S U P P L E M E N T A  HT PARAMETERS SHELL TUBE WALL CORRECTION 1.040 .000 PRANDTL NUMBER 6.4 3.8 RYNLD NO, AVG 79. 818. RYNLD NO, IN BUN 50. 1000. RYNLD NO,OUT BUN 114. 651. FOULNG LAYER IN0014 .0014  THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL 55.04 43.29 1.62 .05 PCT OVER DESIGN .12 TOT FOUL RESIST .000217 DIFF RESIST .000016	CODE = 8 at exchanger experiment  R Y R E S U L T S  SHELLSIDE PERFORMANCE NOMINAL VEL, X-FLOW FT/S NOMINAL VEL, WINDOW FT/S CROSSFLOW COEF BTU/HR-FT2 WINDOW COEF BTU/HR-FT2  SHELLSIDE FLOW, % OF TOTA HEAT TRANSFER X-FLOW TUBE TO BAFFLE LEAKAGE A MAIN CROSSFLOW BUNDLE TO SHELL BYPASS BAFFLE TO SHELL BYPASS BAFFLE TO SHELL LEAKAGE B TUBE PASSLANE BYPASS SHELLSIDE HEAT TRANSFER B TOTAL = (BETA) (GAMMA) (FIN) BETA (BAFF CUT FACTOR) GAMMA (TUBE ROW ENTRY EFCT)	9/23/3 CASE 17  .03 .05 2-F 135.6 2-F 132.5  AL 79.81 A = 2.55 B = 68.32 C = 10.98 E = 18.15 F = .00  FACTORS = .598 = .920 = .650

SHELL NOZZLE DATA HT UNDR NOZ IN. HT OPP NOZ IN. VELOCITY FT/S DENSITY LB/FT3 NOZZ RHO*VSQ LB/FT6 BUND RHO*VSQ LB/FT6	.25 .25 .16 .16 62.535 61.803 -S2 1 1	WINDOW END ZON CROSS F INLET N OUTLET	E LOW OZZLE		TOTAL = 9.9 = 7.9 = 6.0 = 40.3 = 36.0
TUBE NOZZLE DATA VELOCITY FT/S DENSITY LB/FT3 PRESS. DROP %	.44 .44 61.291 61.950 5.9 3.7	DRY WET		=	150. 165.
□□Washington Unive Young model F302DY		at exchang	er experime		9/23/ 3 CASE 18
SIZE 4- 18 TYPE BE		HOT TU Tube	NTAL BAFFLE BE SIDE BLE LIQ	S, RATING COLD SI Shell	HELL SIDE l
TOTAL FLOW RATE	KLB/HR		.300		.300
			OUT		
TEMPERATURE					
DENSITY					
VISCOSITY			.8147		
SPECIFIC HEAT					
THERMAL COND. MOLAR MASS	LB/LBMOL		18.02		18.02
TEMP, AVG & SKIN	DEGF		91 2		
VISCOSITY, AVG & S					
PRESSURE, IN & DES					
PRESSURE DROP, TOT					
VELOCITY, CALC & M.	AX ALLOWED FT/S	.29	10.00	.05	10.00
FOULING RESISTANCE					
FILM COEFFICIENT	BTU/HR-FT2-	-F 20	3.53	1!	57.05
TOTAL HEAT DUTY RE	OUIRED MEGBTU/HI	3			.016407
EFF TEMP DIF, DEGF	(LMTD= 45.3,F=	= .67,BYPA	SS= .93,BAF	F=1.00)	28.4
OVERALL COEFF REQU					80.74
CLEAN & FOULED COE	FF BTU/HR-F1	Γ2-F	82.55		81.06
SHELLS IN SERIES					
PASSES, SHELL					
SHELL DIAMETER IN.	3.820	TEMA SHEL	L TYPE E	; REAR HI	EAD FXTS
BAFFLE TYPE H					
SPACING, CENTRAL					
SPACING, INLET SPACING, OUTLET		CUT DISTA	NCE FROM CE	NTER, IN.	.764
BAFFLE THICKNESS		IMPINGEME	NT BAFFLE I	NCLUDED	NO
PAIRS OF SEALING D			BLANK AREA		

TUBE TYPE	PLAIN M	ATERIAL ELECTROLYTI	C COPPER
NO. OF TUBES/SHELL	76 E	ST MAX TUBE COUNT	36
TUBE LGTH, OVERALL FT	1.500 T	UBE PITCH IN.	.3125
TUBE LGTH, EFF FT		UBE OUTSIDE DIAM IN.	
TUBE LAYOUT DEG		UBE INSIDE DIAM IN.	
		UBE SURFACE RATIO, OUT/IN	
SHL NOZZ ID, IN&OUT 1.0	1.0 T	UBE NOZZ ID, IN&OUT IN.	.8 .8
* CALCULATED ITEMHEAT	BALANCE C	ODE = 8	
□□Washington University C	hE433 heat	exchanger experiment	E0002 P 37
Young model F302DY4P			9/23/ 3
-			CASE 18
SUPPLEMEN	TAR	Y RESULTS	
HT PARAMETERS SHELL	TUBE	SHELLSIDE PERFORMANCE	
	.000		.04
		, -	
PRANDTL NUMBER 6.9			
		CROSSFLOW COEF BTU/HR-FT2	
		WINDOW COEF BTU/HR-FT2	2-F 158.5
RYNLD NO, OUT BUN 153.			
FOULNG LAYER IN0014	.0014	SHELLSIDE FLOW, % OF TOTA	L
		HEAT TRANSFER X-FLOW	81.05
THERMAL RESISTANCE, % OF	TOTAL	TUBE TO BAFFLE LEAKAGE A	2.66
SHELL TUBE FOULING M	ETAL	MAIN CROSSFLOW B	8 = 69.36
		BUNDLE TO SHELL BYPASS C	
		BAFFLE TO SHELL LEAKAGE E	
TOT FOUL RESIST			
	.000217	TODE TABOLAND DITAGO T	00
DIFF RESISI	.000043	SHELLSIDE HEAT TRANSFER F	יז כיייס הי
DIAMETRAL CLEARANCES			
		TOTAL = (BETA) (GAMMA) (FIN)	
BUNDLE TO SHELL IN.		BETA (BAFF CUT FACTOR)	
	.0284	·	
BAFFLE TO SHELL IN.	.1000	END (HT LOSS IN END ZONE)	= .994
		_	
		SHELL PRESSURE DROP, % OF	
	5		= 9.4
HT OPP NOZ IN2			= 6.2
VELOCITY FT/S .2			= 4.9
DENSITY LB/FT3 62.53	5 61.962	INLET NOZZLE	= 41.5
NOZZ RHO*VSQ LB/FT-S2	3 3	OUTLET NOZZLE	= 38.0
BUND RHO*VSQ LB/FT-S2	2 2		
TUBE NOZZLE DATA I	N OUT	WEIGHT PER SHELL, LB	
VELOCITY FT/S .4			150.
DENSITY LB/FT3 61.29			165.
	6 3.5		± 00 •
		exchanger experiment	EUUU3 D 30
	TIEAL	cycliques eyberiment	
Young model F302DY4P			9/23/ 3
OTER 4 10 EVEN DOM	T DAGG == 0	M GEOMENIAL DISELEG DISELEG	CASE 19
SIZE 4- 18 TYPE BEM, MULT	I-PASS FLO	W, SEGMENTAL BAFFLES, RATING	
		HOT TUBE SIDE COLD S	SHELL SIDE

Tube

Shell

			BLE LIQ	SENSI	BIE IIO
TOTAL FLOW RATE	KT.B/HB	SENSI	300	SHIST	400
IOIAH IHOW KAIH	KDD/III	TN	.300 OUT	TN	OIIT
TEMPERATURE	DEGE	140 0	78 1*	40 0	86 2*
DENSITY	LB/FT3	61.2913	62.1613	62.5352	62.0667
VISCOSITY	CP	. 4726	. 8851	1.4791	. 8055
SPECIFIC HEAT	BTII/I.B-F	9973	1 0006	1 0058	9998
THERMAL COND. MOLAR MASS	BTU/HR-FT-F	.3723	.3576	.3466	.3597
MOLAR MASS	LB/LBMOL		18.02		18.02
TEMP, AVG & SKIN VISCOSITY, AVG & S	DEGF	109.1	85.7	63.1	84.8
VISCOSITY, AVG & S	KIN CP	.6298	.8099	1.0690	.8183
PRESSURE, IN & DES	IGN PSIA	50.00	165.00	50.00	165.00
PRESSURE DROP, TOT	' & ALLOWED PSI	.03	10.00	.00	10.00
VELOCITY, CALC & M	ALLOWED FT	/s .29	10.00	.06	10.00
FOULING RESISTANCE	HR-FT2-F/F	STU .C	00010	.0	00010
FILM COEFFICIENT	BTU/HR-FT2	2-F 20	3.30	18	32.70
TOTAL HEAT DUTY RE					.018520
EFF TEMP DIF, DEGE			ASS= .94,BAE	F=1.00)	29.6
OVERALL COEFF REQU	IRED BTU/HR-H	FT2-F			87.55
CLEAN & FOULED COE	FF BTU/HR-I	FT2-F	89.07	1	87.26
SHELLS IN SERIES	1 PARALLEL 1	TOTAL EFF	T AREA	FT2	7.1
PASSES, SHELL					
SHELL DIAMETER IN.	3.820	TEMA SHEI	LL TYPE E	; REAR HE	EAD FXTS
BAFFLE TYPE H	ORZ SEGMENTL	CROSS PAS	SSES PER SHE	CLL PASS	4
SPACING, CENTRAL SPACING, INLET	IN. 4.309	BAFFLE CU	JT, PCT SHEL	ıL I.D.	30.00
SPACING, INLET SPACING, OUTLET	IN. 4.309	CUT DISTA	ANCE FROM CE	INTER, IN.	. / 64
BAFFLE THICKNESS	IN. 4.309	TMDTNCDM		NOTHDED	NO
PAIRS OF SEALING D	IN125	IMPINGEME	INT BAFFLE I	NCLUDED	
PAIRS OF SEALING I	NEATCE2 I	IORESHEEI	. BLANK AREA	1, 6	. 0
TUBE TYPE	PLAIN	матгртат	r T	FCTDAT VTTA	CODDED
NO. OF TUBES/SHELI			TUBE COUNT	исткопттт <i>с</i>	36
TUBE LGTH, OVERALI		TUBE PITO		IN.	.3125
TUBE LGTH, EFF			SIDE DIAM	IN.	.250
TUBE LAYOUT	DEG 60		DE DIAM	IN.	.214
PITCH RATIO	1.250		FACE RATIO,		1.184
SHL NOZZ ID, IN&OU			Z ID, IN&OUT		
			,		
* CALCULATED ITE	MHEAT BALANCE	E CODE = 8			
□□Washington Unive			ger experime	ent	E0002 P 39
Young model F302DY	_	-	-		9/23/ 3
-					CASE 19
S U P P L E	M E N T A	R Y F	R E S U	L T S	
HT PARAMETERS	SHELL TUBE	SHELI	SIDE PERFOR	RMANCE	
WALL CORRECTION	1.038 .000	NOMINAI	VEL, X-FLOW	FT/S	.05
PRANDTL NUMBER	7.3 4.2	NOMINAI	VEL, WINDOW	I FT/S	.10

				100 5
RYNLD NO, AVG 141 RYNLD NO, IN BUN 102 RYNLD NO, OUT BUN 187	1. /51.	CROSSFLOW CO	EF BTU/HR-FT2	2-F 183.5
RYNLD NO, IN BUN 102	2. 1000.	WINDOW COEF	BTU/HR-FT2	2-F 184.5
RYNLD NO, OUT BUN 187	7. 534.			
FOULNG LAYER IN001	.0014	SHELLSIDE	FLOW, % OF TOTA	AL .
FOULNG LAYER IN001		HEAT TRANSFE	R X-FLOW	81.35
THERMAL RESISTANCE, % C	OF TOTAL	TUBE TO BAFF	LE LEAKAGE A	2.84
SHELL TUBE FOULING	METAI.	MAIN CROSSEL	OW F	8 = 68.79
THERMAL RESISTANCE, % C SHELL TUBE FOULING 47.23 50.82 1.89 PCT OVER DESIGN	0.6	BIINDLE TO SH	ELL BYPASS (	' = 11 99
DOT OVER DESIGN	- 37	DAFFIF TO CU	EII IENKACE E	16 30
PCT OVER DESIGN TOT FOUL RESIST	000217	DAFFILE TO SIL	E DADYCC E	7 - 10.50
TOT FOUL RESIST	.000217	TUBE PASSLAN	E BIPASS F	00
DIFF RESIST	00003/			
		SHELLSIDE	HEAT TRANSFER F	TACTORS
DIAMETRAL CLEARANCES BUNDLE TO SHELL IN		TOTAL = (BETA	)(GAMMA)(FIN)	= .610
BUNDLE TO SHELL IN	15000	BETA (BAFF	CUT FACTOR)	= .920
TUBE TO BAFFLE HOLE IN	J 0284	GAMMA (TIIRE	ROW ENTRY EFCT)	= 663
BAFFLE TO SHELL IN	N1000	END (HT LO	SS IN END ZONE)	= .994
		,	,	
SHELL NOZZLE DATA	TN OUT	SHELL PRES	SIIRE DROP % OF	י יי∩יי∆ו.
HI ONDR NOZ IN.	.25	WINDOW		- 9.1
HT OPP NOZ IN.	.25	END ZONE		= 5.4
VELOCITY FT/S	.33 .33	CROSS FLOW		= 4.5
DENSITY LB/FT3 62.	.535 62.067	INLET NOZZLE		= 41.9
HT UNDR NOZ IN. HT OPP NOZ IN. VELOCITY FT/S DENSITY LB/FT3 62. NOZZ RHO*VSQ LB/FT-S2	6 6	OUTLET NOZZL	E	= 39.0
BUND RHO*VSQ LB/FT-S2	4 4			
TUBE NOZZLE DATA	IN OUT	WEIGHT PER	SHELL, LB	
			- ,	
VELOCITY FT/S	. 44 . 44	DRY	=	150.
TUBE NOZZLE DATA VELOCITY FT/S DENSITY LB/FT3 61	.44 .44	DRY WET	=	150. 165
DENSITY LB/FT3 61.	.291 62.161	DRY WET	=	150. 165.
DENSITY LB/FT3 61. PRESS. DROP %	.291 62.161 5.4 3.4	WET	=	165.
DENSITY LB/FT3 61. PRESS. DROP %  University	.291 62.161 5.4 3.4	WET	=	165. E0002 P 40
DENSITY LB/FT3 61. PRESS. DROP %	.291 62.161 5.4 3.4	WET	=	165. E0002 P 40 9/23/ 3
DENSITY LB/FT3 61. PRESS. DROP %  UNIVERSITY UNIVERSITY UNIVERSITY UNIVERSITY	.291 62.161 5.4 3.4 y ChE433 heat	WET exchanger ex	= periment	165. E0002 P 40 9/23/ 3 CASE 20
DENSITY LB/FT3 61.  PRESS. DROP %  University  Young model F302DY4P  SIZE 4- 18 TYPE BEM, MU	.291 62.161 5.4 3.4 y ChE433 heat	WET exchanger ex W. SEGMENTAL	= periment BAFFLES, RATING	165. E0002 P 40 9/23/ 3 CASE 20
DENSITY LB/FT3 61.  PRESS. DROP %  University  Young model F302DY4P  SIZE 4- 18 TYPE BEM, MU	.291 62.161 5.4 3.4 y ChE433 heat	WET exchanger ex W. SEGMENTAL	= periment BAFFLES, RATING	165. E0002 P 40 9/23/ 3 CASE 20
DENSITY LB/FT3 61.  PRESS. DROP %  University  Young model F302DY4P  SIZE 4- 18 TYPE BEM, MU	.291 62.161 5.4 3.4 y ChE433 heat	WET exchanger ex W. SEGMENTAL	= periment BAFFLES, RATING	165. E0002 P 40 9/23/ 3 CASE 20
DENSITY LB/FT3 61.  PRESS. DROP %  University  Young model F302DY4P  SIZE 4- 18 TYPE BEM, MU	.291 62.161 5.4 3.4 y ChE433 heat	WET exchanger ex W. SEGMENTAL	= periment BAFFLES, RATING	165. E0002 P 40 9/23/ 3 CASE 20
DENSITY LB/FT3 61.  PRESS. DROP %  University  Young model F302DY4P  SIZE 4- 18 TYPE BEM, MU	.291 62.161 5.4 3.4 y ChE433 heat	WET exchanger ex W. SEGMENTAL	= periment BAFFLES, RATING	165. E0002 P 40 9/23/ 3 CASE 20
DENSITY LB/FT3 61. PRESS. DROP %  UNIVERSITY UNIVERSITY UNIVERSITY UNIVERSITY	.291 62.161 5.4 3.4 y ChE433 heat	WET exchanger ex W, SEGMENTAL HOT TUBE SI Tube SENSIBLE L .300	periment  BAFFLES, RATING DE COLD S Shel IQ SENS	165.  E0002 P 40 9/23/ 3 CASE 20 GHELL SIDE L1 SIBLE LIQ .500
DENSITY LB/FT3 61.  PRESS. DROP %  □□Washington University Young model F302DY4P  SIZE 4- 18 TYPE BEM, MU  TOTAL FLOW RATE KLB/	.291 62.161 5.4 3.4 y ChE433 heat JLTI-PASS FLO	WET exchanger ex W, SEGMENTAL HOT TUBE SI Tube SENSIBLE L .300 IN O	periment  BAFFLES, RATING DE COLD S Shel IQ SENS	165.  E0002 P 40 9/23/3 CASE 20 G SHELL SIDE L1 SIBLE LIQ .500 OUT
DENSITY LB/FT3 61.  PRESS. DROP %  □□Washington University Young model F302DY4P  SIZE 4- 18 TYPE BEM, MU  TOTAL FLOW RATE KLB/  TEMPERATURE DEGE	.291 62.161 5.4 3.4 Y ChE433 heat JLTI-PASS FLO	wet exchanger ex  W, SEGMENTAL HOT TUBE SI Tube SENSIBLE L .300 IN O 140.0 7	periment  BAFFLES, RATING DE COLD S Shell IQ SENS  UT IN 3.1* 40.0	165.  E0002 P 40 9/23/ 3 CASE 20 G SHELL SIDE .1 SIBLE LIQ .500 OUT 79.9*
DENSITY LB/FT3 61.  PRESS. DROP %  DWashington University Young model F302DY4P  SIZE 4- 18 TYPE BEM, MU  TOTAL FLOW RATE KLB/ TEMPERATURE DEGE DENSITY LB/F	.291 62.161 5.4 3.4 y ChE433 heat JLTI-PASS FLO /HR	wet exchanger ex  W, SEGMENTAL HOT TUBE SI Tube SENSIBLE L .300 IN O 140.0 7 1.2913 62.2	periment  BAFFLES, RATING DE COLD S Shell IQ SENS  UT IN 3.1* 40.0 176 62.5352	165.  E0002 P 40 9/23/3 CASE 20 G SHELL SIDE .1 SIBLE LIQ .500 OUT 79.9* 62.1407
DENSITY LB/FT3 61.  PRESS. DROP %  DWashington University Young model F302DY4P  SIZE 4- 18 TYPE BEM, MU  TOTAL FLOW RATE KLB/ TEMPERATURE DEGE DENSITY LB/F VISCOSITY CP	.291 62.161 5.4 3.4 y ChE433 heat JLTI-PASS FLO /HR	wet exchanger ex w, segmental HOT TUBE SI Tube SENSIBLE L .300 IN O 140.0 7 1.2913 62.2 .4726 .9	### Periment  BAFFLES, RATING DE COLD S Shell IQ SENS  UT IN 3.1* 40.0 176 62.5352 409 1.4791	165.  E0002 P 40 9/23/ 3 CASE 20  GHELL SIDE .1 SIBLE LIQ .500 OUT 79.9* 62.1407 .8664
DENSITY LB/FT3 61.  PRESS. DROP %  DWashington University Young model F302DY4P  SIZE 4- 18 TYPE BEM, MU  TOTAL FLOW RATE KLB/ TEMPERATURE DEGE DENSITY LB/F VISCOSITY CP SPECIFIC HEAT BTU/	.291 62.161 5.4 3.4 y ChE433 heat JLTI-PASS FLO /HR FT3 6	wet exchanger ex  W, SEGMENTAL HOT TUBE SI Tube SENSIBLE L .300 IN O 140.0 7 1.2913 62.2 .4726 .9 .9973 1.0	### ##################################	165.  E0002 P 40 9/23/3 CASE 20 G SHELL SIDE .1 SIBLE LIQ .500 OUT 79.9* 62.1407 .8664 1.0004
DENSITY LB/FT3 61.  PRESS. DROP %  □□Washington University Young model F302DY4P  SIZE 4- 18 TYPE BEM, MU  TOTAL FLOW RATE KLB/F  TEMPERATURE DEGE DENSITY LB/F VISCOSITY CP SPECIFIC HEAT BTU/ THERMAL COND. BTU/	.291 62.161 5.4 3.4 y ChE433 heat JLTI-PASS FLO /HR FT3 6 /LB-F /HR-FT-F	wet exchanger ex w, segmental HOT TUBE SI Tube SENSIBLE L .300 IN O 140.0 7 1.2913 62.2 .4726 .9	### ##################################	165.  E0002 P 40 9/23/ 3 CASE 20  GHELL SIDE .1 SIBLE LIQ .500 OUT 79.9* 62.1407 .8664
DENSITY LB/FT3 61.  PRESS. DROP %  DWashington University Young model F302DY4P  SIZE 4- 18 TYPE BEM, MU  TOTAL FLOW RATE KLB/ TEMPERATURE DEGE DENSITY LB/F VISCOSITY CP SPECIFIC HEAT BTU/	.291 62.161 5.4 3.4 y ChE433 heat JLTI-PASS FLO /HR FT3 6 /LB-F /HR-FT-F	WET  exchanger ex  W, SEGMENTAL  HOT TUBE SI  Tube  SENSIBLE L  .300  IN O 140.0 7 1.2913 62.2 .4726 .9 .9973 1.0 .3723 .3	### ##################################	165.  E0002 P 40 9/23/3 CASE 20 G SHELL SIDE .1 SIBLE LIQ .500 OUT 79.9* 62.1407 .8664 1.0004
DENSITY LB/FT3 61.  PRESS. DROP %  □□Washington University Young model F302DY4P  SIZE 4- 18 TYPE BEM, MU  TOTAL FLOW RATE KLB/F  TEMPERATURE DEGE DENSITY LB/F VISCOSITY CP SPECIFIC HEAT BTU/ THERMAL COND. BTU/	.291 62.161 5.4 3.4 y ChE433 heat JLTI-PASS FLO /HR FT3 6 /LB-F /HR-FT-F	WET  exchanger ex  W, SEGMENTAL  HOT TUBE SI  Tube  SENSIBLE L  .300  IN O 140.0 7 1.2913 62.2 .4726 .9 .9973 1.0 .3723 .3	### Periment  BAFFLES, RATING DE COLD S Shell IQ SENS  UT IN 3.1* 40.0 176 62.5352 409 1.4791 011 1.0058 562 .3466 .02	165.  E0002 P 40 9/23/3 CASE 20 G SHELL SIDE .1 SIBLE LIQ .500 OUT 79.9* 62.1407 .8664 1.0004 .3581 18.02
DENSITY LB/FT3 61.  PRESS. DROP %  □□Washington University Young model F302DY4P  SIZE 4- 18 TYPE BEM, MU  TOTAL FLOW RATE KLB/F  TEMPERATURE DEGE DENSITY LB/F VISCOSITY CP SPECIFIC HEAT BTU/ THERMAL COND. BTU/	.291 62.161 5.4 3.4 Y ChE433 heat  JLTI-PASS FLO  /HR  FT3 6  /LB-F /HR-FT-F LBMOL	WET  exchanger ex  W, SEGMENTAL  HOT TUBE SI  Tube  SENSIBLE L  .300  IN O 140.0 7 1.2913 62.2 .4726 .9 .9973 1.0 .3723 .3	### Periment  BAFFLES, RATING DE COLD S	165.  E0002 P 40 9/23/3 CASE 20 G SHELL SIDE .1 SIBLE LIQ .500 OUT 79.9* 62.1407 .8664 1.0004 .3581 18.02
DENSITY LB/FT3 61.  PRESS. DROP %  □□Washington University Young model F302DY4P  SIZE 4- 18 TYPE BEM, MU  TOTAL FLOW RATE KLB/  TEMPERATURE DEGE DENSITY LB/F VISCOSITY CP SPECIFIC HEAT BTU/ THERMAL COND. BTU/ MOLAR MASS LB/I	.291 62.161 5.4 3.4 Y ChE433 heat  JLTI-PASS FLO  /HR  FT3 6  /LB-F /HR-FT-F LBMOL  DEGF	WET  exchanger ex  W, SEGMENTAL  HOT TUBE SI  Tube  SENSIBLE L  .300  IN O 140.0 7 1.2913 62.2 .4726 .9 .9973 1.0 .3723 .3  18	### Periment  BAFFLES, RATING DE COLD S Shell IQ SENS  UT IN 3.1* 40.0 176 62.5352 409 1.4791 011 1.0058 562 .3466 .02	165.  E0002 P 40 9/23/3 CASE 20 G SHELL SIDE .1 SIBLE LIQ .500 OUT 79.9* 62.1407 .8664 1.0004 .3581 18.02
DENSITY LB/FT3 61.  PRESS. DROP %  □□Washington University Young model F302DY4P  SIZE 4- 18 TYPE BEM, MU  TOTAL FLOW RATE KLB/F  TEMPERATURE DEGE DENSITY LB/F VISCOSITY CP SPECIFIC HEAT BTU/ THERMAL COND. BTU/ MOLAR MASS LB/I  TEMP, AVG & SKIN VISCOSITY, AVG & SKIN	.291 62.161 5.4 3.4 y ChE433 heat  JLTI-PASS FLO  /HR  FT3 6  /LB-F /HR-FT-F LBMOL  DEGF CP	WET  exchanger ex  W, SEGMENTAL  HOT TUBE SI  Tube  SENSIBLE L  .300  IN O 140.0 7 1.2913 62.2 .4726 .9 .9973 1.0 .3723 .3  18	### Periment  BAFFLES, RATING DE COLD S Shell IQ SENS  UT IN 3.1* 40.0 176 62.5352 409 1.4791 011 1.0058 562 .3466 .02	165.  E0002 P 40 9/23/3 CASE 20 G SHELL SIDE .1 SIBLE LIQ .500 OUT 79.9* 62.1407 .8664 1.0004 .3581 18.02
DENSITY LB/FT3 61.  PRESS. DROP %  □□Washington University Young model F302DY4P  SIZE 4- 18 TYPE BEM, MU  TOTAL FLOW RATE KLB/  TEMPERATURE DEGE DENSITY LB/E VISCOSITY CP SPECIFIC HEAT BTU/ THERMAL COND. BTU/ MOLAR MASS LB/I  TEMP, AVG & SKIN	.291 62.161 5.4 3.4 y ChE433 heat  JLTI-PASS FLO  /HR  FT3 6  /LB-F /HR-FT-F LBMOL  DEGF CP	WET  exchanger ex  W, SEGMENTAL  HOT TUBE SI  Tube  SENSIBLE L  .300  IN O 140.0 7 1.2913 62.2 .4726 .9 .9973 1.0 .3723 .3  18	### Periment  BAFFLES, RATING DE COLD S Shell IQ SENS  UT IN 3.1* 40.0 176 62.5352 409 1.4791 011 1.0058 562 .3466 .02	165.  E0002 P 40 9/23/3 CASE 20 G SHELL SIDE .1 SIBLE LIQ .500 OUT 79.9* 62.1407 .8664 1.0004 .3581 18.02
DENSITY LB/FT3 61.  PRESS. DROP %  □□Washington University Young model F302DY4P  SIZE 4- 18 TYPE BEM, MU  TOTAL FLOW RATE KLB/F  TEMPERATURE DEGE DENSITY LB/F VISCOSITY CP SPECIFIC HEAT BTU/ THERMAL COND. BTU/ MOLAR MASS LB/I  TEMP, AVG & SKIN VISCOSITY, AVG & SKIN PRESSURE, IN & DESIGN	.291 62.161 5.4 3.4 y ChE433 heat  JLTI-PASS FLO  /HR  FT3 6  /LB-F /HR-FT-F LBMOL  DEGF CP PSIA	WET  exchanger ex  W, SEGMENTAL  HOT TUBE SI  Tube  SENSIBLE L  .300  IN O 140.0 7 1.2913 62.2 .4726 .9 .9973 1.0 .3723 .3  18 106.6 8 .6461 .8 50.00 165	### Periment  BAFFLES, RATING  DE COLD S	165.  E0002 P 40 9/23/3 CASE 20 G SHELL SIDE SIBLE LIQ .500 OUT 79.9* 62.1407 .8664 1.0004 .3581 18.02 80.5 .8604 165.00
DENSITY LB/FT3 61.  PRESS. DROP %  □□Washington University Young model F302DY4P  SIZE 4- 18 TYPE BEM, MU  TOTAL FLOW RATE KLB/  TEMPERATURE DEGE DENSITY LB/F VISCOSITY CP SPECIFIC HEAT BTU/ THERMAL COND. BTU/ MOLAR MASS LB/I  TEMP, AVG & SKIN VISCOSITY, AVG & SKIN PRESSURE, IN & DESIGN  PRESSURE DROP, TOT & AI	.291 62.161 5.4 3.4 Y ChE433 heat  JLTI-PASS FLO  /HR  FT3 6  /LB-F /HR-FT-F LBMOL  DEGF CP PSIA  LLOWED PSI	WET  exchanger ex  W, SEGMENTAL  HOT TUBE SI Tube  SENSIBLE L  .300 IN O 140.0 7 1.2913 62.2 .4726 .9 .9973 1.0 .3723 .3 18 106.6 8 .6461 .8 50.00 165	### Periment  BAFFLES, RATING  DE COLD S	165.  E0002 P 40 9/23/3 CASE 20  SHELL SIDE  SIBLE LIQ .500  OUT 79.9* 62.1407 .8664 1.0004 .3581 18.02 80.5 .8604 165.00
DENSITY LB/FT3 61.  PRESS. DROP %  □□Washington University Young model F302DY4P  SIZE 4- 18 TYPE BEM, MU  TOTAL FLOW RATE KLB/F  TEMPERATURE DEGE DENSITY LB/F VISCOSITY CP SPECIFIC HEAT BTU/ THERMAL COND. BTU/ MOLAR MASS LB/I  TEMP, AVG & SKIN VISCOSITY, AVG & SKIN PRESSURE, IN & DESIGN	.291 62.161 5.4 3.4 Y ChE433 heat  JLTI-PASS FLO  HR  FT3 6  LB-F  HR-FT-F  LBMOL  DEGF  CP PSIA  LLOWED PSI	WET  exchanger ex  W, SEGMENTAL  HOT TUBE SI Tube  SENSIBLE L  .300 IN O 140.0 7 1.2913 62.2 .4726 .9 .9973 1.0 .3723 .3 18 106.6 8 .6461 .8 50.00 165	### Periment  BAFFLES, RATING  DE COLD S	165.  E0002 P 40 9/23/3 CASE 20 G SHELL SIDE SIBLE LIQ .500 OUT 79.9* 62.1407 .8664 1.0004 .3581 18.02 80.5 .8604 165.00
DENSITY LB/FT3 61.  PRESS. DROP %  □□Washington University Young model F302DY4P  SIZE 4- 18 TYPE BEM, MU  TOTAL FLOW RATE KLB/  TEMPERATURE DEGE DENSITY LB/F VISCOSITY CP SPECIFIC HEAT BTU/ THERMAL COND. BTU/ MOLAR MASS LB/I  TEMP, AVG & SKIN VISCOSITY, AVG & SKIN PRESSURE, IN & DESIGN  PRESSURE DROP, TOT & AI	.291 62.161 5.4 3.4 Y ChE433 heat  JLTI-PASS FLO  /HR  F FT3 6  /LB-F /HR-FT-F LBMOL  DEGF CP PSIA  LLOWED PSI LLOWED FT/S	WET  exchanger ex  W, SEGMENTAL  HOT TUBE SI Tube SENSIBLE L .300 IN O 140.0 7 1.2913 62.2 .4726 .9 .9973 1.0 .3723 .3 I8	### Periment  BAFFLES, RATING COLD S	165.  E0002 P 40 9/23/3 CASE 20  SHELL SIDE  SIBLE LIQ .500  OUT 79.9* 62.1407 .8664 1.0004 .3581 18.02 80.5 .8604 165.00

FILM COEFFICIENT		-F 203.18 20	06.97
	ED MEGBTU/HI MTD= 45.3,F	R = .71,BYPASS= .94,BAFF=1.00)	
OVERALL COEFF REQUIRED	BTU/HR-F	T2-F	92.79
CLEAN & FOULED COEFF	BTU/HR-F	T2-F 94.44	92.35
		TOTAL EFF AREA FT2	
		EFFECTIVE AREA FT2/SHELL	
SHELL DIAMETER IN.	3.820	TEMA SHELL TYPE E ; REAR HE	CAD FXTS
BAFFLE TYPE HORZ	SEGMENTL	CROSS PASSES PER SHELL PASS	
SPACING, CENTRAL IN.			
SPACING, INLET IN.		CUT DISTANCE FROM CENTER, IN.	.764
SPACING, OUTLET IN.			
		IMPINGEMENT BAFFLE INCLUDED	
PAIRS OF SEALING DEVIC	ES 1	TUBESHEET BLANK AREA, %	.0
TUBE TYPE	PLAIN	MATERIAL ELECTROLYTIC	COPPER
NO. OF TUBES/SHELL		EST MAX TUBE COUNT	36
TUBE LGTH, OVERALL FT	1.500	TUBE PITCH IN.	.3125
TUBE LGTH, EFF FT	1.436	TUBE OUTSIDE DIAM IN.	.250
		TUBE INSIDE DIAM IN.	
PITCH RATIO	1.250	TUBE SURFACE RATIO, OUT/IN	1.184
SHL NOZZ ID, IN&OUT	1.0 1.0	TUBE NOZZ ID, IN&OUT IN.	.8 .8
* CALCULATED ITEMH	FA'I' BALANCE	(CODE = 8)	
□□Washington Universit Young model F302DY4P	y ChE433 he	at exchanger experiment	E0002 P 41 9/23/ 3 CASE 20
□□Washington Universit Young model F302DY4P	y ChE433 he	at exchanger experiment	9/23/ 3
□□Washington Universit Young model F302DY4P  S U P P L E M E  HT PARAMETERS SHE	y ChE433 he.  N T A 1  LL TUBE	at exchanger experiment  R Y R E S U L T S  SHELLSIDE PERFORMANCE	9/23/ 3 CASE 20
□□Washington Universit Young model F302DY4P  S U P P L E M E  HT PARAMETERS SHE WALL CORRECTION 1.0	y ChE433 head N T A DEL TUBE 37 .000	at exchanger experiment  R Y R E S U L T S  SHELLSIDE PERFORMANCE NOMINAL VEL, X-FLOW FT/S	9/23/ 3 CASE 20
University Young model F302DY4P  S U P P L E M E  HT PARAMETERS SHE WALL CORRECTION 1.0 PRANDTL NUMBER 7	N T A LL TUBE 37 .000 .7 4.3	at exchanger experiment  R Y R E S U L T S  SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S  NOMINAL VEL, WINDOW FT/S	9/23/ 3 CASE 20 .07 .13
University oung model F302DY4P  S U P P L E M E  HT PARAMETERS SHE WALL CORRECTION 1.0 PRANDTL NUMBER 7 RYNLD NO, AVG 16	N T A D LL TUBE 37 .000 .7 4.3 9. 732.	at exchanger experiment  R Y R E S U L T S  SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S  NOMINAL VEL, WINDOW FT/S  CROSSFLOW COEF BTU/HR-FT2-	9/23/3 CASE 20 .07 .13
University oung model F302DY4P  S U P P L E M E  HT PARAMETERS SHE WALL CORRECTION 1.0 PRANDTL NUMBER 7 RYNLD NO, AVG 16 RYNLD NO, IN BUN 12	N T A 1  LL TUBE 37 .000 .7 4.3 9. 732. 7. 1000.	at exchanger experiment  R Y R E S U L T S  SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S  NOMINAL VEL, WINDOW FT/S	9/23/3 CASE 20 .07 .13
Universit Young model F302DY4P  S U P P L E M E  HT PARAMETERS SHE WALL CORRECTION 1.0 PRANDTL NUMBER 7 RYNLD NO, AVG 16 RYNLD NO, IN BUN 12 RYNLD NO,OUT BUN 21	N T A 1  LL TUBE 37 .000 .7 4.3 9. 732. 7. 1000. 7. 502.	at exchanger experiment  R Y R E S U L T S  SHELLSIDE PERFORMANCE NOMINAL VEL,X-FLOW FT/S NOMINAL VEL,WINDOW FT/S CROSSFLOW COEF BTU/HR-FT2-WINDOW COEF BTU/HR-FT2-	9/23/3 CASE 20 .07 .13 F 207.8 F 209.1
Universit Young model F302DY4P  S U P P L E M E  HT PARAMETERS SHE WALL CORRECTION 1.0 PRANDTL NUMBER 7 RYNLD NO, AVG 16 RYNLD NO, IN BUN 12 RYNLD NO,OUT BUN 21	N T A 1  LL TUBE 37 .000 .7 4.3 9. 732. 7. 1000. 7. 502.	at exchanger experiment  R Y R E S U L T S  SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S  NOMINAL VEL, WINDOW FT/S  CROSSFLOW COEF BTU/HR-FT2-  WINDOW COEF BTU/HR-FT2-  SHELLSIDE FLOW, % OF TOTAL	9/23/3 CASE 20 .07 .13 F 207.8 F 209.1
□□Washington Universit Young model F302DY4P  S U P P L E M E  HT PARAMETERS SHE WALL CORRECTION 1.0 PRANDTL NUMBER 7 RYNLD NO, AVG 16 RYNLD NO, IN BUN 12 RYNLD NO,OUT BUN 21 FOULNG LAYER IN00	N T A D LL TUBE 37 .000 .7 4.3 9. 732. 7. 1000. 7. 502. 14 .0014	at exchanger experiment  R Y R E S U L T S  SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S  NOMINAL VEL, WINDOW FT/S  CROSSFLOW COEF BTU/HR-FT2-  WINDOW COEF BTU/HR-FT2-  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW	9/23/3 CASE 20 .07 .13 FF 207.8 FF 209.1
Universityoung model F302DY4P  S U P P L E M E  HT PARAMETERS SHE WALL CORRECTION 1.0 PRANDTL NUMBER 7 RYNLD NO, AVG 16 RYNLD NO, IN BUN 12 RYNLD NO,OUT BUN 21 FOULNG LAYER IN00  THERMAL RESISTANCE, %	N T A D LL TUBE 37 .000 .7 4.3 9. 732. 7. 1000. 7. 502. 14 .0014 OF TOTAL	at exchanger experiment  R Y R E S U L T S  SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S  NOMINAL VEL, WINDOW FT/S  CROSSFLOW COEF BTU/HR-FT2-  WINDOW COEF BTU/HR-FT2-  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW  TUBE TO BAFFLE LEAKAGE A	9/23/3 CASE 20 .07 .13 F 207.8 F 209.1 
Universityoung model F302DY4P  S U P P L E M E  HT PARAMETERS SHE WALL CORRECTION 1.0 PRANDTL NUMBER 7 RYNLD NO, AVG 16 RYNLD NO, IN BUN 12 RYNLD NO,OUT BUN 21 FOULNG LAYER IN00  THERMAL RESISTANCE, % SHELL TUBE FOULING	N T A 1  LL TUBE 37 .000 .7 4.3 9. 732. 7. 1000. 7. 502. 14 .0014  OF TOTAL METAL	at exchanger experiment  R Y R E S U L T S  SHELLSIDE PERFORMANCE NOMINAL VEL, X-FLOW FT/S NOMINAL VEL, WINDOW FT/S CROSSFLOW COEF BTU/HR-FT2- WINDOW COEF BTU/HR-FT2- SHELLSIDE FLOW, % OF TOTAL HEAT TRANSFER X-FLOW TUBE TO BAFFLE LEAKAGE A MAIN CROSSFLOW B	9/23/3 CASE 20 .07 .13 FF 207.8 FF 209.1 .81.43 = 3.02 = 68.00
Universit Young model F302DY4P  S U P P L E M E  HT PARAMETERS SHE WALL CORRECTION 1.0 PRANDTL NUMBER 7 RYNLD NO, AVG 16 RYNLD NO, IN BUN 12 RYNLD NO,OUT BUN 21 FOULNG LAYER IN00  THERMAL RESISTANCE, % SHELL TUBE FOULING 44.12 53.81 2.00	N T A D LL TUBE 37 .000 .7 4.3 9. 732. 7. 1000. 7. 502. 14 .0014  OF TOTAL METAL .07	AT EXCHANGER EXPERIMENT  R Y R E S U L T S  SHELLSIDE PERFORMANCE NOMINAL VEL, X-FLOW FT/S NOMINAL VEL, WINDOW FT/S CROSSFLOW COEF BTU/HR-FT2- WINDOW COEF BTU/HR-FT2- SHELLSIDE FLOW, % OF TOTAL HEAT TRANSFER X-FLOW TUBE TO BAFFLE LEAKAGE A MAIN CROSSFLOW B BUNDLE TO SHELL BYPASS C	9/23/3 CASE 20 .07 .13 F 207.8 F 209.1 81.43 = 3.02 = 68.00 = 12.83
Universit Young model F302DY4P  S U P P L E M E  HT PARAMETERS SHE WALL CORRECTION 1.0 PRANDTL NUMBER 7 RYNLD NO, AVG 16 RYNLD NO, IN BUN 12 RYNLD NO, OUT BUN 21 FOULNG LAYER IN00  THERMAL RESISTANCE, % SHELL TUBE FOULING 44.12 53.81 2.00 PCT OVER DESIGN	N T A D LL TUBE 37 .000 .7 4.3 9. 732. 7. 1000. 7. 502. 14 .0014  OF TOTAL METAL .0747	AT EXCHANGER EXPERIMENT  R Y R E S U L T S  SHELLSIDE PERFORMANCE NOMINAL VEL, X-FLOW FT/S NOMINAL VEL, WINDOW FT/S CROSSFLOW COEF BTU/HR-FT2- WINDOW COEF BTU/HR-FT2-  SHELLSIDE FLOW, % OF TOTAL HEAT TRANSFER X-FLOW TUBE TO BAFFLE LEAKAGE A MAIN CROSSFLOW B BUNDLE TO SHELL BYPASS C BAFFLE TO SHELL LEAKAGE E	9/23/3 CASE 20 .07 .13 F 207.8 F 209.1 81.43 = 3.02 = 68.00 = 12.83 = 16.15
THERMAL RESISTANCE, % SHELL TUBE FOULING 44.12 53.81 2.00 POUND MODEL TO THE TOUL RESIST	N T A 1  LL TUBE 37 .000 .7 4.3 9. 732. 7. 1000. 7. 502. 14 .0014  OF TOTAL METAL .0747 .000217	AT EXCHANGER EXPERIMENT  R Y R E S U L T S  SHELLSIDE PERFORMANCE NOMINAL VEL, X-FLOW FT/S NOMINAL VEL, WINDOW FT/S CROSSFLOW COEF BTU/HR-FT2- WINDOW COEF BTU/HR-FT2-  SHELLSIDE FLOW, % OF TOTAL HEAT TRANSFER X-FLOW TUBE TO BAFFLE LEAKAGE A MAIN CROSSFLOW B BUNDLE TO SHELL BYPASS C BAFFLE TO SHELL LEAKAGE E	9/23/3 CASE 20 .07 .13 F 207.8 F 209.1 81.43 = 3.02 = 68.00 = 12.83 = 16.15
Universit Young model F302DY4P  S U P P L E M E  HT PARAMETERS SHE WALL CORRECTION 1.0 PRANDTL NUMBER 7 RYNLD NO, AVG 16 RYNLD NO, IN BUN 12 RYNLD NO, OUT BUN 21 FOULNG LAYER IN00  THERMAL RESISTANCE, % SHELL TUBE FOULING 44.12 53.81 2.00 PCT OVER DESIGN	N T A 1  LL TUBE 37 .000 .7 4.3 9. 732. 7. 1000. 7. 502. 14 .0014  OF TOTAL METAL .0747 .000217	AT EXCHANGER EXPERIMENT  R Y R E S U L T S  SHELLSIDE PERFORMANCE NOMINAL VEL, X-FLOW FT/S NOMINAL VEL, WINDOW FT/S CROSSFLOW COEF BTU/HR-FT2- WINDOW COEF BTU/HR-FT2-  SHELLSIDE FLOW, % OF TOTAL HEAT TRANSFER X-FLOW TUBE TO BAFFLE LEAKAGE A MAIN CROSSFLOW B BUNDLE TO SHELL BYPASS C BAFFLE TO SHELL LEAKAGE E TUBE PASSLANE BYPASS F	9/23/3 CASE 20 .07 .13 FF 207.8 FF 209.1 81.43 = 3.02 = 68.00 = 12.83 = 16.15 = .00
University oung model F302DY4P  S U P P L E M E  HT PARAMETERS SHE WALL CORRECTION 1.0 PRANDTL NUMBER 7 RYNLD NO, AVG 16 RYNLD NO, IN BUN 12 RYNLD NO,OUT BUN 21 FOULNG LAYER IN00  THERMAL RESISTANCE, % SHELL TUBE FOULING 44.12 53.81 2.00 PCT OVER DESIGN TOT FOUL RESIST DIFF RESIST	Y ChE433 he.  N T A  LL TUBE 37 .000 .7 4.3 9. 732. 7. 1000. 7. 502. 14 .0014  OF TOTAL METAL .07 .000217 .000051	AT EXCHANGER EXPERIMENT  R Y R E S U L T S  SHELLSIDE PERFORMANCE NOMINAL VEL, X-FLOW FT/S NOMINAL VEL, WINDOW FT/S CROSSFLOW COEF BTU/HR-FT2-WINDOW COEF BTU/HR-FT2-  SHELLSIDE FLOW, % OF TOTAL HEAT TRANSFER X-FLOW TUBE TO BAFFLE LEAKAGE A MAIN CROSSFLOW B BUNDLE TO SHELL BYPASS C BAFFLE TO SHELL LEAKAGE E TUBE PASSLANE BYPASS F	9/23/3 CASE 20 .07 .13 F 207.8 F 209.1 81.43 = 3.02 = 68.00 = 12.83 = 16.15 = .00
University oung model F302DY4P  S U P P L E M E  HT PARAMETERS SHE WALL CORRECTION 1.0 PRANDTL NUMBER 7 RYNLD NO, AVG 16 RYNLD NO, IN BUN 12 RYNLD NO, OUT BUN 21 FOULNG LAYER IN00  THERMAL RESISTANCE, % SHELL TUBE FOULING 44.12 53.81 2.00 PCT OVER DESIGN TOT FOUL RESIST DIFF RESIST	N T A  LL TUBE 37 .000 .7 4.3 9. 732. 7. 1000. 7. 502. 14 .0014  OF TOTAL METAL .07 .000217 .000051	AT EXCHANGER EXPERIMENT  R Y R E S U L T S  SHELLSIDE PERFORMANCE NOMINAL VEL, X-FLOW FT/S NOMINAL VEL, WINDOW FT/S CROSSFLOW COEF BTU/HR-FT2- WINDOW COEF BTU/HR-FT2-  SHELLSIDE FLOW, % OF TOTAL HEAT TRANSFER X-FLOW TUBE TO BAFFLE LEAKAGE A MAIN CROSSFLOW B BUNDLE TO SHELL BYPASS C BAFFLE TO SHELL BYPASS C BAFFLE TO SHELL LEAKAGE E TUBE PASSLANE BYPASS F  SHELLSIDE HEAT TRANSFER FA TOTAL = (BETA) (GAMMA) (FIN)	9/23/3 CASE 20  .07 .13 F 207.8 F 209.1  81.43 = 3.02 = 68.00 = 12.83 = 16.15 = .00  ACTORS = .625
DOWNSHINGTON University Young model F302DY4P  S U P P L E M E  HT PARAMETERS SHE WALL CORRECTION 1.0 PRANDTL NUMBER 7 RYNLD NO, AVG 16 RYNLD NO, IN BUN 12 RYNLD NO, OUT BUN 21 FOULNG LAYER IN00  THERMAL RESISTANCE, % SHELL TUBE FOULING 44.12 53.81 2.00 PCT OVER DESIGN TOT FOUL RESIST DIFF RESIST  DIAMETRAL CLEARANCES BUNDLE TO SHELL I	N T A  LL TUBE 37 .000 .7 4.3 9. 732. 7. 1000. 7. 502. 14 .0014  OF TOTAL METAL .07 .000217 .000051  N5000	AT EXCHANGER EXPERIMENT  R Y R E S U L T S  SHELLSIDE PERFORMANCE NOMINAL VEL, X-FLOW FT/S NOMINAL VEL, WINDOW FT/S CROSSFLOW COEF BTU/HR-FT2- WINDOW COEF BTU/HR-FT2- SHELLSIDE FLOW, % OF TOTAL HEAT TRANSFER X-FLOW TUBE TO BAFFLE LEAKAGE A MAIN CROSSFLOW B BUNDLE TO SHELL BYPASS C BAFFLE TO SHELL BYPASS C BAFFLE TO SHELL LEAKAGE E TUBE PASSLANE BYPASS F  SHELLSIDE HEAT TRANSFER FA TOTAL = (BETA) (GAMMA) (FIN) BETA (BAFF CUT FACTOR)	9/23/3 CASE 20 .07 .13 F 207.8 F 209.1 81.43 = 3.02 = 68.00 = 12.83 = 16.15 = .00 ACTORS = .625 = .920
DOWNSHINGTON University Young model F302DY4P  S U P P L E M E  HT PARAMETERS SHE WALL CORRECTION 1.0 PRANDTL NUMBER 7 RYNLD NO, AVG 16 RYNLD NO, IN BUN 12 RYNLD NO, OUT BUN 21 FOULNG LAYER IN00  THERMAL RESISTANCE, % SHELL TUBE FOULING 44.12 53.81 2.00 PCT OVER DESIGN TOT FOUL RESIST DIFF RESIST  DIAMETRAL CLEARANCES BUNDLE TO SHELL I TUBE TO BAFFLE HOLE I	N T A  LL TUBE 37 .000 .7 4.3 9. 732. 7. 1000. 7. 502. 14 .0014  OF TOTAL METAL .07 .000217000051  N5000 N0284	AT EXCHANGER EXPERIMENT  R Y R E S U L T S  SHELLSIDE PERFORMANCE NOMINAL VEL, X-FLOW FT/S NOMINAL VEL, WINDOW FT/S CROSSFLOW COEF BTU/HR-FT2- WINDOW COEF BTU/HR-FT2- SHELLSIDE FLOW, % OF TOTAL HEAT TRANSFER X-FLOW TUBE TO BAFFLE LEAKAGE A MAIN CROSSFLOW B BUNDLE TO SHELL BYPASS C BAFFLE TO SHELL LEAKAGE E TUBE PASSLANE BYPASS F  SHELLSIDE HEAT TRANSFER FA TOTAL = (BETA) (GAMMA) (FIN) BETA (BAFF CUT FACTOR) GAMMA (TUBE ROW ENTRY EFCT)	9/23/3 CASE 20 .07 .13 F 207.8 F 209.1 81.43 = 3.02 = 68.00 = 12.83 = 16.15 = .00 ACTORS = .625 = .920 = .679
DOWNSHINGTON University Young model F302DY4P  S U P P L E M E  HT PARAMETERS SHE WALL CORRECTION 1.0 PRANDTL NUMBER 7 RYNLD NO, AVG 16 RYNLD NO, IN BUN 12 RYNLD NO, OUT BUN 21 FOULNG LAYER IN00  THERMAL RESISTANCE, % SHELL TUBE FOULING 44.12 53.81 2.00 PCT OVER DESIGN TOT FOUL RESIST DIFF RESIST  DIAMETRAL CLEARANCES BUNDLE TO SHELL I TUBE TO BAFFLE HOLE I	N T A  LL TUBE 37 .000 .7 4.3 9. 732. 7. 1000. 7. 502. 14 .0014  OF TOTAL METAL .07 .000217000051  N5000 N0284	AT EXCHANGER EXPERIMENT  R Y R E S U L T S  SHELLSIDE PERFORMANCE NOMINAL VEL, X-FLOW FT/S NOMINAL VEL, WINDOW FT/S CROSSFLOW COEF BTU/HR-FT2- WINDOW COEF BTU/HR-FT2- SHELLSIDE FLOW, % OF TOTAL HEAT TRANSFER X-FLOW TUBE TO BAFFLE LEAKAGE A MAIN CROSSFLOW B BUNDLE TO SHELL BYPASS C BAFFLE TO SHELL BYPASS C BAFFLE TO SHELL LEAKAGE E TUBE PASSLANE BYPASS F  SHELLSIDE HEAT TRANSFER FA TOTAL = (BETA) (GAMMA) (FIN) BETA (BAFF CUT FACTOR)	9/23/3 CASE 20 .07 .13 F 207.8 F 209.1 81.43 = 3.02 = 68.00 = 12.83 = 16.15 = .00 ACTORS = .625 = .920 = .679

		cne433b (4	10).OUT		
HT UNDR NOZ IN.	.25	WINDOW			= 9.0
HT OPP NOZ IN.	.25	END ZON	E		= 5.0
HT OPP NOZ IN. VELOCITY FT/S	41 41	CROSS F	T.OW		= 4 2
DENGITY IB/ET3	62 535 62 1/1	TNIET N			- 12 2
DENSITY LB/FT3	02.555 02.141		NOTTE		= 5.0 = 4.2 = 42.2 = 39.7
NOZZ RHO*VSQ LB/FT	-52 10 10	OUTLET	NOZZLŁ		= 39.7
BUND RHO*VSQ LB/FT	-S2 7 7				
TUBE NOZZLE DATA	IN OUT	WEIGH	T PER SHELI	L, LB	
VELOCITY FT/S	.44 .44	DRY		=	150.
DENSITY LB/FT3				=	165.
					100.
PRESS. DROP %					70000 P 40
$\square\square$ Washington Unive	_	at exchang	er experime	ent	
Young model F302DY	4 P				9/23/ 3
					CASE 21
SIZE 4- 18 TYPE BE	M, MULTI-PASS FI	LOW, SEGME	NTAL BAFFLI	ES, RATING	
	,		BE SIDE		
		muh o		Chall	
		Tube	BLE LIQ	SHETI	-
		SENSI	BTE TIÖ	SENSI	BPE PIŐ
TOTAL FLOW RATE	KLB/HR		.300		.600
TEMPERATURE DENSITY		IN	OUT	IN	OUT
TEMPERATURE	DEGF	140.0	69.5*	40.0	75.1*
DENSITY	LB/FT3	61.2913	62.2574	62.5352	62.1957
VISCOSITY	CP	4726	9851	1 4791	9183
CDECTET HEAD		0072	1 0016	1 0050	1 0000
SPECIFIC HEAT	BIU/LB-F	.99/3	1.0016	1.0036	1.0009
THERMAL COND.	BTU/HR-FT-F	.3/23	.3552	.3466	.3568
MOLAR MASS	LB/LBMOL		18.02		18.02
			18.02		
TEMP, AVG & SKIN	DEGF	104.7	78.2	57.6	77.1
VISCOSITY, AVG & S	KIN CP	.6584	.8850	1.1509	.8959
PRESSURE, IN & DES					
,					
PRESSURE DROP, TOT	c ATTOMED DST	0.3	10 00	0.1	10 00
VELOCITY CALC S M	AV ALLOWED EM/(	.00	10.00	10	10.00
VELOCITY, CALC & M	AX ALLOWED FT/S	.29	10.00	.10	10.00
	/		0.01.0	,	0.01.0
FOULING RESISTANCE				. (	
FILM COEFFICIENT	BTU/HR-FT2-	-F 20	3.14	23	30.02
TOTAL HEAT DUTY RE	QUIRED MEGBTU/HF	3			.021130
EFF TEMP DIF, DEGF	(LMTD= 44.9,F=	= .73,BYPA	SS= .94, BA	FF=1.00)	30.6
OVERALL COEFF REQU					96.51
CLEAN & FOULED COE			98 96	5	
CHEIN W LOOPED COL	II DIO/IIICII	12 1	30.31	,	J0.01
CHELLO IN CEDIES	1 החדדה 1		7.007	TITE O	7.1
SHELLS IN SERIES	I PARALLEL I	TOTAL EFF	AKEA	F12	7.1
PASSES, SHELL					
SHELL DIAMETER IN.	3.820	TEMA SHEL	L TYPE E	; REAR HE	EAD FXTS
BAFFLE TYPE H					
SPACING, CENTRAL	IN. 4.309	BAFFLE CU	T, PCT SHE	LL I.D.	30.00
SPACING, INLET	IN. 4.309	CUT DISTA	NCE FROM CI	ENTER, IN.	.764
SPACING, OUTLET				,	
BAFFLE THICKNESS	TN 125	TMPTNCEME	NT BAFFT.F	NCLUDED	NO
DAIDS OF SEATING D	±1N ±45	THI THREME	DINNU ADD.		110
PAIRS OF SEALING D	rvicro I	TORESHEET	DLANK AKEA	1, 6	. 0

NO. OF TUBES/SHELL	PLAIN MA	ST MAX TUBE COUNT	YTIC COPPER
TUBE LGTH, OVERALL FT	1.500 T	JBE PITCH IN.	.3125
TUBE LGTH, EFF FT		JBE OUTSIDE DIAM IN.	.250
		JBE INSIDE DIAM IN.	.214
PITCH RATIO	1.250 T	JBE SURFACE RATIO, OUT/IN	1.184
PITCH RATIO SHL NOZZ ID, IN&OUT 1.0	1.0 T	JBE NOZZ ID, IN&OUT IN.	.8 .8
		,	
* CALCULATED ITEMHEAT \( \subseteq \text{Washington University Characteristics} \) Young model F302DY4P			E0002 P 43 9/23/ 3 CASE 21
S U P P L E M E N	T A R	Y RESULTS	5
HT PARAMETERS SHELL	TUBE	SHELLSIDE PERFORMANCE	
WALL CORRECTION 1.036	.000	NOMINAL VEL, X-FLOW FT/S	.08
PRANDTL NUMBER 7.9	4.4	NOMINAL VEL, WINDOW FT/S	.15
RYNLD NO, AVG 196.	718	CROSSFLOW COEF BTU/HR-H	FT2-F 230.9
RYNLD NO, IN BUN 153.	1000.	WINDOW COEF BTU/HR-H	FT2-F 232.4
RYNLD NO, IN BUN 153. RYNLD NO, OUT BUN 246.	480.		
FOULNG LAYER IN0014	.0014	SHELLSIDE FLOW, % OF TO HEAT TRANSFER X-FLOW	OTAL
		HEAT TRANSFER X-FLOW	81.51
THERMAL RESISTANCE, % OF T	COTAL	TUBE TO BAFFLE LEAKAGE	A = 3.18
SHELL TUBE FOULING ME 41.53 56.30 2.09	CTAL	MAIN CROSSFLOW	B = 67.31
41.53 56.30 2.09	.07	BUNDLE TO SHELL BYPASS	C = 13.56
PCT OVER DESIGN	.10	BAFFLE TO SHELL LEAKAGE	E = 15.95
TOT FOUL RESIST .	000217	TUBE PASSLANE BYPASS	F = .00
	000011		
		SHELLSIDE HEAT TRANSFER	R FACTORS
DIAMETRAL CLEARANCES		TOTAL = (BETA) (GAMMA) (FIN)	
BUNDLE TO SHELL IN.	.5000	BETA (BAFF CUT FACTOR)	
TUBE TO BAFFLE HOLE IN.	.0284	GAMMA (TUBE ROW ENTRY EFO	CT) = .695
BAFFLE TO SHELL IN.	.1000	END (HT LOSS IN END ZON	NE) = .994
		SHELL PRESSURE DROP, %	
HT UNDR NOZ IN25		WINDOW	= 8.9
HT OPP NOZ IN25		END ZONE	= 4.6
		CROSS FLOW	= 3.9
DENSITY LB/FT3 62.535		INLET NOZZLE	= 42.3
NOZZ RHO*VSQ LB/FT-S2 14		OUTLET NOZZLE	= 40.2
BUND RHO*VSQ LB/FT-S2 10	10		
TUBE NOZZLE DATA IN	I OUT	WEIGHT PER SHELL, LB	
VELOCITY FT/S .44	. 44	DRY	= 150.
DENSITY LB/FT3 61.291			= 165.
	3.2		
□□Washington University Ch		exchanger experiment	E0002 P 44
Young model F302DY4P	1 1000		9/23/ 3 CASE 22
SIZE 4- 18 TYPE BEM, MULTI	-PASS FLO	N, SEGMENTAL BAFFLES, RATI	ING
		HOT TUBE SIDE COLI	SHELL SIDE
		Tube Sh	nell
		SENSIBLE LIQ SE	ENSIBLE LIQ

			40).OUT		
TOTAL FLOW RATE	KLB/HR		.300		.700
		IN	.300 OUT	IN	OUT
TEMPERATURE	DECE	1/10 0	66 5*	40.0	71 3*
DENSITY	TD /Dm2	(1 2012	(2 2006	40.0	(1.3
VISCOSITY					
SPECIFIC HEAT	BTU/LB-F	.9973	1.0019	1.0058	1.0013
THERMAL COND.	BTU/HR-FT-F	.3723	.3544	.3466	.3557
MOLAR MASS			18.02		
110 2111 11110 0	22, 221102				
TEMP, AVG & SKIN	DECE				
VISCOSITY, AVG & S					
PRESSURE, IN & DES	IGN PSIA	50.00	165.00	50.00	165.00
PRESSURE DROP, TOT	' & ALLOWED PS:	.03	10.00	.01	10.00
VELOCITY, CALC & M					
VELOCITI, CALC & M	AN ALLOWED FI/	.29	10.00	• 1 1	10.00
FOULING RESISTANCE					
FILM COEFFICIENT	BTU/HR-FT2	2-F 20	3.07	2	52.24
TOTAL HEAT DUTY RE	OUIRED MEGRTHI/I	HR.			.022017
EFF TEMP DIF, DEGF	-		\CC- 01 D71		
			13394, DAI	r-1.00)	
OVERALL COEFF REQU					100.36
CLEAN & FOULED COE	FF BTU/HR-F	FT2-F	102.83	3	100.26
SHELLS IN SERIES	1 PARALLEL 1	TOTAL EFF	AREA	FT2	7.1
PASSES, SHELL					
SHELL DIAMETER IN.	3.020	IEMA SHEI	T TIPE E	; KEAK H.	EAD FX15
BAFFLE TYPE H					
SPACING, CENTRAL	IN. 4.309	BAFFLE CU	JT, PCT SHE	LL I.D.	30.00
SPACING, INLET	TN. 4.309	CUT DISTA	NCE FROM CE	ENTER. IN.	. 764
SPACING, OUTLET					
		T145 T116 T14			370
BAFFLE THICKNESS					
PAIRS OF SEALING D	EVICES 1	TUBESHEET	BLANK AREA	A,	.0
TUBE TYPE	PLAIN	MATERIAL	E	LECTROLYTI	C COPPER
NO. OF TUBES/SHELL					
TUBE LGTH, OVERALL			CH		.3125
TUBE LGTH, EFF					
	DEG 60	TUBE INSI	DE DIAM	IN.	.214
TUBE LAYOUT	220 00				
TUBE LAYOUT PITCH RATIO			FACE RATIO,	OUT/IN	1.184
PITCH RATIO	1.250	TUBE SURI			
	1.250	TUBE SURI			
PITCH RATIO SHL NOZZ ID, IN&OU	1.250 TT 1.0 1.0	TUBE SURI			
PITCH RATIO SHL NOZZ ID, IN&OU * CALCULATED ITE	1.250 T 1.0 1.0 MHEAT BALANCE	TUBE SURE TUBE NOZZ  E CODE = 8	Z ID, IN&OU	Γ IN.	.8 .8
PITCH RATIO SHL NOZZ ID, IN&OU  * CALCULATED ITE  Washington Unive	1.250 IT 1.0 1.0 MMHEAT BALANCE ersity ChE433 he	TUBE SURE TUBE NOZZ  E CODE = 8	Z ID, IN&OU	Γ IN.	.8 .8 E0002 P 45
PITCH RATIO SHL NOZZ ID, IN&OU * CALCULATED ITE	1.250 IT 1.0 1.0 MMHEAT BALANCE ersity ChE433 he	TUBE SURE TUBE NOZZ  E CODE = 8	Z ID, IN&OU	Γ IN.	.8 .8
PITCH RATIO SHL NOZZ ID, IN&OU  * CALCULATED ITE  Washington Unive	1.250 IT 1.0 1.0 MMHEAT BALANCE ersity ChE433 he	TUBE SURE TUBE NOZZ  E CODE = 8	Z ID, IN&OU	Γ IN.	.8 .8 E0002 P 45 9/23/ 3
PITCH RATIO SHL NOZZ ID, IN&OU  * CALCULATED ITE  Washington Univeryoung model F302DY	1.250 IT 1.0 1.0  MHEAT BALANCE Prsity ChE433 here	TUBE SURI TUBE NOZZ E CODE = 8 eat exchang	I ID, IN&OU	I IN.	.8 .8 E0002 P 45
PITCH RATIO SHL NOZZ ID, IN&OU  * CALCULATED ITE  Washington Unive	1.250 IT 1.0 1.0  MHEAT BALANCE Prsity ChE433 here	TUBE SURI TUBE NOZZ E CODE = 8 eat exchang	I ID, IN&OU	I IN.	.8 .8 E0002 P 45 9/23/ 3
PITCH RATIO SHL NOZZ ID, IN&OU  * CALCULATED ITE  Washington Unive Young model F302DY  S U P P L E	1.250 T 1.0 1.0 MHEAT BALANCE ersity ChE433 he 4P M E N T A	TUBE SURI TUBE NOZZ E CODE = 8 eat exchang R Y I	Z ID, IN&OUT ger experime	I IN. ent L T S	.8 .8 E0002 P 45 9/23/ 3
PITCH RATIO SHL NOZZ ID, IN&OU  * CALCULATED ITE  Washington Unive Young model F302DY  S U P P L E  HT PARAMETERS	1.250 T 1.0 1.0  MHEAT BALANCE ersity ChE433 he 44P  M E N T A  SHELL TUBE	TUBE SURI TUBE NOZZ E CODE = 8 eat exchang R Y F	Z ID, IN&OUT ger experime R E S U LSIDE PERFOR	I IN. ent L T S RMANCE	.8 .8 E0002 P 45 9/23/ 3 CASE 22
PITCH RATIO SHL NOZZ ID, IN&OU  * CALCULATED ITE  Washington Unive Young model F302DY  S U P P L E	1.250 T 1.0 1.0  MHEAT BALANCE ersity ChE433 he 44P  M E N T A  SHELL TUBE	TUBE SURI TUBE NOZZ E CODE = 8 eat exchang R Y F	Z ID, IN&OUT ger experime R E S U LSIDE PERFOR	I IN. ent L T S RMANCE	.8 .8 E0002 P 45 9/23/ 3 CASE 22
PITCH RATIO SHL NOZZ ID, IN&OU  * CALCULATED ITE  Washington Unive Young model F302DY  S U P P L E  HT PARAMETERS	1.250 T 1.0 1.0  MHEAT BALANCE Prsity ChE433 here AP  M E N T A  SHELL TUBE 1.034 .000	TUBE SURI TUBE NOZZ  E CODE = 8 eat exchang  R Y I  SHELI NOMINAI	Z ID, IN&OUT ger experime R E S U LSIDE PERFOR	I IN.  Ent  L T S  RMANCE V FT/S	.8 .8 E0002 P 45 9/23/ 3 CASE 22
PITCH RATIO SHL NOZZ ID, IN&OU  * CALCULATED ITE  Washington Unive Young model F302DY  S U P P L E  HT PARAMETERS WALL CORRECTION	1.250 T 1.0 1.0  M-HEAT BALANCE Exity ChE433 here AP  M E N T A  SHELL TUBE 1.034 .000 8.2 4.4	TUBE SURI TUBE NOZZ  E CODE = 8 eat exchang  R Y I  SHELI NOMINAI NOMINAI	ger experime  R E S U  LSIDE PERFOR  L VEL, X-FLOW  L VEL, WINDOW	I IN. Ent  L T S  RMANCE V FT/S V FT/S	.8 .8  E0002 P 45 9/23/ 3 CASE 22

			che433b(			
RYNLD NO, IN BUN			WINDOW	COEF	BTU/HR-FT2	-F 254.9
RYNLD NO, OUT BUN						
FOULNG LAYER IN.	.0014	.0014				
THERMAL RESISTANCE	° ∩r m	∩ ™ ⊼ T		RANSFER X-F		
SHELL TUBE FOU						
39.30 58.45 2						
PCT OVER DESIGN		10	BAFFLE	TO SHELL L	EAKAGE E	= 15.80
TOT FOUL RESIST			TUBE PA	ASSLANE BYP	'ASS F	= .00
DIFF RESIST			CHETT	SIDE HEAT		A CHOD C
DIAMETRAL CLEARA BUNDLE TO SHELL	NCEC		DUETT	SIDE REAL =(BETA)(GAM		
DIAMETRAL CLEARA	NCES	5000	IOIAL -	-(BETA) (GAM (BAFF CUT F		
BUNDLE TO SHELL	IN.	.3000	BEIA			
TUBE TO BAFFLE HOL						
BAFFLE TO SHELL	IN.	.1000	END (	(HT LOSS IN	END ZONE)	= .994
SHELL NOZZLE DAT	A TN	OUT	SHELI	PRESSURE	DROP. % OF	TOTAL
HT UNDR NOZ IN.						= 8.8
HT OPP NOZ IN.				1E		= 4.3
VELOCITY FT/S						= 3.7
DENSITY LB/FT3						= 42.5
NOZZ RHO*VSQ LB/FT						= 40.6
BUND RHO*VSQ LB/FT			OOTHET	NOZZIE		- 40.0
DOND KHO VOQ LD/FI	52 15	13				
TUBE NOZZLE DATA	IN	OUT	WEIGH	HT PER SHEL	L, LB	
VELOCITY FT/S	.44	. 44	DRY		=	150.
DENSITY LB/FT3	61.291	62.289	WET		=	165.
DENSITY LB/FT3 PRESS. DROP %			WET		=	165.
PRESS. DROP %	5.1	3.2		ger experim		
PRESS. DROP %	5.1 rsity Ch	3.2		ger experim	ent	
PRESS. DROP %	5.1 rsity Ch	3.2		ger experim	nent	E0002 P 46
PRESS. DROP %	5.1 rsity Ch 4P	3.2 E433 hea	t exchanç		nent	E0002 P 46 9/23/ 3 CASE 23
PRESS. DROP % □□Washington Unive Young model F302DY	5.1 rsity Ch 4P	3.2 E433 hea -PASS FL	t exchang OW, SEGME		ent ES, RATING	E0002 P 46 9/23/ 3 CASE 23
PRESS. DROP % □□Washington Unive Young model F302DY	5.1 rsity Ch 4P	3.2 E433 hea -PASS FL	t exchang OW, SEGME	ENTAL BAFFL JBE SIDE	ent ES, RATING	E0002 P 46 9/23/ 3 CASE 23 HELL SIDE
PRESS. DROP % □□Washington Unive Young model F302DY SIZE 4- 18 TYPE BE	5.1 rsity Ch 4P M, MULTI	3.2 E433 hea -PASS FL	t exchang OW, SEGME HOT TU Tube SENSI	ENTAL BAFFL JBE SIDE IBLE LIQ	ment ES, RATING COLD S Shel SENS	E0002 P 46 9/23/ 3 CASE 23 HELL SIDE 1 IBLE LIQ
PRESS. DROP % □□Washington Unive Young model F302DY	5.1 rsity Ch 4P M, MULTI	3.2 E433 hea -PASS FL	t exchang OW, SEGME HOT TU Tube SENSI	ENTAL BAFFL JBE SIDE IBLE LIQ	ment ES, RATING COLD S Shel SENS	E0002 P 46 9/23/ 3 CASE 23 HELL SIDE 1 IBLE LIQ
PRESS. DROP % □□Washington Unive Young model F302DY SIZE 4- 18 TYPE BE	5.1 rsity Ch 4P M, MULTI KLB/HR	3.2 E433 hea -PASS FL	t exchang  OW, SEGME  HOT TU  Tube  SENSI	ENTAL BAFFL JBE SIDE IBLE LIQ	ES, RATING COLD S Shel SENS	E0002 P 46 9/23/ 3 CASE 23 HELL SIDE 1 IBLE LIQ
PRESS. DROP % □□Washington Unive Young model F302DY SIZE 4- 18 TYPE BE	5.1 rsity Ch 4P M, MULTI	3.2 E433 hea -PASS FL	t exchang OW, SEGME HOT TU Tube SENSI	ENTAL BAFFL JBE SIDE IBLE LIQ .300	ES, RATING COLD S Shel SENS	E0002 P 46 9/23/ 3 CASE 23 HELL SIDE 1 IBLE LIQ .800 OUT
PRESS. DROP %  Unive Young model F302DY  SIZE 4- 18 TYPE BE  TOTAL FLOW RATE	5.1 rsity Ch 4P M, MULTI KLB/HR DEGF	3.2 E433 hea -PASS FL	t exchang  OW, SEGME  HOT TU  Tube  SENSI  IN  140.0	ENTAL BAFFL JBE SIDE IBLE LIQ .300 OUT 64.1*	ES, RATING COLD S Shel SENS IN 40.0	E0002 P 46 9/23/ 3 CASE 23 HELL SIDE 1 IBLE LIQ .800 OUT 68.3*
PRESS. DROP %  Unive Young model F302DY  SIZE 4- 18 TYPE BE  TOTAL FLOW RATE  TEMPERATURE	5.1 rsity Ch 4P M, MULTI  KLB/HR  DEGF LB/FT3	3.2 E433 hea -PASS FL	t exchange OW, SEGME HOT TU Tube SENSI IN 140.0 61.2913	ENTAL BAFFL JBE SIDE IBLE LIQ .300 OUT 64.1*	ES, RATING COLD S Shel SENS IN 40.0 62.5352	E0002 P 46 9/23/3 CASE 23 HELL SIDE 1 IBLE LIQ .800 OUT 68.3* 62.2694
PRESS. DROP %  □□Washington Unive Young model F302DY  SIZE 4- 18 TYPE BE  TOTAL FLOW RATE  TEMPERATURE DENSITY	5.1 rsity Ch 4P M, MULTI  KLB/HR  DEGF LB/FT3 CP	3.2 E433 hea -PASS FL	t exchange OW, SEGME HOT TU Tube SENSI IN 140.0 61.2913 .4726	ENTAL BAFFL JBE SIDE  IBLE LIQ .300 OUT 64.1* 62.3134	ES, RATING COLD S Shel SENS  IN 40.0 62.5352 1.4791	E0002 P 46 9/23/3 CASE 23 HELL SIDE 1 IBLE LIQ .800 OUT 68.3* 62.2694 .9993
PRESS. DROP %  □□Washington Unive Young model F302DY  SIZE 4- 18 TYPE BE  TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY	5.1 rsity Ch 4P M, MULTI  KLB/HR DEGF LB/FT3 CP BTU/LB-	3.2 E433 hea -PASS FL F	t exchange  OW, SEGME  HOT TU  Tube  SENSI  IN  140.0 61.2913  .4726 .9973	ENTAL BAFFL JBE SIDE  IBLE LIQ .300 OUT 64.1* 62.3134 1.0551 1.0022	ES, RATING COLD S Shel SENS  IN 40.0 62.5352 1.4791 1.0058	E0002 P 46 9/23/3 CASE 23 HELL SIDE 1 IBLE LIQ .800 OUT 68.3* 62.2694 .9993 1.0017
PRESS. DROP %  Univeryoung model F302DY  SIZE 4- 18 TYPE BE  TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND.	5.1 rsity Ch 4P M, MULTI  KLB/HR DEGF LB/FT3 CP BTU/LB-	3.2 E433 hea -PASS FL F FT-F	t exchange  OW, SEGME  HOT TU  Tube  SENSI  IN  140.0 61.2913 .4726 .9973 .3723	ENTAL BAFFL UBE SIDE  UBLE LIQ .300 OUT 64.1* 62.3134 1.0551 1.0022 .3537 18.02	ES, RATING COLD S Shell SENS  IN 40.0 62.5352 1.4791 1.0058 .3466	E0002 P 46 9/23/3 CASE 23 HELL SIDE 1 IBLE LIQ .800 OUT 68.3* 62.2694 .9993 1.0017 .3549 18.02
PRESS. DROP %  □□Washington Unive Young model F302DY  SIZE 4- 18 TYPE BE  TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS	5.1 rsity Ch 4P M, MULTI  KLB/HR  DEGF LB/FT3 CP BTU/LB- BTU/HR- LB/LBMO	3.2 E433 hea -PASS FL F FT-F L	Tube SENSI IN 140.0 61.2913 .4726 .9973 .3723	ENTAL BAFFL UBE SIDE  UBLE LIQ .300 OUT 64.1* 62.3134 1.0551 1.0022 .3537 18.02	ES, RATING COLD S Shel SENS  IN 40.0 62.5352 1.4791 1.0058 .3466	E0002 P 46 9/23/ 3 CASE 23  HELL SIDE  IBLE LIQ .800 OUT 68.3* 62.2694 .9993 1.0017 .3549 18.02
PRESS. DROP %  Unive Young model F302DY  SIZE 4- 18 TYPE BE  TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS  TEMP, AVG & SKIN	5.1 rsity Ch 4P M, MULTI  KLB/HR  DEGF LB/FT3 CP BTU/LB- BTU/HR- LB/LBMO  DEG	3.2 E433 hea -PASS FL F FT-F L	Tube SENSI  IN 140.0 61.2913 .4726 .9973 .3723	ENTAL BAFFL  JBE SIDE  IBLE LIQ  .300  OUT  64.1* 62.3134  1.0551  1.0022  .3537  18.02   73.2	ES, RATING COLD S Shel SENS  IN 40.0 62.5352 1.4791 1.0058 .3466	E0002 P 46 9/23/ 3 CASE 23  HELL SIDE  IBLE LIQ .800 OUT 68.3* 62.2694 .9993 1.0017 .3549 18.02 72.0
PRESS. DROP %  □□Washington Unive Young model F302DY  SIZE 4- 18 TYPE BE  TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS  TEMP, AVG & SKIN VISCOSITY, AVG & S	5.1 rsity Ch 4P M, MULTI  KLB/HR  DEGF LB/FT3 CP BTU/LB- BTU/HR- LB/LBMO  DEG  KIN CP	3.2 E433 hea -PASS FL F FT-F L	Tube SENSI  IN 140.0 61.2913 .4726 .9973 .3723	ENTAL BAFFL JBE SIDE  IBLE LIQ .300 OUT 64.1* 62.3134 1.0551 1.0022 .3537 18.02 73.2 .9407	ES, RATING COLD S Shell SENS  IN 40.0 62.5352 1.4791 1.0058 .3466	E0002 P 46 9/23/3 CASE 23 HELL SIDE 1 IBLE LIQ .800 OUT 68.3* 62.2694 .9993 1.0017 .3549 18.02
PRESS. DROP %  Unive Young model F302DY  SIZE 4- 18 TYPE BE  TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS  TEMP, AVG & SKIN	5.1 rsity Ch 4P M, MULTI  KLB/HR  DEGF LB/FT3 CP BTU/LB- BTU/HR- LB/LBMO  DEG  KIN CP	3.2 E433 hea -PASS FL F FT-F L	Tube SENSI  IN 140.0 61.2913 .4726 .9973 .3723	ENTAL BAFFL  JBE SIDE  IBLE LIQ  .300  OUT  64.1* 62.3134  1.0551  1.0022  .3537  18.02   73.2	ES, RATING COLD S Shell SENS  IN 40.0 62.5352 1.4791 1.0058 .3466	E0002 P 46 9/23/3 CASE 23 HELL SIDE 1 IBLE LIQ .800 OUT 68.3* 62.2694 .9993 1.0017 .3549 18.02
PRESS. DROP %  □□Washington Unive Young model F302DY  SIZE 4- 18 TYPE BE  TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS  TEMP, AVG & SKIN VISCOSITY, AVG & S PRESSURE, IN & DES	5.1 rsity Ch 4P M, MULTI  KLB/HR DEGF LB/FT3 CP BTU/LB- BTU/HR- LB/LBMO  DEG KIN CP IGN PSI	3.2 E433 hea -PASS FL F FT-F L F	Tube SENSI  IN 140.0 61.2913 .4726 .9973 .3723	ENTAL BAFFL JBE SIDE  IBLE LIQ .300 OUT 64.1* 62.3134 1.0551 1.0022 .3537 18.02 73.2 .9407 165.00	ES, RATING COLD S Shell SENS  IN 40.0 62.5352 1.4791 1.0058 .3466 54.2 1.2056 50.00	E0002 P 46 9/23/ 3 CASE 23  HELL SIDE  IBLE LIQ .800 OUT 68.3* 62.2694 .9993 1.0017 .3549 18.02 72.0 .9537 165.00
PRESS. DROP %  □□Washington Unive Young model F302DY  SIZE 4- 18 TYPE BE  TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS  TEMP, AVG & SKIN VISCOSITY, AVG & S PRESSURE, IN & DES  PRESSURE DROP, TOT	5.1 rsity Ch 4P M, MULTI  KLB/HR  DEGF LB/FT3 CP BTU/LB- BTU/HR- LB/LBMO  DEG KIN CP IGN PSI	3.2 E433 hea  -PASS FL  F FT-F L F A ED PSI	Tube SENSI  IN 140.0 61.2913 .4726 .9973 .3723	ENTAL BAFFL JBE SIDE  IBLE LIQ .300 OUT 64.1* 62.3134 1.0551 1.0022 .3537 18.02 73.2 .9407 165.00	ES, RATING COLD S Shell SENS  IN 40.0 62.5352 1.4791 1.0058 .3466	E0002 P 46 9/23/ 3 CASE 23  HELL SIDE  IBLE LIQ .800 OUT 68.3* 62.2694 .9993 1.0017 .3549 18.02 72.0 .9537 165.00
PRESS. DROP %  □□Washington Unive Young model F302DY  SIZE 4- 18 TYPE BE  TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS  TEMP, AVG & SKIN VISCOSITY, AVG & S PRESSURE, IN & DES	5.1 rsity Ch 4P M, MULTI  KLB/HR  DEGF LB/FT3 CP BTU/LB- BTU/HR- LB/LBMO  DEG KIN CP IGN PSI	3.2 E433 hea  -PASS FL  F FT-F L F A ED PSI	Tube SENSI  IN 140.0 61.2913 .4726 .9973 .3723	ENTAL BAFFL JBE SIDE  IBLE LIQ .300 OUT 64.1* 62.3134 1.0551 1.0022 .3537 18.02 73.2 .9407 165.00	ES, RATING COLD S Shell SENS  IN 40.0 62.5352 1.4791 1.0058 .3466	E0002 P 46 9/23/ 3 CASE 23  HELL SIDE  IBLE LIQ .800 OUT 68.3* 62.2694 .9993 1.0017 .3549 18.02 72.0 .9537 165.00
PRESS. DROP %  □□Washington Unive Young model F302DY  SIZE 4- 18 TYPE BE  TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS  TEMP, AVG & SKIN VISCOSITY, AVG & S PRESSURE, IN & DES  PRESSURE DROP, TOT	5.1 rsity Ch 4P M, MULTI  KLB/HR  DEGF LB/FT3 CP BTU/LB- BTU/HR- LB/LBMO  DEG KIN CP IGN PSI & ALLOW AX ALLOW	3.2 E433 hea  -PASS FL  F FT-F L  F A ED PSI ED FT/S	Tube SENSI  IN  140.0 61.2913 .4726 .9973 .3723	ENTAL BAFFL JBE SIDE  IBLE LIQ .300 OUT 64.1* 62.3134 1.0551 1.0022 .3537 18.02 73.2 .9407 165.00 10.00 10.00	ES, RATING COLD S Shel SENS  IN 40.0 62.5352 1.4791 1.0058 .3466	E0002 P 46 9/23/ 3 CASE 23  HELL SIDE  IBLE LIQ .800 OUT 68.3* 62.2694 .9993 1.0017 .3549 18.02 72.0 .9537 165.00

_____

TOTAL HEAT DUTY REQUIRED MEGBTU/HR EFF TEMP DIF, DEGF (LMTD= 43.6,F= OVERALL COEFF REQUIRED BTU/HR-FT2	.75,BYPASS= .94,BAFF=1.00)	.022738 30.6 103.91
CLEAN & FOULED COEFF BTU/HR-FT2	2-F 106.22	103.44
SHELLS IN SERIES 1 PARALLEL 1 TASSES, SHELL 1 TUBE 4		
SHELL DIAMETER IN. 3.820		
	CROSS PASSES PER SHELL PASS	
SPACING, CENTRAL IN. 4.309 H	BAFFLE CUT, PCT SHELL I.D.	
SPACING, INLET IN. 4.309 C SPACING, OUTLET IN. 4.309	CUT DISTANCE FROM CENTER, IN.	. / 64
	IMPINGEMENT BAFFLE INCLUDED	NO
	TUBESHEET BLANK AREA, %	.0
	MATERIAL ELECTROLYTIC	
	EST MAX TUBE COUNT TUBE PITCH IN.	36
TUBE LGTH, OVERALL FT 1.500 TUBE LGTH, EFF FT 1.436	TUBE PITCH IN. TUBE OUTSIDE DIAM IN.	.3125
TUBE LAYOUT DEG 60	TUBE INSIDE DIAM IN.	.250
PITCH RATIO 1.250	PUDE INSIDE DIAM IN.	. Z I 4 1 1 Q /l
SHL NOZZ ID, IN&OUT 1.0 1.0	PUBE NOZZ ID. IN&OUT IN	8 8
	,	
* CALCULATED ITEMHEAT BALANCE (	CODE = 8	
□□Washington University ChE433 heat	t exchanger experiment E	0002 P 47
Young model F302DY4P		9/23/ 3
		CASE 23
S U P P L E M E N T A R	Y RESULTS	
IIII DADAMUUUDO OIIDI UUDO	CHELL CIDE DEDECOMANCE	
HT PARAMETERS SHELL TUBE WALL CORRECTION 1.033 .000		1.0
PRANDTL NUMBER 8.3 4.5	NOMINAL VEL, WINDOW FT/S	20
RYNLD NO, AVG 250. 698.	CROSSFIOW COEF BTIL/HR-FT2-F	274 9
RYNLD NO, IN BUN 204. 1000.	WINDOW COEF BTU/HR-FT2-F	276.6
RYNLD NO, OUT BUN 302. 448.		
FOULNG LAYER IN0014 .0014	SHELLSIDE FLOW, % OF TOTAL	
	HEAT TRANSFER X-FLOW	81.55
THERMAL RESISTANCE, % OF TOTAL	TUBE TO BAFFLE LEAKAGE A =	3.46
SHELL TUBE FOULING METAL		66.02
37.36 60.33 2.24 .07	BUNDLE TO SHELL BYPASS C =	14.82
PCT OVER DESIGN45	BAFFLE TO SHELL LEAKAGE E =	
TOT FOUL RESIST .000217	TUBE PASSLANE BYPASS F =	.00
DIFF RESIST000044		
	SHELLSIDE HEAT TRANSFER FAC	
DIAMETRAL CLEARANCES BUNDLE TO SHELL IN5000	TOTAL = (BETA) (GAMMA) (FIN) =	
TUBE TO BAFFLE HOLE IN0284		.920
BAFFLE TO SHELL IN1000		
DATE IO SUBLIL IN1000	TIT TOSS IN FIND TONE) =	. 334
SHELL NOZZLE DATA IN OUT	SHELL PRESSURE DROP, % OF T	'OTAL
HT UNDR NOZ IN25		
III ONDIC NOD III.	WINDOW =	8.9

		CHE 433D (			
HT OPP NOZ IN.	.25	END ZON	E		= 4.1
VELOCITY FT/S	.65 .65	CROSS F	LOW		= 3.6
DENSITY LB/FT3	62.535 62.269	INLET N	OZZLE		= 42.6
NOZZ RHO*VSQ LB/FT	-S2 26 26	OUTLET	NOZZLE		= 40.9
BUND RHO*VSQ LB/FT	-S2 18 18				
201.2 Tale 12g 22, 11	02 20 20				
TIBE NOTTE DATA	TM OIT	WETCU	יי סבט פטבו.	г тр	
TUBE NOZZLE DATA VELOCITY FT/S	. IN OUI	MEIGU	I FER SHEL.	L, LD	150.
VELOCITY FT/S	.44 .44	DRY		=	
DENSITY LB/FT3				=	165.
PRESS. DROP %					
$\square\square$ Washington Unive	rsity ChE433 he	at exchang	er experim	ent	E0002 P 48
Young model F302DY	4 P				9/23/ 3
					CASE 24
SIZE 4- 18 TYPE BE	M, MULTI-PASS F	LOW, SEGME	NTAL BAFFL	ES, RATING	
	,		BE SIDE		
		Tuhe	22 2122	Shell	1
		CENCT	DIE IIO	CENC	TDIE IIO
	MID /IID	SENSI	DUE LIÑ	SENS.	OOO
TOTAL FLOW RATE	KLB/HK		BLE LIQ .300 OUT		.900
		IN	OUT	IN	OUT
TEMPERATURE	DEGF	140.0	62.3*	40.0	65.8*
DENSITY	LB/FT3	61.2913	62.3321	62.5352	62.2961
TEMPERATURE DENSITY VISCOSITY	CP	.4726	1.0809	1.4791	1.0323
SPECIFIC HEAT	BTU/LB-F	. 9973	1.0025	1.0058	1.0020
THERMAL COND. MOLAR MASS	BTU/HR-FT-F	.3723	.3532	.3466	.3542
MOLAR MASS	LB/LBMOL		18.02		18.02
	, -				
TEMP, AVG & SKIN					
VISCOSITY, AVG & S		6836	.9636	1 2270	9776
PRESSURE, IN & DES	TON DOTA	50 00	165 00	50 00	165 00
FRESSORE, IN & DES	IGN FSIA	30.00	103.00	30.00	103.00
PRESSURE DROP, TOT	c attomen not	0.2	10 00	0.0	10 00
PRESSURE DROP, TOT	& ALLOWED PSI	.03	10.00	.02	10.00
VELOCITY, CALC & M	AX ALLOWED FT/	S .29	10.00	. 14	10.00
FOULING RESISTANCE	HR-FT2-F/B	TU .0	0010	- (	00010
FILM COEFFICIENT	BTU/HR-FT2	-F 20	3.02	2	95.08
TOTAL HEAT DUTY RE	QUIRED MEGBTU/H	R			.023291
EFF TEMP DIF, DEGF	(LMTD= 43.1,F	= .76,BYPA	SS= .94,BA	FF=1.00)	30.7
OVERALL COEFF REQU					106.15
CLEAN & FOULED COE			109.2	3	106.31
022111. 4 1 0 0 2 2 2 0 0 2	210/11111		103.1		100.01
SHELLS IN SERIES	1 DADATTET 1	יי∩ייאז ביביב	7057	ਦਾਸ਼ਾ 2	7 1
PASSES, SHELL	1 MIDE 4	TOTAL EFF	AREA	FIZ	7 · 1
SHELL DIAMETER IN.	3.820	TEMA SHEL	L TYPE E	; REAR H	EAD FXTS
BAFFLE TYPE H					
SPACING, CENTRAL	IN. 4.309	BAFFLE CU	T, PCT SHE	LL I.D.	30.00
SPACING, INLET	IN. 4.309	CUT DISTA	NCE FROM C	ENTER, IN.	.764
SPACING, OUTLET	IN. 4.309				
BAFFLE THICKNESS	IN125	IMPINGEME	NT BAFFLE	INCLUDED	NO
PAIRS OF SEALING D	EVICES 1		BLANK ARE		.0
	-		<del></del> -	•	
TUBE TYPE	ΡΤ.ΔΤΜ	MATERIAL	ㅠ.	LECTROLYTI	COPPER
TODE TITE	THATIN	THINTHL	E.		COLLEIN

NO. OF TUBES/SHELL 76 ES	ST MAX TUBE COUNT 36
TUBE LIGTH, OVERALL FT 1.500 TI	JBE PITCH IN3125
	JBE OUTSIDE DIAM IN250
	JBE INSIDE DIAM IN214
PITCH RATIO 1 250 TI	JBE SURFACE RATIO, OUT/IN 1.184
SHI, NOZZ ID. INSOUT 1 0 1 0 TO	JBE NOZZ ID, IN&OUT IN8 .8
one note 12, indoor 1.0 1.0 1.	NOZE NOZE IZ, INGOI IN
* CALCULATED ITEMHEAT BALANCE CO	DDE = 8
	exchanger experiment E0002 P 49
Young model F302DY4P	9/23/ 3
	CASE 24
S U P P L E M E N T A R	
HT PARAMETERS SHELL TUBE	
	NOMINAL VEL, X-FLOW FT/S .12
	NOMINAL VEL, WINDOW FT/S .23
RYNLD NO, AVG 276. 692.	CROSSFLOW COEF BTU/HR-FT2-F 296.3
	WINDOW COEF BTU/HR-FT2-F 298.0
RYNLD NO, OUT BUN 328. 437.	
FOULNG LAYER IN0014 .0014	SHELLSIDE FLOW, % OF TOTAL
	SHELLSIDE FLOW, % OF TOTAL HEAT TRANSFER X-FLOW 81.55
THERMAL RESISTANCE, % OF TOTAL	TUBE TO BAFFLE LEAKAGE A = 3.59
SHELL TUBE FOULING METAL	MAIN CROSSFLOW $B = 65.51$
35.62 62.00 2.31 .08	BUNDLE TO SHELL BYPASS C = 15.31
PCT OVER DESIGN .15	BAFFLE TO SHELL LEAKAGE E = 15.59
TOT FOUL RESIST .000217	BAFFLE TO SHELL LEAKAGE E = 15.59 TUBE PASSLANE BYPASS F = .00
DIFF RESIST .000014	
	SHELLSIDE HEAT TRANSFER FACTORS
DIAMETRAL CLEARANCES	TOTAL = (BETA) (GAMMA) (FIN) = .682
DIAMETRAL CLEARANCES BUNDLE TO SHELL IN5000	TOTAL = (BETA) (GAMMA) (FIN) = .682 BETA (BAFF CUT FACTOR) = .920
DIAMETRAL CLEARANCES BUNDLE TO SHELL IN5000 TUBE TO BAFFLE HOLE IN0284	TOTAL = (BETA) (GAMMA) (FIN) = .682 BETA (BAFF CUT FACTOR) = .920 GAMMA (TUBE ROW ENTRY EFCT) = .741
DIAMETRAL CLEARANCES BUNDLE TO SHELL IN5000 TUBE TO BAFFLE HOLE IN0284	TOTAL = (BETA) (GAMMA) (FIN) = .682 BETA (BAFF CUT FACTOR) = .920
DIAMETRAL CLEARANCES BUNDLE TO SHELL IN5000 TUBE TO BAFFLE HOLE IN0284 BAFFLE TO SHELL IN1000	TOTAL = (BETA) (GAMMA) (FIN) = .682 BETA (BAFF CUT FACTOR) = .920 GAMMA (TUBE ROW ENTRY EFCT) = .741 END (HT LOSS IN END ZONE) = .994
DIAMETRAL CLEARANCES BUNDLE TO SHELL IN5000 TUBE TO BAFFLE HOLE IN0284 BAFFLE TO SHELL IN1000 SHELL NOZZLE DATA IN OUT	TOTAL = (BETA) (GAMMA) (FIN) = .682 BETA (BAFF CUT FACTOR) = .920 GAMMA (TUBE ROW ENTRY EFCT) = .741 END (HT LOSS IN END ZONE) = .994  SHELL PRESSURE DROP, % OF TOTAL
DIAMETRAL CLEARANCES BUNDLE TO SHELL IN5000 TUBE TO BAFFLE HOLE IN0284 BAFFLE TO SHELL IN1000 SHELL NOZZLE DATA IN OUT	TOTAL = (BETA) (GAMMA) (FIN) = .682 BETA (BAFF CUT FACTOR) = .920 GAMMA (TUBE ROW ENTRY EFCT) = .741 END (HT LOSS IN END ZONE) = .994  SHELL PRESSURE DROP, % OF TOTAL
DIAMETRAL CLEARANCES BUNDLE TO SHELL IN5000 TUBE TO BAFFLE HOLE IN0284 BAFFLE TO SHELL IN1000 SHELL NOZZLE DATA IN OUT	TOTAL = (BETA) (GAMMA) (FIN) = .682 BETA (BAFF CUT FACTOR) = .920 GAMMA (TUBE ROW ENTRY EFCT) = .741 END (HT LOSS IN END ZONE) = .994  SHELL PRESSURE DROP, % OF TOTAL
DIAMETRAL CLEARANCES BUNDLE TO SHELL IN5000 TUBE TO BAFFLE HOLE IN0284 BAFFLE TO SHELL IN1000  SHELL NOZZLE DATA IN OUT HT UNDR NOZ IN25 HT OPP NOZ IN25 VELOCITY FT/S .73 .74	TOTAL = (BETA) (GAMMA) (FIN) = .682 BETA (BAFF CUT FACTOR) = .920 GAMMA (TUBE ROW ENTRY EFCT) = .741 END (HT LOSS IN END ZONE) = .994  SHELL PRESSURE DROP, % OF TOTAL WINDOW = 8.9 END ZONE = 3.9 CROSS FLOW = 3.4
DIAMETRAL CLEARANCES BUNDLE TO SHELL IN5000 TUBE TO BAFFLE HOLE IN0284 BAFFLE TO SHELL IN1000  SHELL NOZZLE DATA IN OUT HT UNDR NOZ IN25 HT OPP NOZ IN25 VELOCITY FT/S .73 .74 DENSITY LB/FT3 62.535 62.296	TOTAL = (BETA) (GAMMA) (FIN) = .682 BETA (BAFF CUT FACTOR) = .920 GAMMA (TUBE ROW ENTRY EFCT) = .741 END (HT LOSS IN END ZONE) = .994  SHELL PRESSURE DROP, % OF TOTAL WINDOW = 8.9 END ZONE = 3.9 CROSS FLOW = 3.4 INLET NOZZLE = 42.7
DIAMETRAL CLEARANCES BUNDLE TO SHELL IN5000 TUBE TO BAFFLE HOLE IN0284 BAFFLE TO SHELL IN1000  SHELL NOZZLE DATA IN OUT HT UNDR NOZ IN25 HT OPP NOZ IN25 VELOCITY FT/S .73 .74 DENSITY LB/FT3 62.535 62.296 NOZZ RHO*VSQ LB/FT-S2 33 33	TOTAL = (BETA) (GAMMA) (FIN) = .682 BETA (BAFF CUT FACTOR) = .920 GAMMA (TUBE ROW ENTRY EFCT) = .741 END (HT LOSS IN END ZONE) = .994  SHELL PRESSURE DROP, % OF TOTAL WINDOW = 8.9 END ZONE = 3.9 CROSS FLOW = 3.4
DIAMETRAL CLEARANCES BUNDLE TO SHELL IN5000 TUBE TO BAFFLE HOLE IN0284 BAFFLE TO SHELL IN1000  SHELL NOZZLE DATA IN OUT HT UNDR NOZ IN25 HT OPP NOZ IN25 VELOCITY FT/S .73 .74 DENSITY LB/FT3 62.535 62.296	TOTAL = (BETA) (GAMMA) (FIN) = .682 BETA (BAFF CUT FACTOR) = .920 GAMMA (TUBE ROW ENTRY EFCT) = .741 END (HT LOSS IN END ZONE) = .994  SHELL PRESSURE DROP, % OF TOTAL WINDOW = 8.9 END ZONE = 3.9 CROSS FLOW = 3.4 INLET NOZZLE = 42.7
DIAMETRAL CLEARANCES BUNDLE TO SHELL IN5000 TUBE TO BAFFLE HOLE IN0284 BAFFLE TO SHELL IN1000  SHELL NOZZLE DATA IN OUT HT UNDR NOZ IN25 HT OPP NOZ IN25 VELOCITY FT/S .73 .74 DENSITY LB/FT3 62.535 62.296 NOZZ RHO*VSQ LB/FT-S2 33 33 BUND RHO*VSQ LB/FT-S2 22 22	TOTAL = (BETA) (GAMMA) (FIN) = .682 BETA (BAFF CUT FACTOR) = .920 GAMMA (TUBE ROW ENTRY EFCT) = .741 END (HT LOSS IN END ZONE) = .994  SHELL PRESSURE DROP, % OF TOTAL WINDOW = 8.9 END ZONE = 3.9 CROSS FLOW = 3.4 INLET NOZZLE = 42.7 OUTLET NOZZLE = 41.2
DIAMETRAL CLEARANCES BUNDLE TO SHELL IN5000 TUBE TO BAFFLE HOLE IN0284 BAFFLE TO SHELL IN1000  SHELL NOZZLE DATA IN OUT HT UNDR NOZ IN25 HT OPP NOZ IN25 VELOCITY FT/S .73 .74 DENSITY LB/FT3 62.535 62.296 NOZZ RHO*VSQ LB/FT-S2 33 33 BUND RHO*VSQ LB/FT-S2 22 22  TUBE NOZZLE DATA IN OUT	TOTAL = (BETA) (GAMMA) (FIN) = .682 BETA (BAFF CUT FACTOR) = .920 GAMMA (TUBE ROW ENTRY EFCT) = .741 END (HT LOSS IN END ZONE) = .994  SHELL PRESSURE DROP, % OF TOTAL WINDOW = 8.9 END ZONE = 3.9 CROSS FLOW = 3.4 INLET NOZZLE = 42.7 OUTLET NOZZLE = 41.2
DIAMETRAL CLEARANCES BUNDLE TO SHELL IN5000 TUBE TO BAFFLE HOLE IN0284 BAFFLE TO SHELL IN1000  SHELL NOZZLE DATA IN OUT HT UNDR NOZ IN25 HT OPP NOZ IN25 VELOCITY FT/S .73 .74 DENSITY LB/FT3 62.535 62.296 NOZZ RHO*VSQ LB/FT-S2 33 33 BUND RHO*VSQ LB/FT-S2 22 22  TUBE NOZZLE DATA IN OUT VELOCITY FT/S .44 .44	TOTAL = (BETA) (GAMMA) (FIN) = .682 BETA (BAFF CUT FACTOR) = .920 GAMMA (TUBE ROW ENTRY EFCT) = .741 END (HT LOSS IN END ZONE) = .994  SHELL PRESSURE DROP, % OF TOTAL WINDOW = 8.9 END ZONE = 3.9 CROSS FLOW = 3.4 INLET NOZZLE = 42.7 OUTLET NOZZLE = 41.2  WEIGHT PER SHELL, LB DRY = 150.
DIAMETRAL CLEARANCES BUNDLE TO SHELL IN5000 TUBE TO BAFFLE HOLE IN0284 BAFFLE TO SHELL IN1000  SHELL NOZZLE DATA IN OUT HT UNDR NOZ IN25 HT OPP NOZ IN25 VELOCITY FT/S .73 .74 DENSITY LB/FT3 62.535 62.296 NOZZ RHO*VSQ LB/FT-S2 33 33 BUND RHO*VSQ LB/FT-S2 22 22  TUBE NOZZLE DATA IN OUT VELOCITY FT/S .44 .44 DENSITY LB/FT3 61.291 62.332	TOTAL = (BETA) (GAMMA) (FIN) = .682 BETA (BAFF CUT FACTOR) = .920 GAMMA (TUBE ROW ENTRY EFCT) = .741 END (HT LOSS IN END ZONE) = .994  SHELL PRESSURE DROP, % OF TOTAL WINDOW = 8.9 END ZONE = 3.9 CROSS FLOW = 3.4 INLET NOZZLE = 42.7 OUTLET NOZZLE = 41.2  WEIGHT PER SHELL, LB DRY = 150.
DIAMETRAL CLEARANCES BUNDLE TO SHELL IN5000 TUBE TO BAFFLE HOLE IN0284 BAFFLE TO SHELL IN1000  SHELL NOZZLE DATA IN OUT HT UNDR NOZ IN25 HT OPP NOZ IN25 VELOCITY FT/S .73 .74 DENSITY LB/FT3 62.535 62.296 NOZZ RHO*VSQ LB/FT-S2 33 33 BUND RHO*VSQ LB/FT-S2 22 22  TUBE NOZZLE DATA IN OUT VELOCITY FT/S .44 .44 DENSITY LB/FT3 61.291 62.332 PRESS. DROP % 4.9 3.1	TOTAL = (BETA) (GAMMA) (FIN) = .682 BETA (BAFF CUT FACTOR) = .920 GAMMA (TUBE ROW ENTRY EFCT) = .741 END (HT LOSS IN END ZONE) = .994  SHELL PRESSURE DROP, % OF TOTAL WINDOW = 8.9 END ZONE = 3.9 CROSS FLOW = 3.4 INLET NOZZLE = 42.7 OUTLET NOZZLE = 41.2  WEIGHT PER SHELL, LB DRY = 150. WET = 165.
DIAMETRAL CLEARANCES BUNDLE TO SHELL IN5000 TUBE TO BAFFLE HOLE IN0284 BAFFLE TO SHELL IN1000  SHELL NOZZLE DATA IN OUT HT UNDR NOZ IN25 HT OPP NOZ IN25 VELOCITY FT/S .73 .74 DENSITY LB/FT3 62.535 62.296 NOZZ RHO*VSQ LB/FT-S2 33 33 BUND RHO*VSQ LB/FT-S2 22 22  TUBE NOZZLE DATA IN OUT VELOCITY FT/S .44 .44 DENSITY LB/FT3 61.291 62.332	TOTAL = (BETA) (GAMMA) (FIN) = .682 BETA (BAFF CUT FACTOR) = .920 GAMMA (TUBE ROW ENTRY EFCT) = .741 END (HT LOSS IN END ZONE) = .994  SHELL PRESSURE DROP, % OF TOTAL WINDOW = 8.9 END ZONE = 3.9 CROSS FLOW = 3.4 INLET NOZZLE = 42.7 OUTLET NOZZLE = 41.2  WEIGHT PER SHELL, LB DRY = 150. WET = 165.  exchanger experiment E0002 P 50 9/23/ 3
DIAMETRAL CLEARANCES BUNDLE TO SHELL IN5000 TUBE TO BAFFLE HOLE IN0284 BAFFLE TO SHELL IN1000  SHELL NOZZLE DATA IN OUT HT UNDR NOZ IN25 HT OPP NOZ IN25 VELOCITY FT/S .73 .74 DENSITY LB/FT3 62.535 62.296 NOZZ RHO*VSQ LB/FT-S2 33 33 BUND RHO*VSQ LB/FT-S2 22 22  TUBE NOZZLE DATA IN OUT VELOCITY FT/S .44 .44 DENSITY LB/FT3 61.291 62.332 PRESS. DROP % 4.9 3.1  \[ \Begin{align*}	TOTAL = (BETA) (GAMMA) (FIN) = .682 BETA (BAFF CUT FACTOR) = .920 GAMMA (TUBE ROW ENTRY EFCT) = .741 END (HT LOSS IN END ZONE) = .994  SHELL PRESSURE DROP, % OF TOTAL WINDOW = 8.9 END ZONE = 3.9 CROSS FLOW = 3.4 INLET NOZZLE = 42.7 OUTLET NOZZLE = 42.7 OUTLET NOZZLE = 41.2  WEIGHT PER SHELL, LB DRY = 150. WET = 165.  exchanger experiment E0002 P 50 9/23/3 CASE 25
DIAMETRAL CLEARANCES BUNDLE TO SHELL IN5000 TUBE TO BAFFLE HOLE IN0284 BAFFLE TO SHELL IN1000  SHELL NOZZLE DATA IN OUT HT UNDR NOZ IN25 HT OPP NOZ IN25 VELOCITY FT/S .73 .74 DENSITY LB/FT3 62.535 62.296 NOZZ RHO*VSQ LB/FT-S2 33 33 BUND RHO*VSQ LB/FT-S2 22 22  TUBE NOZZLE DATA IN OUT VELOCITY FT/S .44 .44 DENSITY LB/FT3 61.291 62.332 PRESS. DROP % 4.9 3.1	TOTAL = (BETA) (GAMMA) (FIN) = .682 BETA (BAFF CUT FACTOR) = .920 GAMMA (TUBE ROW ENTRY EFCT) = .741 END (HT LOSS IN END ZONE) = .994  SHELL PRESSURE DROP, % OF TOTAL WINDOW = 8.9 END ZONE = 3.9 CROSS FLOW = 3.4 INLET NOZZLE = 42.7 OUTLET NOZZLE = 42.7 OUTLET NOZZLE = 41.2  WEIGHT PER SHELL, LB DRY = 150. Exchanger experiment = E0002 P 50 9/23/3 CASE 25
DIAMETRAL CLEARANCES BUNDLE TO SHELL IN5000 TUBE TO BAFFLE HOLE IN0284 BAFFLE TO SHELL IN1000  SHELL NOZZLE DATA IN OUT HT UNDR NOZ IN25 HT OPP NOZ IN25 VELOCITY FT/S .73 .74 DENSITY LB/FT3 62.535 62.296 NOZZ RHO*VSQ LB/FT-S2 33 33 BUND RHO*VSQ LB/FT-S2 22 22  TUBE NOZZLE DATA IN OUT VELOCITY FT/S .44 .44 DENSITY LB/FT3 61.291 62.332 PRESS. DROP % 4.9 3.1  \[ \Begin{align*}	TOTAL = (BETA) (GAMMA) (FIN) = .682 BETA (BAFF CUT FACTOR) = .920 GAMMA (TUBE ROW ENTRY EFCT) = .741 END (HT LOSS IN END ZONE) = .994  SHELL PRESSURE DROP, % OF TOTAL WINDOW = 8.9 END ZONE = 3.9 CROSS FLOW = 3.4 INLET NOZZLE = 42.7 OUTLET NOZZLE = 42.7 OUTLET NOZZLE = 41.2  WEIGHT PER SHELL, LB DRY = 150. WET = 165.  exchanger experiment E0002 P 50 9/23/3 CASE 25
DIAMETRAL CLEARANCES BUNDLE TO SHELL IN5000 TUBE TO BAFFLE HOLE IN0284 BAFFLE TO SHELL IN1000  SHELL NOZZLE DATA IN OUT HT UNDR NOZ IN25 HT OPP NOZ IN25 VELOCITY FT/S .73 .74 DENSITY LB/FT3 62.535 62.296 NOZZ RHO*VSQ LB/FT-S2 33 33 BUND RHO*VSQ LB/FT-S2 22 22  TUBE NOZZLE DATA IN OUT VELOCITY FT/S .44 .44 DENSITY LB/FT3 61.291 62.332 PRESS. DROP % 4.9 3.1  \[ \Begin{align*}	TOTAL = (BETA) (GAMMA) (FIN) = .682 BETA (BAFF CUT FACTOR) = .920 GAMMA (TUBE ROW ENTRY EFCT) = .741 END (HT LOSS IN END ZONE) = .994  SHELL PRESSURE DROP, % OF TOTAL WINDOW = 8.9 END ZONE = 3.9 CROSS FLOW = 3.4 INLET NOZZLE = 42.7 OUTLET NOZZLE = 41.2  WEIGHT PER SHELL, LB DRY = 150. WET = 165.  exchanger experiment E0002 P 50 9/23/3 CASE 25  W, SEGMENTAL BAFFLES, RATING HOT TUBE SIDE COLD SHELL SIDE Tube Shell
DIAMETRAL CLEARANCES BUNDLE TO SHELL IN5000 TUBE TO BAFFLE HOLE IN0284 BAFFLE TO SHELL IN1000  SHELL NOZZLE DATA IN OUT HT UNDR NOZ IN25 HT OPP NOZ IN25 VELOCITY FT/S .73 .74 DENSITY LB/FT3 62.535 62.296 NOZZ RHO*VSQ LB/FT-S2 33 33 BUND RHO*VSQ LB/FT-S2 22 22  TUBE NOZZLE DATA IN OUT VELOCITY FT/S .44 .44 DENSITY LB/FT3 61.291 62.332 PRESS. DROP % 4.9 3.1  \[ \Begin{align*}	TOTAL = (BETA) (GAMMA) (FIN) = .682 BETA (BAFF CUT FACTOR) = .920 GAMMA (TUBE ROW ENTRY EFCT) = .741 END (HT LOSS IN END ZONE) = .994  SHELL PRESSURE DROP, % OF TOTAL WINDOW = 8.9 END ZONE = 3.9 CROSS FLOW = 3.4 INLET NOZZLE = 42.7 OUTLET NOZZLE = 41.2  WEIGHT PER SHELL, LB DRY = 150. WET = 165.  exchanger experiment E0002 P 50 9/23/3 CASE 25  W, SEGMENTAL BAFFLES, RATING HOT TUBE SIDE COLD SHELL SIDE Tube Shell

		che433b (	40).001		
		IN	OUT	IN	OUT
TEMPERATURE	DEGF	140.0	103.8*	40.0	112.1*
TEMPERATURE DENSITY	LB/FT3	61.2913	61.8397	62.5352	61.7249
VISCOSITY	CP	4726	.6644	1 4791	6112
VISCOSITY SPECIFIC HEAT		0072	1000	1 0050	0070
SPECIFIC HEAT	BIU/LB-F	.9973	.9984	1.0056	.9979
THERMAL COND.	BTU/HR-FT-F	.3723	.3642	.3466	.3662
MOLAR MASS	LB/LBMOL		18.02		18.02
			10.02		
TEMP, AVG & SKIN VISCOSITY, AVG & S PRESSURE, IN & DES	DEGF	121.9	102.3	76.0	101.6
VISCOSITY, AVG & S	KIN CP	. 5558	. 6750	. 9080	. 6805
DDEGGIDE IN a DEG	TON DOTA	50 00	165 00	50 00	165 00
INDUSTRIA, IN & DES	ION IOIA	30.00	100.00	30.00	100.00
	c allowed box	0.0	10.00	0.0	10.00
PRESSURE DROP, TOT	& ALLOWED PSI	.03	10.00	.00	10.00
VELOCITY, CALC & M	AX ALLOWED FT/	s .39	10.00	.03	10.00
FOULING RESISTANCE	HR-FT2-F/B	STU .C	00010	. (	00010
FILM COEFFICIENT					34.45
TOTAL HEAT DUTY RE	OUTRED MEGRTU/H	IR			.014426
EFF TEMP DIF, DEGF			.cc_ 01 D7		
OVERALL COEFF REQU	TRED BTU/HR-F	''I'2-F'			75.39
CLEAN & FOULED COE	FF BTU/HR-F	'T2-F	76.8	2	75.61
SHELLS IN SERIES	1 PARALLEL 1	TOTAL EFF	AREA	FT2	7.1
PASSES, SHELL	1 TUBE 4	EFFECTIVE	AREA	FT2/SHELL	7.1
SHELL DIAMETER IN.					
				•	
BYELL AADE R	OD7 SECMENTI	CDOGG DNG	CEC DED CH	FII DAGG	1
BAFFLE TYPE H	ONZ SEGMENTE	CNOSS FAS	IN DON CUR	TI I D	30 00
SPACING, CENTRAL	IN. 4.309	BAFFLE CC	T, PCT SHE	LL 1.D.	30.00
SPACING, INLET	IN. 4.309	CUT DISTA	ANCE FROM C	ENTER, IN.	.764
SPACING, OUTLET	IN. 4.309				
BAFFLE THICKNESS	IN125	IMPINGEME	INT BAFFLE	INCLUDED	NO
PAIRS OF SEALING D					
TUBE TYPE NO. OF TUBES/SHELL TUBE LGTH, OVERALL	PLATN	MATERTAL.	E	LECTROLYTIC	COPPER
NO OF THE CAUSE!	76		ייוסם ייסוויי		36
NO. OF TUBES/SHELL	70	ESI MAA I	CH COONT		
•					.3125
TUBE LGTH, EFF			SIDE DIAM	IN.	.250
TUBE LAYOUT	DEG 60	TUBE INSI	DE DIAM	IN.	.214
PITCH RATIO	1.250	TUBE SURF	TACE RATIO,	OUT/IN	1.184
SHL NOZZ ID, IN&OU	T 1.0 1.0	TUBE NOZZ	ID, IN&OU	T IN.	.8 .8
•			,		
* CALCULATED ITE	MUFAT BAIANCE	CODE - 8			
□□Washington Unive					E0000 D E1
_	-	eat exchang	der exberru	enc	E0002 P 51
Young model F302DY	4 P				9/23/ 3
					CASE 25
S U P P L E	M E N T A	R Y F	R E S U	L T S	
HT PARAMETERS	SHELL TUBE	SHELI	SIDE PERFO	RMANCE	
WALL CORRECTION			VEL, X-FLO		.03
PRANDTL NUMBER	6.2 3.6		VEL, WINDO		.05
RYNLD NO, AVG			LOW COEF		
RYNLD NO, IN BUN	50. 1334.	WINDOW	COEF	BTU/HR-FT2-	-F 132.8

			CITE 433D (	•		
RYNLD NO, OUT BUN	121.	949.				
FOULNG LAYER IN.	.0014	.0014	SHEL	LSIDE FLOW,	% OF TOTA	L
FOULNG LAYER IN.			неат ті	RANSFER X-FI	UO.1	79.96
THERMAL RESISTANCE	° OF EO	плτ		O DARRIE IR		- 2.56
IHERMAL RESISTANCE	, 6 OF 10	1AL	TOBE I	J BAFFLE LEA	ANAGE A	
SHELL TUBE FOU	LING MET	AL	MAIN C	ROSSFLOW	В	= 68.46
55.61 42.70 1 PCT OVER DESIGN	.64 .	05	BUNDLE	TO SHELL BY	YPASS C	= 10.98
PCT OVER DESIGN TOT FOUL RESIST DIFF RESIST		.29	BAFFLE	TO SHELL LI	EAKAGE E	= 18.00
TOT FOIL RESIST	0	00217	TUBE P	ASSLANE BYP	ASS F	= 00
DIEE BEGIGE	. 0	00020	1000 11	ioodiiid biii	100	• • •
DIFF KESISI	. 0	00039				
DIAMETRAL CLEARA	NCES		TOTAL :	=(BETA)(GAM	MA) (FIN)	= .598
DIAMETRAL CLEARA BUNDLE TO SHELL	IN.	.5000	BETA	(BAFF CUT FA	ACTOR)	= .920
TIBE TO BAFFLE HOL	E TN	0284	CDMMD	(TIBE ROW E	TERV EECT)	= 650
BAFFLE TO SHELL	_ IN.	1000	END	(HT LOCC IN	END ZONE)	- 000
DAFFLE IO SHELL	T IN •	.1000	END	(11 1022 11)	END ZONE)	990
SHELL NOZZLE DAT	A IN	OUT	SHEL	L PRESSURE 1	DROP, % OF	TOTAL
HT UNDR NOZ IN.	.25		WINDOW			= 9.8
HT OPP NOZ IN.	.25		END ZOI	NE		= 7.7
HT UNDR NOZ IN. HT OPP NOZ IN. VELOCITY FT/S DENSITY LB/FT3 NOZZ RHO*VSQ LB/FT	16	17	CROSS	FI OW		- 5 9
VELOCITI FI/S	.10	.17	CROSS .	E LOW		- 3.9
DENSITY LB/FT3	62.535	61.725	TNTET 1	NOZZLE		= 40.6
NOZZ RHO*VSQ LB/FT	-S2 1	1	OUTLET	NOZZLE		= 36.1
BUND RHO*VSQ LB/FT	-S2 1	1				
TUBE NOZZLE DATA	TN	OHT	WEIG	HT DER SHELL	г. т.в	
VELOCITY FT/S	T 1/	50	MHIO	III I III OIIIII.		1 = 0
VELOCITY FT/S	.59	.59	DRY		=	150.
DENSITY LB/FT3	61.291	61.840	$\mathtt{WET}$		=	165.
PRESS. DROP %	7.4	4.7				
			t exchan	ger experim	ent	E0002 P 52
□□Washington Unive	rsity ChE		t exchan	ger experime	ent	
	rsity ChE		t exchan	ger experime	ent	9/23/ 3
□□Washington Unive Young model F302DY	rsity ChE 4P	433 hea				9/23/ 3 CASE 26
□□Washington Unive	rsity ChE 4P	433 hea	OW, SEGM	ENTAL BAFFLI	ES, RATING	9/23/ 3 CASE 26
□□Washington Unive Young model F302DY	rsity ChE 4P	433 hea	OW, SEGMI	ENTAL BAFFLI UBE SIDE	ES, RATING COLD S	9/23/ 3 CASE 26 HELL SIDE
□□Washington Unive Young model F302DY	rsity ChE 4P	433 hea	OW, SEGMI	ENTAL BAFFLI UBE SIDE	ES, RATING COLD S	9/23/ 3 CASE 26 HELL SIDE
□□Washington Unive Young model F302DY SIZE 4- 18 TYPE BE	rsity ChE 4P M, MULTI-	433 hea PASS FL	OW, SEGMI	ENTAL BAFFLI UBE SIDE	ES, RATING COLD S	9/23/ 3 CASE 26 HELL SIDE
□□Washington Unive Young model F302DY SIZE 4- 18 TYPE BE	rsity ChE 4P M, MULTI-	433 hea PASS FL	OW, SEGMI	ENTAL BAFFLI UBE SIDE	ES, RATING COLD S	9/23/ 3 CASE 26 HELL SIDE
□□Washington Unive Young model F302DY SIZE 4- 18 TYPE BE	rsity ChE 4P M, MULTI-	433 hea PASS FL	OW, SEGMI	ENTAL BAFFLI UBE SIDE	ES, RATING COLD S	9/23/ 3 CASE 26 HELL SIDE
□□Washington Unive Young model F302DY SIZE 4- 18 TYPE BE TOTAL FLOW RATE	rsity ChE 4P M, MULTI- KLB/HR	433 hea PASS FL	OW, SEGM HOT T Tube SENS	ENTAL BAFFLI UBE SIDE IBLE LIQ .400 OUT	ES, RATING COLD S. Shel SENS	9/23/3 CASE 26 HELL SIDE 1 IBLE LIQ .300 OUT
□□Washington Unive Young model F302DY SIZE 4- 18 TYPE BE	rsity ChE 4P M, MULTI- KLB/HR	433 hea PASS FL	OW, SEGM HOT T Tube SENS	ENTAL BAFFLI UBE SIDE	ES, RATING COLD S. Shel SENS	9/23/3 CASE 26 HELL SIDE 1 IBLE LIQ .300 OUT
□□Washington Unive Young model F302DY SIZE 4- 18 TYPE BE TOTAL FLOW RATE	rsity ChE 4P M, MULTI- KLB/HR	433 hea	OW, SEGMI HOT TI Tube SENS IN 140.0	ENTAL BAFFLI UBE SIDE IBLE LIQ .400 OUT	ES, RATING COLD S: Shel SENS IN 40.0	9/23/3 CASE 26 HELL SIDE 1 IBLE LIQ .300 OUT 100.7*
□□Washington Unive Young model F302DY SIZE 4- 18 TYPE BE  TOTAL FLOW RATE  TEMPERATURE DENSITY	rsity ChE 4P M, MULTI- KLB/HR DEGF LB/FT3	433 hea	OW, SEGMI HOT TI Tube SENS: IN 140.0 61.2913	ENTAL BAFFLIUBE SIDE  IBLE LIQ .400 OUT 94.3* 61.9661	ES, RATING COLD S: Shel. SENS IN 40.0 62.5352	9/23/ 3 CASE 26 HELL SIDE 1 IBLE LIQ .300 OUT 100.7* 61.8816
□□Washington Unive Young model F302DY SIZE 4- 18 TYPE BE  TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY	rsity ChE 4P M, MULTI- KLB/HR DEGF LB/FT3 CP	433 hea	OW, SEGMI HOT TI Tube SENS: IN 140.0 61.2913	ENTAL BAFFLIUBE SIDE  IBLE LIQ .400 OUT 94.3* 61.9661 .7358	ES, RATING COLD S: Shel SENS IN 40.0 62.5352 1.4791	9/23/3 CASE 26 HELL SIDE 1 IBLE LIQ .300 OUT 100.7* 61.8816 .6864
□□Washington Unive Young model F302DY SIZE 4- 18 TYPE BE  TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT	rsity ChE 4P M, MULTI- KLB/HR DEGF LB/FT3 CP BTU/LB-F	433 hea	OW, SEGMI HOT TI Tube SENS: IN 140.0 61.2913 .4726 .9973	ENTAL BAFFLI UBE SIDE IBLE LIQ .400 OUT 94.3* 61.9661 .7358 .9991	ES, RATING COLD S: Shel SENS  IN 40.0 62.5352 1.4791 1.0058	9/23/3 CASE 26 HELL SIDE 1 IBLE LIQ .300 OUT 100.7* 61.8816 .6864 .9986
□□Washington Unive Young model F302DY SIZE 4- 18 TYPE BE  TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND.	rsity ChE 4P M, MULTI-  KLB/HR  DEGF LB/FT3 CP BTU/LB-F BTU/HR-F	433 hea PASS FL	OW, SEGMI HOT TI Tube SENS: IN 140.0 61.2913	ENTAL BAFFLI UBE SIDE IBLE LIQ .400 OUT 94.3* 61.9661 .7358 .9991 .3618	ES, RATING COLD S: Shel SENS IN 40.0 62.5352 1.4791	9/23/3 CASE 26 HELL SIDE 1 IBLE LIQ .300 OUT 100.7* 61.8816 .6864 .9986 .3634
□□Washington Unive Young model F302DY SIZE 4- 18 TYPE BE  TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND.	rsity ChE 4P M, MULTI- KLB/HR DEGF LB/FT3 CP BTU/LB-F	433 hea PASS FL	OW, SEGMI HOT TI Tube SENS: IN 140.0 61.2913 .4726 .9973	ENTAL BAFFLI UBE SIDE IBLE LIQ .400 OUT 94.3* 61.9661 .7358 .9991	ES, RATING COLD S: Shel SENS  IN 40.0 62.5352 1.4791 1.0058	9/23/3 CASE 26 HELL SIDE 1 IBLE LIQ .300 OUT 100.7* 61.8816 .6864 .9986
□□Washington Unive Young model F302DY SIZE 4- 18 TYPE BE  TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND.	rsity ChE 4P M, MULTI-  KLB/HR  DEGF LB/FT3 CP BTU/LB-F BTU/HR-F	433 hea PASS FL	OW, SEGMI HOT TI Tube SENS: IN 140.0 61.2913 .4726 .9973 .3723	ENTAL BAFFLI UBE SIDE IBLE LIQ .400 OUT 94.3* 61.9661 .7358 .9991 .3618	ES, RATING COLD S: Shel. SENS  IN 40.0 62.5352 1.4791 1.0058 .3466	9/23/3 CASE 26 HELL SIDE 1 IBLE LIQ .300 OUT 100.7* 61.8816 .6864 .9986 .3634
ODWashington Univer Young model F302DY  SIZE 4- 18 TYPE BE  TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS	rsity ChE 4P M, MULTI- KLB/HR DEGF LB/FT3 CP BTU/LB-F BTU/HR-F LB/LBMOL	433 hea PASS FL	OW, SEGMI HOT TI Tube SENS: IN 140.0 61.2913 .4726 .9973 .3723	ENTAL BAFFLI UBE SIDE IBLE LIQ .400 OUT 94.3* 61.9661 .7358 .9991 .3618 18.02	ES, RATING COLD S: Shel. SENS  IN 40.0 62.5352 1.4791 1.0058 .3466	9/23/3 CASE 26 HELL SIDE 1 IBLE LIQ .300 OUT 100.7* 61.8816 .6864 .9986 .3634 18.02
TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS  TEMP, AVG & SKIN	rsity ChE 4P M, MULTI-  KLB/HR  DEGF LB/FT3 CP BTU/LB-F BTU/HR-F LB/LBMOL  DEGF	433 hea PASS FL	OW, SEGMI HOT TI Tube SENS: IN 140.0 61.2913 .4726 .9973 .3723	ENTAL BAFFLI UBE SIDE IBLE LIQ .400 OUT 94.3* 61.9661 .7358 .9991 .3618 18.02	ES, RATING COLD S: Shel. SENS  IN 40.0 62.5352 1.4791 1.0058 .3466	9/23/3 CASE 26 HELL SIDE 1 IBLE LIQ .300 OUT 100.7* 61.8816 .6864 .9986 .3634 18.02
TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS  TEMP, AVG & SKIN VISCOSITY, AVG & S	rsity ChE 4P  M, MULTI-  KLB/HR  DEGF LB/FT3 CP BTU/LB-F BTU/HR-F LB/LBMOL  DEGF  KIN CP	433 hea PASS FL	OW, SEGMI HOT TI Tube SENS: IN 140.0 61.2913 .4726 .9973 .3723	ENTAL BAFFLI UBE SIDE  IBLE LIQ .400 OUT 94.3* 61.9661 .7358 .9991 .3618 18.02 95.3 .7275	ES, RATING COLD S: Shel. SENS  IN 40.0 62.5352 1.4791 1.0058 .3466 70.4 .9737	9/23/3 CASE 26 HELL SIDE 1 IBLE LIQ .300 OUT 100.7* 61.8816 .6864 .9986 .3634 18.02
TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS  TEMP, AVG & SKIN	rsity ChE 4P  M, MULTI-  KLB/HR  DEGF LB/FT3 CP BTU/LB-F BTU/HR-F LB/LBMOL  DEGF  KIN CP	433 hea PASS FL	OW, SEGMI HOT TI Tube SENS: IN 140.0 61.2913 .4726 .9973 .3723	ENTAL BAFFLI UBE SIDE IBLE LIQ .400 OUT 94.3* 61.9661 .7358 .9991 .3618 18.02	ES, RATING COLD S: Shel. SENS  IN 40.0 62.5352 1.4791 1.0058 .3466 70.4 .9737	9/23/3 CASE 26 HELL SIDE 1 IBLE LIQ .300 OUT 100.7* 61.8816 .6864 .9986 .3634 18.02
TOTAL FLOW RATE  TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS  TEMP, AVG & SKIN VISCOSITY, AVG & S PRESSURE, IN & DES	rsity ChE 4P M, MULTI-  KLB/HR  DEGF LB/FT3 CP BTU/LB-F BTU/HR-F LB/LBMOL  DEGF KIN CP IGN PSIA	433 hea	OW, SEGMI HOT TI Tube SENS: IN 140.0 61.2913 .4726 .9973 .3723	ENTAL BAFFLI UBE SIDE  IBLE LIQ .400 OUT 94.3* 61.9661 .7358 .9991 .3618 18.02 95.3 .7275 165.00	ES, RATING COLD S: Shell SENS  IN 40.0 62.5352 1.4791 1.0058 .3466	9/23/3 CASE 26 HELL SIDE 1 IBLE LIQ .300 OUT 100.7* 61.8816 .6864 .9986 .3634 18.02
TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS  TEMP, AVG & SKIN VISCOSITY, AVG & S PRESSURE, IN & DES  PRESSURE DROP, TOT	rsity ChE 4P  M, MULTI-  KLB/HR  DEGF LB/FT3 CP BTU/LB-F BTU/HR-F LB/LBMOL  DEGF KIN CP IGN PSIA	433 hea PASS FL T-F D PSI	OW, SEGMI HOT TI Tube SENS: IN 140.0 61.2913 .4726 .9973 .3723	ENTAL BAFFLI UBE SIDE  IBLE LIQ .400 OUT 94.3* 61.9661 .7358 .9991 .3618 18.02 95.3 .7275 165.00	ES, RATING COLD S: Shell SENS  IN 40.0 62.5352 1.4791 1.0058 .3466	9/23/3 CASE 26 HELL SIDE 1 IBLE LIQ .300 OUT 100.7* 61.8816 .6864 .9986 .3634 18.02  94.4 .7344 165.00
TOTAL FLOW RATE  TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS  TEMP, AVG & SKIN VISCOSITY, AVG & S PRESSURE, IN & DES	rsity ChE 4P  M, MULTI-  KLB/HR  DEGF LB/FT3 CP BTU/LB-F BTU/HR-F LB/LBMOL  DEGF KIN CP IGN PSIA	433 hea PASS FL T-F D PSI	OW, SEGMI HOT TI Tube SENS: IN 140.0 61.2913 .4726 .9973 .3723	ENTAL BAFFLI UBE SIDE  IBLE LIQ .400 OUT 94.3* 61.9661 .7358 .9991 .3618 18.02 95.3 .7275 165.00	ES, RATING COLD S: Shell SENS  IN 40.0 62.5352 1.4791 1.0058 .3466	9/23/3 CASE 26 HELL SIDE 1 IBLE LIQ .300 OUT 100.7* 61.8816 .6864 .9986 .3634 18.02
TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS  TEMP, AVG & SKIN VISCOSITY, AVG & S PRESSURE, IN & DES  PRESSURE DROP, TOT	rsity ChE 4P  M, MULTI-  KLB/HR  DEGF LB/FT3 CP BTU/LB-F BTU/HR-F LB/LBMOL  DEGF KIN CP IGN PSIA	433 hea PASS FL T-F D PSI	OW, SEGMI HOT TI Tube SENS: IN 140.0 61.2913 .4726 .9973 .3723	ENTAL BAFFLI UBE SIDE  IBLE LIQ .400 OUT 94.3* 61.9661 .7358 .9991 .3618 18.02 95.3 .7275 165.00	ES, RATING COLD S: Shell SENS  IN 40.0 62.5352 1.4791 1.0058 .3466	9/23/3 CASE 26 HELL SIDE 1 IBLE LIQ .300 OUT 100.7* 61.8816 .6864 .9986 .3634 18.02  94.4 .7344 165.00
TOTAL FLOW RATE  TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS  TEMP, AVG & SKIN VISCOSITY, AVG & S PRESSURE, IN & DES  PRESSURE DROP, TOT VELOCITY, CALC & M	rsity ChE 4P  M, MULTI-  KLB/HR  DEGF LB/FT3 CP BTU/LB-F BTU/HR-F LB/LBMOL  DEGF KIN CP IGN PSIA & ALLOWE AX ALLOWE	433 hea PASS FL  T-F  D PSI D FT/S	OW, SEGMI HOT TU Tube SENS: IN 140.0 61.2913 .4726 .9973 .3723	ENTAL BAFFLIUBE SIDE  IBLE LIQ .400 OUT 94.3* 61.9661 .7358 .9991 .3618 18.02 95.3 .7275 165.00  10.00 10.00	ES, RATING COLD S. Shel. SENS  IN 40.0 62.5352 1.4791 1.0058 .3466 70.4 .9737 50.00 .05	9/23/3 CASE 26 HELL SIDE 1 IBLE LIQ .300 OUT 100.7* 61.8816 .6864 .9986 .3634 18.02 
TOTAL FLOW RATE  TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS  TEMP, AVG & SKIN VISCOSITY, AVG & S PRESSURE, IN & DES  PRESSURE DROP, TOT VELOCITY, CALC & M  FOULING RESISTANCE	rsity ChE 4P  M, MULTI-  KLB/HR  DEGF LB/FT3 CP BTU/LB-F BTU/HR-F LB/LBMOL  DEGF KIN CP IGN PSIA & ALLOWE AX ALLOWE HR-F	433 hea PASS FL  T-F  D PSI D FT/S T2-F/BT	OW, SEGMI HOT TU Tube SENS: IN 140.0 61.2913 .4726 .9973 .3723	ENTAL BAFFLIUBE SIDE  IBLE LIQ .400 OUT 94.3* 61.9661 .7358 .9991 .3618 18.02 95.3 .7275 165.00 10.00 10.00	ES, RATING COLD S. Shel SENS  IN 40.0 62.5352 1.4791 1.0058 .3466	9/23/3 CASE 26 HELL SIDE 1 IBLE LIQ .300 OUT 100.7* 61.8816 .6864 .9986 .3634 18.02 
TOTAL FLOW RATE  TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS  TEMP, AVG & SKIN VISCOSITY, AVG & S PRESSURE, IN & DES  PRESSURE DROP, TOT VELOCITY, CALC & M	rsity ChE 4P  M, MULTI-  KLB/HR  DEGF LB/FT3 CP BTU/LB-F BTU/HR-F LB/LBMOL  DEGF KIN CP IGN PSIA & ALLOWE AX ALLOWE HR-F	433 hea PASS FL  T-F  D PSI D FT/S T2-F/BT	OW, SEGMI HOT TU Tube SENS: IN 140.0 61.2913 .4726 .9973 .3723	ENTAL BAFFLIUBE SIDE  IBLE LIQ .400 OUT 94.3* 61.9661 .7358 .9991 .3618 18.02 95.3 .7275 165.00 10.00 10.00	ES, RATING COLD S. Shel SENS  IN 40.0 62.5352 1.4791 1.0058 .3466	9/23/3 CASE 26 HELL SIDE 1 IBLE LIQ .300 OUT 100.7* 61.8816 .6864 .9986 .3634 18.02 

TOTAL HEAT DUTY REQUIRED MEGBTU/H EFF TEMP DIF, DEGF (LMTD= 46.4,F	= .72,BYPASS= .93,BAFF=1.00) 31.1
OVERALL COEFF REQUIRED BTU/HR-F CLEAN & FOULED COEFF BTU/HR-F	T2-F       82.13         T2-F       84.04       82.51
SHELLS IN SERIES 1 PARALLEL 1 PASSES, SHELL 1 TUBE 4	TOTAL EFF AREA FT2 7.1 EFFECTIVE AREA FT2/SHELL 7.1
SHELL DIAMETER IN. 3.820	TEMA SHELL TYPE E ; REAR HEAD FXTS
BAFFLE TYPE HORZ SEGMENTL	CROSS PASSES PER SHELL PASS 4
SPACING, CENTRAL IN. 4.309 SPACING, INLET IN. 4.309	BAFFLE CUT, PCT SHELL I.D. 30.00 CUT DISTANCE FROM CENTER, IN764
SPACING, OUTLET IN. 4.309	COI DISTANCE FROM CENTER, IN
BAFFLE THICKNESS IN125	IMPINGEMENT BAFFLE INCLUDED NO
PAIRS OF SEALING DEVICES 1	TUBESHEET BLANK AREA, % .0
TUBE TYPE PLAIN	MATERIAL ELECTROLYTIC COPPER
NO. OF TUBES/SHELL 76 TUBE LGTH, OVERALL FT 1.500	EST MAX TUBE COUNT 36 TUBE PITCH IN3125
TUBE LGTH, EFF FT 1.436	TUBE OUTSIDE DIAM IN250
	TUBE INSIDE DIAM IN214
	TUBE SURFACE RATIO, OUT/IN 1.184
SHL NOZZ ID, IN&OUT 1.0 1.0	TUBE NOZZ ID, IN&OUT IN8 .8
* CALCULATED ITEMHEAT BALANCE □□Washington University ChE433 he Young model F302DY4P	
S U P P L E M E N T A	CASE 26 RYRESULTS
	R Y R E S U L T S
HT PARAMETERS SHELL TUBE WALL CORRECTION 1.040 .000	R Y R E S U L T S  SHELLSIDE PERFORMANCE
HT PARAMETERS SHELL TUBE WALL CORRECTION 1.040 .000	R Y R E S U L T S  SHELLSIDE PERFORMANCE
HT PARAMETERS SHELL TUBE WALL CORRECTION 1.040 .000 PRANDTL NUMBER 6.6 3.8 RYNLD NO, AVG 116. 1084.	SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S .04  NOMINAL VEL, WINDOW FT/S .08  CROSSFLOW COEF BTU/HR-FT2-F 159.2
HT PARAMETERS SHELL TUBE WALL CORRECTION 1.040 .000 PRANDTL NUMBER 6.6 3.8 RYNLD NO, AVG 116. 1084. RYNLD NO, IN BUN 76. 1334.	SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S .04  NOMINAL VEL, WINDOW FT/S .08  CROSSFLOW COEF BTU/HR-FT2-F 159.2
HT PARAMETERS SHELL TUBE WALL CORRECTION 1.040 .000 PRANDTL NUMBER 6.6 3.8 RYNLD NO, AVG 116. 1084.	SHELLSIDE PERFORMANCE  NOMINAL VEL,X-FLOW FT/S .04  NOMINAL VEL,WINDOW FT/S .08  CROSSFLOW COEF BTU/HR-FT2-F 159.2  WINDOW COEF BTU/HR-FT2-F 160.0  SHELLSIDE FLOW, % OF TOTAL
HT PARAMETERS SHELL TUBE WALL CORRECTION 1.040 .000 PRANDTL NUMBER 6.6 3.8 RYNLD NO, AVG 116. 1084. RYNLD NO, IN BUN 76. 1334. RYNLD NO,OUT BUN 164. 857. FOULNG LAYER IN0014 .0014	SHELLSIDE PERFORMANCE  NOMINAL VEL,X-FLOW FT/S .04  NOMINAL VEL,WINDOW FT/S .08  CROSSFLOW COEF BTU/HR-FT2-F 159.2  WINDOW COEF BTU/HR-FT2-F 160.0  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.20
HT PARAMETERS SHELL TUBE WALL CORRECTION 1.040 .000 PRANDTL NUMBER 6.6 3.8 RYNLD NO, AVG 116. 1084. RYNLD NO, IN BUN 76. 1334. RYNLD NO,OUT BUN 164. 857. FOULNG LAYER IN0014 .0014 THERMAL RESISTANCE, % OF TOTAL	SHELLSIDE PERFORMANCE  NOMINAL VEL,X-FLOW FT/S .04  NOMINAL VEL,WINDOW FT/S .08  CROSSFLOW COEF BTU/HR-FT2-F 159.2  WINDOW COEF BTU/HR-FT2-F 160.0  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.20  TUBE TO BAFFLE LEAKAGE A = 2.67
HT PARAMETERS SHELL TUBE WALL CORRECTION 1.040 .000 PRANDTL NUMBER 6.6 3.8 RYNLD NO, AVG 116. 1084. RYNLD NO, IN BUN 76. 1334. RYNLD NO,OUT BUN 164. 857. FOULNG LAYER IN0014 .0014 THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL	SHELLSIDE PERFORMANCE  NOMINAL VEL,X-FLOW FT/S .04  NOMINAL VEL,WINDOW FT/S .08  CROSSFLOW COEF BTU/HR-FT2-F 159.2  WINDOW COEF BTU/HR-FT2-F 160.0  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.20  TUBE TO BAFFLE LEAKAGE A = 2.67  MAIN CROSSFLOW B = 69.50
HT PARAMETERS SHELL TUBE WALL CORRECTION 1.040 .000 PRANDTL NUMBER 6.6 3.8 RYNLD NO, AVG 116. 1084. RYNLD NO, IN BUN 76. 1334. RYNLD NO,OUT BUN 164. 857. FOULNG LAYER IN0014 .0014 THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL	SHELLSIDE PERFORMANCE  NOMINAL VEL,X-FLOW FT/S .04  NOMINAL VEL,WINDOW FT/S .08  CROSSFLOW COEF BTU/HR-FT2-F 159.2  WINDOW COEF BTU/HR-FT2-F 160.0  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.20  TUBE TO BAFFLE LEAKAGE A = 2.67  MAIN CROSSFLOW B = 69.50
HT PARAMETERS SHELL TUBE WALL CORRECTION 1.040 .000 PRANDTL NUMBER 6.6 3.8 RYNLD NO, AVG 116. 1084. RYNLD NO, IN BUN 76. 1334. RYNLD NO,OUT BUN 164. 857. FOULNG LAYER IN0014 .0014 THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL	SHELLSIDE PERFORMANCE  NOMINAL VEL,X-FLOW FT/S .04  NOMINAL VEL,WINDOW FT/S .08  CROSSFLOW COEF BTU/HR-FT2-F 159.2  WINDOW COEF BTU/HR-FT2-F 160.0  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.20  TUBE TO BAFFLE LEAKAGE A = 2.67  MAIN CROSSFLOW B = 69.50
HT PARAMETERS SHELL TUBE WALL CORRECTION 1.040 .000 PRANDTL NUMBER 6.6 3.8 RYNLD NO, AVG 116. 1084. RYNLD NO, IN BUN 76. 1334. RYNLD NO,OUT BUN 164. 857. FOULNG LAYER IN0014 .0014 THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL	SHELLSIDE PERFORMANCE  NOMINAL VEL,X-FLOW FT/S .04  NOMINAL VEL,WINDOW FT/S .08  CROSSFLOW COEF BTU/HR-FT2-F 159.2  WINDOW COEF BTU/HR-FT2-F 160.0  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.20  TUBE TO BAFFLE LEAKAGE A = 2.67  MAIN CROSSFLOW B = 69.50
HT PARAMETERS SHELL TUBE WALL CORRECTION 1.040 .000 PRANDTL NUMBER 6.6 3.8 RYNLD NO, AVG 116. 1084. RYNLD NO, IN BUN 76. 1334. RYNLD NO,OUT BUN 164. 857. FOULNG LAYER IN0014 .0014  THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL 51.48 46.68 1.79 .06 PCT OVER DESIGN .47 TOT FOUL RESIST .000217 DIFF RESIST .000057	SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S .04  NOMINAL VEL, WINDOW FT/S .08  CROSSFLOW COEF BTU/HR-FT2-F 159.2  WINDOW COEF BTU/HR-FT2-F 160.0  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.20  TUBE TO BAFFLE LEAKAGE A = 2.67  MAIN CROSSFLOW B = 69.50  BUNDLE TO SHELL BYPASS C = 11.16  BAFFLE TO SHELL LEAKAGE E = 16.67  TUBE PASSLANE BYPASS F = .00
HT PARAMETERS SHELL TUBE WALL CORRECTION 1.040 .000 PRANDTL NUMBER 6.6 3.8 RYNLD NO, AVG 116. 1084. RYNLD NO, IN BUN 76. 1334. RYNLD NO,OUT BUN 164. 857. FOULNG LAYER IN0014 .0014  THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL 51.48 46.68 1.79 .06 PCT OVER DESIGN .47 TOT FOUL RESIST .000217 DIFF RESIST .000057	SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S .04  NOMINAL VEL, WINDOW FT/S .08  CROSSFLOW COEF BTU/HR-FT2-F 159.2  WINDOW COEF BTU/HR-FT2-F 160.0  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.20  TUBE TO BAFFLE LEAKAGE A = 2.67  MAIN CROSSFLOW B = 69.50  BUNDLE TO SHELL BYPASS C = 11.16  BAFFLE TO SHELL LEAKAGE E = 16.67  TUBE PASSLANE BYPASS F = .00  SHELLSIDE HEAT TRANSFER FACTORS  TOTAL = (BETA) (GAMMA) (FIN) = .598
HT PARAMETERS SHELL TUBE WALL CORRECTION 1.040 .000 PRANDTL NUMBER 6.6 3.8 RYNLD NO, AVG 116. 1084. RYNLD NO, IN BUN 76. 1334. RYNLD NO,OUT BUN 164. 857. FOULNG LAYER IN0014 .0014  THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL 51.48 46.68 1.79 .06 PCT OVER DESIGN .47 TOT FOUL RESIST .000217 DIFF RESIST .000057  DIAMETRAL CLEARANCES BUNDLE TO SHELL IN5000	SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S .04  NOMINAL VEL, WINDOW FT/S .08  CROSSFLOW COEF BTU/HR-FT2-F 159.2  WINDOW COEF BTU/HR-FT2-F 160.0  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.20  TUBE TO BAFFLE LEAKAGE A = 2.67  MAIN CROSSFLOW B = 69.50  BUNDLE TO SHELL BYPASS C = 11.16  BAFFLE TO SHELL LEAKAGE E = 16.67  TUBE PASSLANE BYPASS F = .00  SHELLSIDE HEAT TRANSFER FACTORS  TOTAL = (BETA) (GAMMA) (FIN) = .598  BETA (BAFF CUT FACTOR) = .920
HT PARAMETERS SHELL TUBE WALL CORRECTION 1.040 .000 PRANDTL NUMBER 6.6 3.8 RYNLD NO, AVG 116. 1084. RYNLD NO, IN BUN 76. 1334. RYNLD NO,OUT BUN 164. 857. FOULNG LAYER IN0014 .0014  THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL 51.48 46.68 1.79 .06 PCT OVER DESIGN .47 TOT FOUL RESIST .000217 DIFF RESIST .000057  DIAMETRAL CLEARANCES BUNDLE TO SHELL IN5000 TUBE TO BAFFLE HOLE IN0284	SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S .04  NOMINAL VEL, WINDOW FT/S .08  CROSSFLOW COEF BTU/HR-FT2-F 159.2  WINDOW COEF BTU/HR-FT2-F 160.0  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.20  TUBE TO BAFFLE LEAKAGE A = 2.67  MAIN CROSSFLOW B = 69.50  BUNDLE TO SHELL BYPASS C = 11.16  BAFFLE TO SHELL LEAKAGE E = 16.67  TUBE PASSLANE BYPASS F = .00  SHELLSIDE HEAT TRANSFER FACTORS  TOTAL = (BETA) (GAMMA) (FIN) = .598  BETA (BAFF CUT FACTOR) = .920  GAMMA (TUBE ROW ENTRY EFCT) = .650
HT PARAMETERS SHELL TUBE WALL CORRECTION 1.040 .000 PRANDTL NUMBER 6.6 3.8 RYNLD NO, AVG 116. 1084. RYNLD NO, IN BUN 76. 1334. RYNLD NO,OUT BUN 164. 857. FOULNG LAYER IN0014 .0014  THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL 51.48 46.68 1.79 .06 PCT OVER DESIGN .47 TOT FOUL RESIST .000217 DIFF RESIST .000057  DIAMETRAL CLEARANCES BUNDLE TO SHELL IN5000 TUBE TO BAFFLE HOLE IN0284	SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S .04  NOMINAL VEL, WINDOW FT/S .08  CROSSFLOW COEF BTU/HR-FT2-F 159.2  WINDOW COEF BTU/HR-FT2-F 160.0  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.20  TUBE TO BAFFLE LEAKAGE A = 2.67  MAIN CROSSFLOW B = 69.50  BUNDLE TO SHELL BYPASS C = 11.16  BAFFLE TO SHELL LEAKAGE E = 16.67  TUBE PASSLANE BYPASS F = .00  SHELLSIDE HEAT TRANSFER FACTORS  TOTAL = (BETA) (GAMMA) (FIN) = .598  BETA (BAFF CUT FACTOR) = .920
HT PARAMETERS SHELL TUBE WALL CORRECTION 1.040 .000 PRANDTL NUMBER 6.6 3.8 RYNLD NO, AVG 116. 1084. RYNLD NO, IN BUN 76. 1334. RYNLD NO,OUT BUN 164. 857. FOULNG LAYER IN0014 .0014  THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL 51.48 46.68 1.79 .06 PCT OVER DESIGN .47 TOT FOUL RESIST .000217 DIFF RESIST .000057  DIAMETRAL CLEARANCES BUNDLE TO SHELL IN5000 TUBE TO BAFFLE HOLE IN0284 BAFFLE TO SHELL IN1000	SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S .04  NOMINAL VEL, WINDOW FT/S .08  CROSSFLOW COEF BTU/HR-FT2-F 159.2  WINDOW COEF BTU/HR-FT2-F 160.0  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.20  TUBE TO BAFFLE LEAKAGE A = 2.67  MAIN CROSSFLOW B = 69.50  BUNDLE TO SHELL BYPASS C = 11.16  BAFFLE TO SHELL LEAKAGE E = 16.67  TUBE PASSLANE BYPASS F = .00  SHELLSIDE HEAT TRANSFER FACTORS  TOTAL = (BETA) (GAMMA) (FIN) = .598  BETA (BAFF CUT FACTOR) = .920  GAMMA (TUBE ROW ENTRY EFCT) = .650
HT PARAMETERS SHELL TUBE WALL CORRECTION 1.040 .000 PRANDTL NUMBER 6.6 3.8 RYNLD NO, AVG 116. 1084. RYNLD NO, IN BUN 76. 1334. RYNLD NO,OUT BUN 164. 857. FOULNG LAYER IN0014 .0014  THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL 51.48 46.68 1.79 .06 PCT OVER DESIGN .47 TOT FOUL RESIST .000217 DIFF RESIST .000057  DIAMETRAL CLEARANCES BUNDLE TO SHELL IN5000 TUBE TO BAFFLE HOLE IN0284 BAFFLE TO SHELL IN1000	SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S .04  NOMINAL VEL, WINDOW FT/S .08  CROSSFLOW COEF BTU/HR-FT2-F 159.2  WINDOW COEF BTU/HR-FT2-F 160.0  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.20  TUBE TO BAFFLE LEAKAGE A = 2.67  MAIN CROSSFLOW B = 69.50  BUNDLE TO SHELL BYPASS C = 11.16  BAFFLE TO SHELL LEAKAGE E = 16.67  TUBE PASSLANE BYPASS F = .00  SHELLSIDE HEAT TRANSFER FACTORS  TOTAL = (BETA) (GAMMA) (FIN) = .598  BETA (BAFF CUT FACTOR) = .920  GAMMA (TUBE ROW ENTRY EFCT) = .650  END (HT LOSS IN END ZONE) = .994

	0.4	) dccreiio			4 0
VELOCITY FT/S					= 4.8
DENSITY LB/FT3	62.535 61.882	INLET N	IOZZLE		= 41.8
NOZZ RHO*VSQ LB/FT-	S2 3 3	OUTLET	NOZZLE		= 38.0
BUND RHO*VSQ LB/FT-	S2 2 2				
TUBE NOZZLE DATA VELOCITY FT/S	IN OUT	WEIGH	IT PER SHEL	L, LB	
VELOCITY FT/S	.59 .58	DRY		=	150.
DENSITY LB/FT3				=	165.
PRESS. DROP %	7.1 4.5				
□□Washington Univer	sity ChE433 he	at exchand	ger experime	ent	E0002 P 54
Young model F302DY4		-	, <u>+</u>		9/23/ 3
3					CASE 27
SIZE 4- 18 TYPE BEM	. MULTI-PASS F	LOW, SEGME	NTAL BAFFL	ES. RATING	
2122 1 10 1112 221	, 110211 11100 1		JBE SIDE		
		CENCI	BLE LIQ	SHEL	TDIE IIO
TOTAL FLOW RATE	עז ה / ווה	SENSI	.DUE LIQ	SENS.	TOUE TIA
IOIAL FLOW RAIE	KLB/ HK	T.N.T	.400 OUT	TNI	.400
TEMPERATURE DENSITY VISCOSITY	DE CE	110 0	00.1	1 N	00.1
TEMPERATURE .	DEGF	140.0	87.3*	40.0	92.4*
DENSITY	LB/FT3	61.2913	62.0527	62.5352	61.9894
VISCOSITY	CP	.4726	.7949 .9997	1.4791	.7507
SPECIFIC HEAT	RTII/I.R-F	99.73	9997	1 0058	9997
THERMAL COND.  MOLAR MASS	BTU/HR-FT-F	.3723	.3600	.3466	.3613
MOLAR MASS	LB/LBMOL		18.02		18.02
TEMP, AVG & SKIN	DEGF	113.7	89.7	66.2	88.8
VISCOSITY, AVG & SK	IN CP	.6017	.7737	1.0265	.7820
VISCOSITY, AVG & SK PRESSURE, IN & DESIGN	GN PSIA	50.00	165.00	50.00	165.00
PRESSURE DROP, TOT	& ALLOWED PSI	.04	10.00	.00	10.00
VELOCITY, CALC & MAX	X ALLOWED FT/:	s .39	10.00	.06	10.00
FOULING RESISTANCE	HR-FT2-F/B	ru .C	00010	. (	00010
FILM COEFFICIENT	BTU/HR-FT2	-F 20	9.12	1	85.24
TOTAL HEAT DUTY REQ	UTRED MEGBTU/H	R			.021018
EFF TEMP DIF, DEGF	(I.MTD= 47 5 F	= 74 RYPZ	ASS= 94 BAI	FF=1 00)	33 1
OVERALL COEFF REQUI			100 . J 1 <b>,</b> DI11	11 1.00)	88.95
CLEAN & FOULED COEF			90.98	2	89.10
CHEAN & FOOLED COEF.	r bio/iix r	12 F	50.50	5	03.10
SHELLS IN SERIES 1	ר דיד דיד 1		ת יו כו ת	Em O	7 1
PASSES, SHELL 1	PARALLEL I	TOTAL EFF	ARLA	FIZ	7.1
SHELL DIAMETER IN.	TUBE 4	EFFECTIVE	AKLA	FTZ/SHELL	/.I
SHELL DIAMETER IN.	3.820	TEMA SHEI	T TYPE E	; REAR H	EAD FXTS
BAFFLE TYPE HO	RZ SEGMENTL	CROSS PAS	SSES PER SHI	LLL PASS	4
SPACING, CENTRAL I	N. 4.309	BAFFLE CU	JT, PCT SHE	LL I.D.	30.00
SPACING, INLET	N. 4.309	CUT DISTA	ANCE FROM CI	ENTER, IN.	.764
SPACING, OUTLET I	N. 4.309				
BAFFLE THICKNESS I	N125	IMPINGEME	INT BAFFLE	INCLUDED	NO
PAIRS OF SEALING DE	VICES 1	TUBESHEET	BLANK ARE	A, %	.0
TUBE TYPE	PLAIN	MATERIAL	El	LECTROLYTI	C COPPER
NO. OF TUBES/SHELL	76	EST MAX T	UBE COUNT		36

TUBE LGTH, OVERALL FT TUBE LGTH, EFF FT TUBE LAYOUT DEG PITCH RATIO SHL NOZZ ID, IN&OUT 1.0  * CALCULATED ITEMHEAT: DUMASHINGTON University Ch Young model F302DY4P	1.436 TU 60 TU 1.250 TU 1.0 TU	JBE OUTSIDE DIAM I JBE INSIDE DIAM I JBE SURFACE RATIO, OUT JBE NOZZ ID, IN&OUT I DDE = 8	IN. IN. I/IN	.250 .214 1.184 .8
S U P P L E M E N	T A R	Y RESUL	T S	CASE 27
HT PARAMETERS SHELL WALL CORRECTION 1.039 PRANDTL NUMBER 7.0 RYNLD NO, AVG 147. RYNLD NO, IN BUN 102. RYNLD NO,OUT BUN 200. FOULNG LAYER IN0014	.000 4.0 1048. 1334.	NOMINAL VEL, X-FLOW F NOMINAL VEL, WINDOW F CROSSFLOW COEF BTU/ WINDOW COEF BTU/	TT/S TT/S 'HR-FT2- 'HR-FT2-	.10 F 186.0 F 187.1
FOULNG LAYER IN0014  THERMAL RESISTANCE, % OF TO SHELL TUBE FOULING ME 47.56 50.44 1.93  PCT OVER DESIGN TOT FOUL RESIST .  DIFF RESIST .	OTAL TAL .06 .17 000217 000019	TUBE TO BAFFLE LEAKAG MAIN CROSSFLOW BUNDLE TO SHELL BYPAS BAFFLE TO SHELL LEAKA TUBE PASSLANE BYPASS	GE A B SS C AGE E F	= 2.88 = 68.64 = 12.15 = 16.32 = .00
DIAMETRAL CLEARANCES BUNDLE TO SHELL IN. TUBE TO BAFFLE HOLE IN. BAFFLE TO SHELL IN.	.5000 .0284	TOTAL = (BETA) (GAMMA) (BETA (BAFF CUT FACTO GAMMA (TUBE ROW ENTRY	(FIN) OR) ( EFCT)	= .613 = .920 = .666
SHELL NOZZLE DATA IN HT UNDR NOZ IN25 HT OPP NOZ IN25 VELOCITY FT/S .33 DENSITY LB/FT3 62.535 NOZZ RHO*VSQ LB/FT-S2 6 BUND RHO*VSQ LB/FT-S2 4	.33 61.989 6	SHELL PRESSURE DROPWINDOW END ZONE CROSS FLOW INLET NOZZLE OUTLET NOZZLE	₽, % OF	TOTAL = 9.1 = 5.3 = 4.4 = 42.2 = 39.0
TUBE NOZZLE DATA IN VELOCITY FT/S .59 DENSITY LB/FT3 61.291 PRESS. DROP % 6.9 DDWashington University Ch Young model F302DY4P	.58 62.053 4.3	WEIGHT PER SHELL, I DRY WET exchanger experiment	=	150. 165. E0002 P 56 9/23/ 3 CASE 28
SIZE 4- 18 TYPE BEM, MULTI  TOTAL FLOW RATE KLB/HR	-PASS FLOV	N, SEGMENTAL BAFFLES, HOT TUBE SIDE Tube SENSIBLE LIQ .400 IN OUT	COLD SH Shell	ELL SIDE

		1 4221 (	40) 011		
		che433b(	40).OUT	4.0	0.6.01
TEMPERATURE DENSITY	DEGF	140.0	82.3*	40.0	86.0*
DENSITY	LB/FT3	61.2913	62.1138	62.5352	62.0691
VISCOSITY	CP ,	.4726	.8431	1.4791	.8073
SPECIFIC HEAT			1.0002		
THERMAL COND.		.3723	.3587	.3466	.3597
MOLAR MASS	LB/LBMOL		18.02		18.02
TEMP, AVG & SKIN	DEGE	111.1	85.4	63.0	84.4
VISCOSITY, AVG & S	SKIN CP	.61/0	.8128	1.0/03	.8224
PRESSURE, IN & DES	SIGN PSIA	50.00	165.00	50.00	165.00
PRESSURE DROP, TOT	' & ATTOMED DG	г 04	10 00	0.1	10 00
VELOCITY, CALC & N					10.00
VEHOCITI, CALC & P	IAK ADDOWED FI		10.00	.00	10.00
FOULING RESISTANCE	HR-FT2-F/I	BTU .(	00010	. (	00010
FILM COEFFICIENT	BTU/HR-FT2	2-F 20	09.00	21	
TOTAL HEAT DUTY RE	QUIRED MEGBTU/	НR			.023053
EFF TEMP DIF, DEGE	(LMTD= 47.9,	F = .76, BYP	ASS= .94,BA	FF=1.00)	34.2
OVERALL COEFF REQUIRED COE	FF BTU/HR-I	FT2-F	96.5	4	94.37
SHELLS IN SERIES					
PASSES, SHELL	1 TUBE 4	EFFECTIVE	E AREA	FT2/SHELL	7.1
SHELL DIAMETER IN.	3.820	TEMA SHE	LL TYPE E	; REAR HI	EAD FXTS
BAFFLE TYPE F		CROSS PAS	SSES PER SH	ELL PASS	4
SPACING, CENTRAL					
SPACING, INLET		CUT DISTA	ANCE FROM C	ENTER, IN.	.764
SPACING, OUTLET					
BAFFLE THICKNESS					
PAIRS OF SEALING I	EVICES I	TUBESHEE'	I' BLANK ARE.	A, %	.0
TUBE TYPE	ΡΤ.ΔΤΝ	ΜΔΨΕΡΤΔΙ.	E	T.E.CTROT.VTT	COPPER
NO. OF TUBES/SHELI	. 76	TAILMIAL TO TAIL			
TUBE LGTH, OVERALI	л 70 Ет 1500	יייום המווח	CH COONT		.3125
TUBE LGTH, EFF			SIDE DIAM	IN.	.250
			IDE DIAM		.214
PITCH RATIO			FACE RATIO,		
SHL NOZZ ID, IN&OU					
SHE NOZE ID, INGO	,1 1.0 1.0	TODE NOZZ	I ID, INGOO	1 111.	.0 .0
* CALCULATED ITE	MHEAT BALANCE	E CODE = 8			
□□Washington Unive	ersity ChE433 he	eat exchand	ger experim	ent	E0002 P 57
Young model F302DY	_		_		9/23/ 3
-					CASE 28
S U P P L E	M E N T A	R Y I	R E S U	L T S	
HT PARAMETERS		SHEL	LSIDE PERFO	RMANCE	
WALL CORRECTION		NOMINA	L VEL, X-FLO	W FT/S	.07
PRANDTL NUMBER	7.3 4.1	NOMINA	L VEL, WINDO	W FT/S	.13
RYNLD NO, AVG		CROSSF1	LOW COEF	BTU/HR-FT2	-F 210.8
RYNLD NO, IN BUN		WINDOW	COEF	BTU/HR-FT2	-F 212.1
RYNLD NO, OUT BUN	233. 748.				

cne433b(40).001		
HEAT TRANSFER X-FLOW	81.46	
TUBE TO BAFFLE LEAKA	3.07	
MAIN CROSSFLOW	B = 67.84	
BUNDLE TO SHELL BYPA	C = 13.00	
BAFFLE TO SHELL LEAK	AGE $E = 16.09$	
TUBE PASSLANE BYPASS	F = .00	
SHELLSIDE HEAT TRA	NSFER FACTORS	
TOTAL = (BETA) (GAMMA)	(FIN) = .628	
BETA (BAFF CUT FACT)	OR) = .920	
GAMMA (TUBE ROW ENTR	Y = EFCT) = .683	
,	,	
SHELL PRESSURE DRO	P. % OF TOTAL	
WINDOW		
END ZONE		
	= 42 4	
	= 39 7	
001111 1102211	33 <b>.</b> 1	
WEIGHT DER SHELL	r.B	
DDV	ط ط 150	
Men		
MET	_ 105.	
t oughanger ouneriment	E0003 D 5	0
t exchanger experiment		8
t exchanger experiment	9/23/ 3	8
	9/23/ 3 CASE 29	8
OW, SEGMENTAL BAFFLES,	9/23/ 3 CASE 29 RATING	8
OW, SEGMENTAL BAFFLES, HOT TUBE SIDE	9/23/ 3 CASE 29 RATING COLD SHELL SIDE	
OW, SEGMENTAL BAFFLES, HOT TUBE SIDE	9/23/ 3 CASE 29 RATING COLD SHELL SIDE	
OW, SEGMENTAL BAFFLES, HOT TUBE SIDE	9/23/ 3 CASE 29 RATING COLD SHELL SIDE	
OW, SEGMENTAL BAFFLES, HOT TUBE SIDE	9/23/ 3 CASE 29 RATING COLD SHELL SIDE	
OW, SEGMENTAL BAFFLES, HOT TUBE SIDE	9/23/ 3 CASE 29 RATING COLD SHELL SIDE	
AOW, SEGMENTAL BAFFLES, HOT TUBE SIDE Tube SENSIBLE LIQ .400 IN OUT 140.0 78.3*	9/23/3 CASE 29 RATING COLD SHELL SIDE Shell SENSIBLE LIQ .600 IN OUT 40.0 80.9*	
OW, SEGMENTAL BAFFLES, HOT TUBE SIDE Tube SENSIBLE LIQ .400 IN OUT 140.0 78.3* 61.2913 62.1591 6	9/23/3 CASE 29 RATING COLD SHELL SIDE Shell SENSIBLE LIQ .600 IN OUT 40.0 80.9* 2.5352 62.1294	
OW, SEGMENTAL BAFFLES, HOT TUBE SIDE Tube SENSIBLE LIQ .400 IN OUT 140.0 78.3* 61.2913 62.1591 6.	9/23/3 CASE 29 RATING COLD SHELL SIDE Shell SENSIBLE LIQ .600 IN OUT 40.0 80.9* 2.5352 62.1294 1.4791 .8564	
OW, SEGMENTAL BAFFLES, HOT TUBE SIDE Tube SENSIBLE LIQ .400 IN OUT 140.0 78.3* 61.2913 62.1591 64726 .8831 .9973 1.0006	9/23/3 CASE 29 RATING COLD SHELL SIDE Shell SENSIBLE LIQ .600 IN OUT 40.0 80.9* 2.5352 62.1294 1.4791 .8564 1.0058 1.0003	
AOW, SEGMENTAL BAFFLES, HOT TUBE SIDE Tube SENSIBLE LIQ .400 IN OUT 140.0 78.3* 61.2913 62.1591 64726 .8831 .9973 1.0006 .3723 .3576	9/23/3 CASE 29  RATING COLD SHELL SIDE Shell SENSIBLE LIQ .600 IN OUT 40.0 80.9* 2.5352 62.1294 1.4791 .8564 1.0058 1.0003 .3466 .3583	
OW, SEGMENTAL BAFFLES, HOT TUBE SIDE Tube SENSIBLE LIQ .400 IN OUT 140.0 78.3* 61.2913 62.1591 64726 .8831 .9973 1.0006 .3723 .3576 18.02	9/23/3 CASE 29 RATING COLD SHELL SIDE Shell SENSIBLE LIQ .600 IN OUT 40.0 80.9* 2.5352 62.1294 1.4791 .8564 1.0058 1.0003 .3466 .3583 18.02	
OW, SEGMENTAL BAFFLES, HOT TUBE SIDE Tube SENSIBLE LIQ .400 IN OUT 140.0 78.3* 61.2913 62.1591 64726 .8831 .9973 1.0006 .3723 .3576 18.02	9/23/3 CASE 29 RATING COLD SHELL SIDE Shell SENSIBLE LIQ .600 IN OUT 40.0 80.9* 2.5352 62.1294 1.4791 .8564 1.0058 1.0003 .3466 .3583 18.02	
OW, SEGMENTAL BAFFLES, HOT TUBE SIDE Tube SENSIBLE LIQ .400 IN OUT 140.0 78.3* 61.2913 62.1591 64726 .8831 .9973 1.0006 .3723 .3576 18.02	9/23/3 CASE 29 RATING COLD SHELL SIDE Shell SENSIBLE LIQ .600 IN OUT 40.0 80.9* 2.5352 62.1294 1.4791 .8564 1.0058 1.0003 .3466 .3583	
OW, SEGMENTAL BAFFLES, HOT TUBE SIDE Tube SENSIBLE LIQ .400 IN OUT 140.0 78.3* 61.2913 62.1591 64726 .8831 .9973 1.0006 .3723 .3576 18.02 109.2 81.9 .6292 .8466	9/23/3 CASE 29 RATING COLD SHELL SIDE Shell SENSIBLE LIQ .600 IN OUT 40.0 80.9* 2.5352 62.1294 1.4791 .8564 1.0058 1.0003 .3466 .3583 18.02 60.5 80.8 1.1069 .8574	
OW, SEGMENTAL BAFFLES, HOT TUBE SIDE Tube SENSIBLE LIQ .400 IN OUT 140.0 78.3* 61.2913 62.1591 64726 .8831 .9973 1.0006 .3723 .3576 18.02	9/23/3 CASE 29 RATING COLD SHELL SIDE Shell SENSIBLE LIQ .600 IN OUT 40.0 80.9* 2.5352 62.1294 1.4791 .8564 1.0058 1.0003 .3466 .3583 18.02 60.5 80.8 1.1069 .8574	
OW, SEGMENTAL BAFFLES, HOT TUBE SIDE Tube SENSIBLE LIQ .400 IN OUT 140.0 78.3* 61.2913 62.1591 64726 .8831 .9973 1.0006 .3723 .3576 18.02	9/23/ 3	
OW, SEGMENTAL BAFFLES, HOT TUBE SIDE TUBE SENSIBLE LIQ .400 IN OUT 140.0 78.3* 61.2913 62.1591 64726 .8831 .9973 1.0006 .3723 .3576 18.02 109.2 81.9 .6292 .8466 50.00 165.00	9/23/ 3	
OW, SEGMENTAL BAFFLES, HOT TUBE SIDE Tube SENSIBLE LIQ .400 IN OUT 140.0 78.3* 61.2913 62.1591 64726 .8831 .9973 1.0006 .3723 .3576 18.02	9/23/ 3	
OW, SEGMENTAL BAFFLES, HOT TUBE SIDE Tube SENSIBLE LIQ .400 IN OUT 140.0 78.3* 61.2913 62.1591 64726 .8831 .9973 1.0006 .3723 .3576 18.02	9/23/ 3	
OW, SEGMENTAL BAFFLES, HOT TUBE SIDE Tube SENSIBLE LIQ .400 IN OUT 140.0 78.3* 61.2913 62.1591 64726 .8831 .9973 1.0006 .3723 .3576 18.02 109.2 81.9 .6292 .8466 50.00 165.00 .04 10.00 .39 10.00	9/23/ 3	
OW, SEGMENTAL BAFFLES, HOT TUBE SIDE Tube SENSIBLE LIQ .400 IN OUT 140.0 78.3* 61.2913 62.1591 64726 .8831 .9973 1.0006 .3723 .3576 18.02	9/23/ 3	
OW, SEGMENTAL BAFFLES, HOT TUBE SIDE Tube SENSIBLE LIQ .400 IN OUT 140.0 78.3* 61.2913 62.1591 64726 .8831 .9973 1.0006 .3723 .3576 18.02 109.2 81.9 .6292 .8466 50.00 165.00 .04 10.00 .39 10.00	9/23/ 3	
	SHELLSIDE FLOW, % ( HEAT TRANSFER X-FLOW TUBE TO BAFFLE LEAKA( MAIN CROSSFLOW BUNDLE TO SHELL BYPAS BAFFLE TO SHELL LEAKA TUBE PASSLANE BYPASS  SHELLSIDE HEAT TRAI TOTAL = (BETA) (GAMMA) BETA (BAFF CUT FACTO GAMMA (TUBE ROW ENTRY END (HT LOSS IN EN)  SHELL PRESSURE DROW WINDOW END ZONE CROSS FLOW INLET NOZZLE OUTLET NOZZLE	SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW  TUBE TO BAFFLE LEAKAGE  A = 3.07  MAIN CROSSFLOW  B = 67.84  BUNDLE TO SHELL BYPASS  C = 13.00  BAFFLE TO SHELL LEAKAGE  E = 16.09  TUBE PASSLANE BYPASS  F = .00  SHELLSIDE HEAT TRANSFER FACTORS  TOTAL = (BETA) (GAMMA) (FIN) = .628  BETA (BAFF CUT FACTOR) = .920  GAMMA (TUBE ROW ENTRY EFCT) = .683  END (HT LOSS IN END ZONE) = .994  SHELL PRESSURE DROP, % OF TOTAL  WINDOW = 9.0  END ZONE = 4.9  CROSS FLOW = 4.1  INLET NOZZLE = 42.4  OUTLET NOZZLE = 39.7  WEIGHT PER SHELL, LB  DRY = 150.

	che433b(40).OUT
EFF TEMP DIF, DEGF (LMTD= 48.0, F	'= .78,BYPASS= .94,BAFF=1.00) 34.9
OVERALL COEFF REQUIRED BTU/HR-F	T2-F 98.62
CLEAN & FOULED COEFF BTU/HR-F	T2-F 101.20 98.76
SHELLS IN SERIES 1 PARALLEL 1	TOTAL EFF AREA FT2 7.1
PASSES, SHELL 1 TUBE 4	
SHELL DIAMETER IN. 3.820	TEMA SHELL TYPE E ; REAR HEAD FXTS
SHELL DIAMETER IN. 5.020	TEMA SHELL TIFE E , KEAK HEAD FAIS
BAFFLE TYPE HORZ SEGMENTL	CDOCC DACCEC DED CHELL DACC
	CROSS PASSES PER SHELL PASS 4
SPACING, CENTRAL IN. 4.309	BAFFLE CUT, PCT SHELL I.D. 30.00
SPACING, INLET IN. 4.309	CUT DISTANCE FROM CENTER, IN764
SPACING, OUTLET IN. 4.309	
BAFFLE THICKNESS IN125	IMPINGEMENT BAFFLE INCLUDED NO
PAIRS OF SEALING DEVICES 1	TUBESHEET BLANK AREA, % .0
TUBE TYPE PLAIN	MATERIAL ELECTROLYTIC COPPER
NO. OF TUBES/SHELL 76	EST MAX TUBE COUNT 36
TUBE LGTH, OVERALL FT 1.500	TUBE PITCH IN3125
TUBE LGTH, EFF FT 1.436	TUBE OUTSIDE DIAM IN250
TUBE LAYOUT DEG 60	TUBE INSIDE DIAM IN214
PITCH RATIO 1.250	TUBE SURFACE RATIO, OUT/IN 1.184
SHL NOZZ ID, IN&OUT 1.0 1.0	TUBE NOZZ ID, IN&OUT IN8 .8
SHL NOZZ ID, IN&OUT 1.0 1.0	TOBE NOZZ ID, IN&OUT INO .O
+ 03100113000 10011 1011100	GODT 0
* CALCULATED ITEMHEAT BALANCE	
□□Washington University ChE433 he	
Young model F302DY4P	9/23/ 3
	CASE 29
S U P P L E M E N T A	R Y R E S U L T S
S U P P L E M E N T A	R Y R E S U L T S
S U P P L E M E N T A  HT PARAMETERS SHELL TUBE	R Y R E S U L T S  SHELLSIDE PERFORMANCE
	SHELLSIDE PERFORMANCE
HT PARAMETERS SHELL TUBE WALL CORRECTION 1.036 .000	SHELLSIDE PERFORMANCE NOMINAL VEL, X-FLOW FT/S .08
HT PARAMETERS SHELL TUBE WALL CORRECTION 1.036 .000 PRANDTL NUMBER 7.6 4.2	SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S .08  NOMINAL VEL, WINDOW FT/S .15
HT PARAMETERS SHELL TUBE WALL CORRECTION 1.036 .000 PRANDTL NUMBER 7.6 4.2 RYNLD NO, AVG 204. 1002.	SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S .08  NOMINAL VEL, WINDOW FT/S .15  CROSSFLOW COEF BTU/HR-FT2-F 234.4
HT PARAMETERS SHELL TUBE WALL CORRECTION 1.036 .000 PRANDTL NUMBER 7.6 4.2 RYNLD NO, AVG 204. 1002. RYNLD NO, IN BUN 153. 1334.	SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S .08  NOMINAL VEL, WINDOW FT/S .15  CROSSFLOW COEF BTU/HR-FT2-F 234.4  WINDOW COEF BTU/HR-FT2-F 235.9
HT PARAMETERS SHELL TUBE WALL CORRECTION 1.036 .000 PRANDTL NUMBER 7.6 4.2 RYNLD NO, AVG 204. 1002. RYNLD NO, IN BUN 153. 1334. RYNLD NO,OUT BUN 264. 714.	SHELLSIDE PERFORMANCE  NOMINAL VEL,X-FLOW FT/S .08  NOMINAL VEL,WINDOW FT/S .15  CROSSFLOW COEF BTU/HR-FT2-F 234.4  WINDOW COEF BTU/HR-FT2-F 235.9
HT PARAMETERS SHELL TUBE WALL CORRECTION 1.036 .000 PRANDTL NUMBER 7.6 4.2 RYNLD NO, AVG 204. 1002. RYNLD NO, IN BUN 153. 1334. RYNLD NO,OUT BUN 264. 714.	SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S .08  NOMINAL VEL, WINDOW FT/S .15  CROSSFLOW COEF BTU/HR-FT2-F 234.4  WINDOW COEF BTU/HR-FT2-F 235.9  SHELLSIDE FLOW, % OF TOTAL
HT PARAMETERS SHELL TUBE WALL CORRECTION 1.036 .000 PRANDTL NUMBER 7.6 4.2 RYNLD NO, AVG 204. 1002. RYNLD NO, IN BUN 153. 1334. RYNLD NO,OUT BUN 264. 714. FOULNG LAYER IN0014 .0014	SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S .08  NOMINAL VEL, WINDOW FT/S .15  CROSSFLOW COEF BTU/HR-FT2-F 234.4  WINDOW COEF BTU/HR-FT2-F 235.9  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.54
HT PARAMETERS SHELL TUBE WALL CORRECTION 1.036 .000 PRANDTL NUMBER 7.6 4.2 RYNLD NO, AVG 204. 1002. RYNLD NO, IN BUN 153. 1334. RYNLD NO,OUT BUN 264. 714. FOULNG LAYER IN0014 .0014 THERMAL RESISTANCE, % OF TOTAL	SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S .08  NOMINAL VEL, WINDOW FT/S .15  CROSSFLOW COEF BTU/HR-FT2-F 234.4  WINDOW COEF BTU/HR-FT2-F 235.9  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.54  TUBE TO BAFFLE LEAKAGE A = 3.22
HT PARAMETERS SHELL TUBE WALL CORRECTION 1.036 .000 PRANDTL NUMBER 7.6 4.2 RYNLD NO, AVG 204. 1002. RYNLD NO, IN BUN 153. 1334. RYNLD NO,OUT BUN 264. 714. FOULNG LAYER IN0014 .0014 THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL	SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S .08  NOMINAL VEL, WINDOW FT/S .15  CROSSFLOW COEF BTU/HR-FT2-F 234.4  WINDOW COEF BTU/HR-FT2-F 235.9  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.54  TUBE TO BAFFLE LEAKAGE A = 3.22  MAIN CROSSFLOW B = 67.15
HT PARAMETERS SHELL TUBE WALL CORRECTION 1.036 .000 PRANDTL NUMBER 7.6 4.2 RYNLD NO, AVG 204. 1002. RYNLD NO, IN BUN 153. 1334. RYNLD NO,OUT BUN 264. 714. FOULNG LAYER IN0014 .0014  THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL 41.82 55.97 2.14 .07	SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S .08  NOMINAL VEL, WINDOW FT/S .15  CROSSFLOW COEF BTU/HR-FT2-F 234.4  WINDOW COEF BTU/HR-FT2-F 235.9  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.54  TUBE TO BAFFLE LEAKAGE A = 3.22  MAIN CROSSFLOW B = 67.15  BUNDLE TO SHELL BYPASS C = 13.73
HT PARAMETERS SHELL TUBE WALL CORRECTION 1.036 .000 PRANDTL NUMBER 7.6 4.2 RYNLD NO, AVG 204. 1002. RYNLD NO, IN BUN 153. 1334. RYNLD NO,OUT BUN 264. 714. FOULNG LAYER IN0014 .0014  THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL 41.82 55.97 2.14 .07	SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S .08  NOMINAL VEL, WINDOW FT/S .15  CROSSFLOW COEF BTU/HR-FT2-F 234.4  WINDOW COEF BTU/HR-FT2-F 235.9  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.54  TUBE TO BAFFLE LEAKAGE A = 3.22  MAIN CROSSFLOW B = 67.15  BUNDLE TO SHELL BYPASS C = 13.73
HT PARAMETERS SHELL TUBE WALL CORRECTION 1.036 .000 PRANDTL NUMBER 7.6 4.2 RYNLD NO, AVG 204. 1002. RYNLD NO, IN BUN 153. 1334. RYNLD NO,OUT BUN 264. 714. FOULNG LAYER IN0014 .0014  THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL 41.82 55.97 2.14 .07	SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S .08  NOMINAL VEL, WINDOW FT/S .15  CROSSFLOW COEF BTU/HR-FT2-F 234.4  WINDOW COEF BTU/HR-FT2-F 235.9  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.54  TUBE TO BAFFLE LEAKAGE A = 3.22  MAIN CROSSFLOW B = 67.15  BUNDLE TO SHELL BYPASS C = 13.73
HT PARAMETERS SHELL TUBE WALL CORRECTION 1.036 .000 PRANDTL NUMBER 7.6 4.2 RYNLD NO, AVG 204. 1002. RYNLD NO, IN BUN 153. 1334. RYNLD NO,OUT BUN 264. 714. FOULNG LAYER IN0014 .0014  THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL 41.82 55.97 2.14 .07 PCT OVER DESIGN .14 TOT FOUL RESIST .000217	SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S .08  NOMINAL VEL, WINDOW FT/S .15  CROSSFLOW COEF BTU/HR-FT2-F 234.4  WINDOW COEF BTU/HR-FT2-F 235.9  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.54  TUBE TO BAFFLE LEAKAGE A = 3.22  MAIN CROSSFLOW B = 67.15  BUNDLE TO SHELL BYPASS C = 13.73  BAFFLE TO SHELL LEAKAGE E = 15.89  TUBE PASSLANE BYPASS F = .00
HT PARAMETERS SHELL TUBE WALL CORRECTION 1.036 .000 PRANDTL NUMBER 7.6 4.2 RYNLD NO, AVG 204. 1002. RYNLD NO, IN BUN 153. 1334. RYNLD NO,OUT BUN 264. 714. FOULNG LAYER IN0014 .0014  THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL 41.82 55.97 2.14 .07	SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S .08  NOMINAL VEL, WINDOW FT/S .15  CROSSFLOW COEF BTU/HR-FT2-F 234.4  WINDOW COEF BTU/HR-FT2-F 235.9  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.54  TUBE TO BAFFLE LEAKAGE A = 3.22  MAIN CROSSFLOW B = 67.15  BUNDLE TO SHELL BYPASS C = 13.73  BAFFLE TO SHELL LEAKAGE E = 15.89  TUBE PASSLANE BYPASS F = .00
HT PARAMETERS SHELL TUBE WALL CORRECTION 1.036 .000 PRANDTL NUMBER 7.6 4.2 RYNLD NO, AVG 204. 1002. RYNLD NO, IN BUN 153. 1334. RYNLD NO,OUT BUN 264. 714. FOULNG LAYER IN0014 .0014  THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL 41.82 55.97 2.14 .07 PCT OVER DESIGN .14 TOT FOUL RESIST .000217 DIFF RESIST .000015	SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S .08  NOMINAL VEL, WINDOW FT/S .15  CROSSFLOW COEF BTU/HR-FT2-F 234.4  WINDOW COEF BTU/HR-FT2-F 235.9  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.54  TUBE TO BAFFLE LEAKAGE A = 3.22  MAIN CROSSFLOW B = 67.15  BUNDLE TO SHELL BYPASS C = 13.73  BAFFLE TO SHELL LEAKAGE E = 15.89  TUBE PASSLANE BYPASS F = .00
HT PARAMETERS SHELL TUBE WALL CORRECTION 1.036 .000 PRANDTL NUMBER 7.6 4.2 RYNLD NO, AVG 204. 1002. RYNLD NO, IN BUN 153. 1334. RYNLD NO,OUT BUN 264. 714. FOULNG LAYER IN0014 .0014  THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL 41.82 55.97 2.14 .07 PCT OVER DESIGN .14 TOT FOUL RESIST .000217 DIFF RESIST .000015	SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S .08  NOMINAL VEL, WINDOW FT/S .15  CROSSFLOW COEF BTU/HR-FT2-F 234.4  WINDOW COEF BTU/HR-FT2-F 235.9  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.54  TUBE TO BAFFLE LEAKAGE A = 3.22  MAIN CROSSFLOW B = 67.15  BUNDLE TO SHELL BYPASS C = 13.73  BAFFLE TO SHELL LEAKAGE E = 15.89  TUBE PASSLANE BYPASS F = .00  SHELLSIDE HEAT TRANSFER FACTORS  TOTAL = (BETA) (GAMMA) (FIN) = .643
HT PARAMETERS SHELL TUBE WALL CORRECTION 1.036 .000 PRANDTL NUMBER 7.6 4.2 RYNLD NO, AVG 204. 1002. RYNLD NO, IN BUN 153. 1334. RYNLD NO,OUT BUN 264. 714. FOULNG LAYER IN0014 .0014  THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL 41.82 55.97 2.14 .07 PCT OVER DESIGN .14 TOT FOUL RESIST .000217 DIFF RESIST .000015  DIAMETRAL CLEARANCES BUNDLE TO SHELL IN5000	SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S .08  NOMINAL VEL, WINDOW FT/S .15  CROSSFLOW COEF BTU/HR-FT2-F 234.4  WINDOW COEF BTU/HR-FT2-F 235.9  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.54  TUBE TO BAFFLE LEAKAGE A = 3.22  MAIN CROSSFLOW B = 67.15  BUNDLE TO SHELL BYPASS C = 13.73  BAFFLE TO SHELL LEAKAGE E = 15.89  TUBE PASSLANE BYPASS F = .00  SHELLSIDE HEAT TRANSFER FACTORS  TOTAL = (BETA) (GAMMA) (FIN) = .643  BETA (BAFF CUT FACTOR) = .920
HT PARAMETERS SHELL TUBE WALL CORRECTION 1.036 .000 PRANDTL NUMBER 7.6 4.2 RYNLD NO, AVG 204. 1002. RYNLD NO, IN BUN 153. 1334. RYNLD NO,OUT BUN 264. 714. FOULNG LAYER IN0014 .0014  THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL 41.82 55.97 2.14 .07 PCT OVER DESIGN .14 TOT FOUL RESIST .000217 DIFF RESIST .000015  DIAMETRAL CLEARANCES BUNDLE TO SHELL IN5000 TUBE TO BAFFLE HOLE IN0284	SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S .08  NOMINAL VEL, WINDOW FT/S .15  CROSSFLOW COEF BTU/HR-FT2-F 234.4  WINDOW COEF BTU/HR-FT2-F 235.9  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.54  TUBE TO BAFFLE LEAKAGE A = 3.22  MAIN CROSSFLOW B = 67.15  BUNDLE TO SHELL BYPASS C = 13.73  BAFFLE TO SHELL LEAKAGE E = 15.89  TUBE PASSLANE BYPASS F = .00  SHELLSIDE HEAT TRANSFER FACTORS  TOTAL = (BETA) (GAMMA) (FIN) = .643  BETA (BAFF CUT FACTOR) = .920  GAMMA (TUBE ROW ENTRY EFCT) = .699
HT PARAMETERS SHELL TUBE WALL CORRECTION 1.036 .000 PRANDTL NUMBER 7.6 4.2 RYNLD NO, AVG 204. 1002. RYNLD NO, IN BUN 153. 1334. RYNLD NO,OUT BUN 264. 714. FOULNG LAYER IN0014 .0014  THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL 41.82 55.97 2.14 .07 PCT OVER DESIGN .14 TOT FOUL RESIST .000217 DIFF RESIST .000015  DIAMETRAL CLEARANCES BUNDLE TO SHELL IN5000 TUBE TO BAFFLE HOLE IN0284	SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S .08  NOMINAL VEL, WINDOW FT/S .15  CROSSFLOW COEF BTU/HR-FT2-F 234.4  WINDOW COEF BTU/HR-FT2-F 235.9  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.54  TUBE TO BAFFLE LEAKAGE A = 3.22  MAIN CROSSFLOW B = 67.15  BUNDLE TO SHELL BYPASS C = 13.73  BAFFLE TO SHELL LEAKAGE E = 15.89  TUBE PASSLANE BYPASS F = .00  SHELLSIDE HEAT TRANSFER FACTORS  TOTAL = (BETA) (GAMMA) (FIN) = .643  BETA (BAFF CUT FACTOR) = .920
HT PARAMETERS SHELL TUBE WALL CORRECTION 1.036 .000 PRANDTL NUMBER 7.6 4.2 RYNLD NO, AVG 204. 1002. RYNLD NO, IN BUN 153. 1334. RYNLD NO,OUT BUN 264. 714. FOULNG LAYER IN0014 .0014  THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL 41.82 55.97 2.14 .07 PCT OVER DESIGN .14 TOT FOUL RESIST .000217 DIFF RESIST .000015  DIAMETRAL CLEARANCES BUNDLE TO SHELL IN5000 TUBE TO BAFFLE HOLE IN0284 BAFFLE TO SHELL IN1000	SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S .08  NOMINAL VEL, WINDOW FT/S .15  CROSSFLOW COEF BTU/HR-FT2-F 234.4  WINDOW COEF BTU/HR-FT2-F 235.9  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.54  TUBE TO BAFFLE LEAKAGE A = 3.22  MAIN CROSSFLOW B = 67.15  BUNDLE TO SHELL BYPASS C = 13.73  BAFFLE TO SHELL LEAKAGE E = 15.89  TUBE PASSLANE BYPASS F = .00  SHELLSIDE HEAT TRANSFER FACTORS  TOTAL = (BETA) (GAMMA) (FIN) = .643  BETA (BAFF CUT FACTOR) = .920  GAMMA (TUBE ROW ENTRY EFCT) = .699  END (HT LOSS IN END ZONE) = .994
HT PARAMETERS SHELL TUBE WALL CORRECTION 1.036 .000 PRANDTL NUMBER 7.6 4.2 RYNLD NO, AVG 204. 1002. RYNLD NO, IN BUN 153. 1334. RYNLD NO,OUT BUN 264. 714. FOULNG LAYER IN0014 .0014  THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL 41.82 55.97 2.14 .07 PCT OVER DESIGN .14 TOT FOUL RESIST .000217 DIFF RESIST .000015  DIAMETRAL CLEARANCES BUNDLE TO SHELL IN5000 TUBE TO BAFFLE HOLE IN0284 BAFFLE TO SHELL IN1000	SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S .08  NOMINAL VEL, WINDOW FT/S .15  CROSSFLOW COEF BTU/HR-FT2-F 234.4  WINDOW COEF BTU/HR-FT2-F 235.9  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.54  TUBE TO BAFFLE LEAKAGE A = 3.22  MAIN CROSSFLOW B = 67.15  BUNDLE TO SHELL BYPASS C = 13.73  BAFFLE TO SHELL LEAKAGE E = 15.89  TUBE PASSLANE BYPASS F = .00  SHELLSIDE HEAT TRANSFER FACTORS  TOTAL = (BETA) (GAMMA) (FIN) = .643  BETA (BAFF CUT FACTOR) = .920  GAMMA (TUBE ROW ENTRY EFCT) = .699  END (HT LOSS IN END ZONE) = .994
HT PARAMETERS SHELL TUBE WALL CORRECTION 1.036 .000 PRANDTL NUMBER 7.6 4.2 RYNLD NO, AVG 204. 1002. RYNLD NO, IN BUN 153. 1334. RYNLD NO,OUT BUN 264. 714. FOULNG LAYER IN0014 .0014  THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL 41.82 55.97 2.14 .07 PCT OVER DESIGN .14 TOT FOUL RESIST .000217 DIFF RESIST .000015  DIAMETRAL CLEARANCES BUNDLE TO SHELL IN5000 TUBE TO BAFFLE HOLE IN0284 BAFFLE TO SHELL IN1000  SHELL NOZZLE DATA IN OUT HT UNDR NOZ IN25	SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S .08  NOMINAL VEL, WINDOW FT/S .15  CROSSFLOW COEF BTU/HR-FT2-F 234.4  WINDOW COEF BTU/HR-FT2-F 235.9  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.54  TUBE TO BAFFLE LEAKAGE A = 3.22  MAIN CROSSFLOW B = 67.15  BUNDLE TO SHELL BYPASS C = 13.73  BAFFLE TO SHELL LEAKAGE E = 15.89  TUBE PASSLANE BYPASS F = .00  SHELLSIDE HEAT TRANSFER FACTORS  TOTAL = (BETA) (GAMMA) (FIN) = .643  BETA (BAFF CUT FACTOR) = .920  GAMMA (TUBE ROW ENTRY EFCT) = .699  END (HT LOSS IN END ZONE) = .994  SHELL PRESSURE DROP, % OF TOTAL  WINDOW = 8.9
HT PARAMETERS SHELL TUBE WALL CORRECTION 1.036 .000 PRANDTL NUMBER 7.6 4.2 RYNLD NO, AVG 204. 1002. RYNLD NO, IN BUN 153. 1334. RYNLD NO,OUT BUN 264. 714. FOULNG LAYER IN0014 .0014  THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL 41.82 55.97 2.14 .07 PCT OVER DESIGN .14 TOT FOUL RESIST .000217 DIFF RESIST .000015  DIAMETRAL CLEARANCES BUNDLE TO SHELL IN5000 TUBE TO BAFFLE HOLE IN0284 BAFFLE TO SHELL IN1000  SHELL NOZZLE DATA IN OUT HT UNDR NOZ IN25 HT OPP NOZ IN25	SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S .08  NOMINAL VEL, WINDOW FT/S .15  CROSSFLOW COEF BTU/HR-FT2-F 234.4  WINDOW COEF BTU/HR-FT2-F 235.9  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.54  TUBE TO BAFFLE LEAKAGE A = 3.22  MAIN CROSSFLOW B = 67.15  BUNDLE TO SHELL BYPASS C = 13.73  BAFFLE TO SHELL LEAKAGE E = 15.89  TUBE PASSLANE BYPASS F = .00  SHELLSIDE HEAT TRANSFER FACTORS  TOTAL = (BETA) (GAMMA) (FIN) = .643  BETA (BAFF CUT FACTOR) = .920  GAMMA (TUBE ROW ENTRY EFCT) = .699  END (HT LOSS IN END ZONE) = .994  SHELL PRESSURE DROP, % OF TOTAL  WINDOW = 8.9  END ZONE = 4.5
HT PARAMETERS SHELL TUBE WALL CORRECTION 1.036 .000 PRANDTL NUMBER 7.6 4.2 RYNLD NO, AVG 204. 1002. RYNLD NO, IN BUN 153. 1334. RYNLD NO,OUT BUN 264. 714. FOULNG LAYER IN0014 .0014  THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL 41.82 55.97 2.14 .07 PCT OVER DESIGN .14 TOT FOUL RESIST .000217 DIFF RESIST .000015  DIAMETRAL CLEARANCES BUNDLE TO SHELL IN5000 TUBE TO BAFFLE HOLE IN0284 BAFFLE TO SHELL IN1000  SHELL NOZZLE DATA IN OUT HT UNDR NOZ IN25	SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S .08  NOMINAL VEL, WINDOW FT/S .15  CROSSFLOW COEF BTU/HR-FT2-F 234.4  WINDOW COEF BTU/HR-FT2-F 235.9  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.54  TUBE TO BAFFLE LEAKAGE A = 3.22  MAIN CROSSFLOW B = 67.15  BUNDLE TO SHELL BYPASS C = 13.73  BAFFLE TO SHELL LEAKAGE E = 15.89  TUBE PASSLANE BYPASS F = .00  SHELLSIDE HEAT TRANSFER FACTORS  TOTAL = (BETA) (GAMMA) (FIN) = .643  BETA (BAFF CUT FACTOR) = .920  GAMMA (TUBE ROW ENTRY EFCT) = .699  END (HT LOSS IN END ZONE) = .994  SHELL PRESSURE DROP, % OF TOTAL  WINDOW = 8.9  END ZONE = 4.5

DENSITY			che433b(4	10).OUT		
### BUND RHO*VSQ LB/FT-SZ 10 10  TUBE NOZZLE DATA IN OUT WEIGHT PER SHELL, LB  VELOCITY F7/S 5.9 .58 DRY = 150.  DENSITY LB/FT3 61.291 62.159 WET = 165.  PRESS. DROP \$ 6.6 4.1  LDWashington University Che433 heat exchanger experiment E0002 P 60  Young model F302DY4P 9/23/3  CASE 30  SIZE 4- 18 TYPE BEM, MULTI-PASS FLOW, SEGMENTAL BAFFLES, RATING HOT TUBE SIDE TUBE SIDE TUBE SHELL SIDE TUBE SIDE TUBE SHELL SIDE SENSIBLE LIQ SENSIBLE SENSISTY LB/FT3 61.2913 62.1959 62.5352 62.1754  VISCOSITY LB/FT3 61.2913 62.1959 62.5352 62.1754  VISCOSITY CP .4726 .9185 1.4791 .8983  SPECIFIC HEAT BTU/LB-F .9973 1.0009 1.0058 1.0007  THERMAL COND. BTU/HR-FT-F .3723 .3568 .3466 .3573  MOLAR MASS LB/LBMOL 18.02 18.02 18.02  TEMP, AVG & SKIN DEGF 107.5 79.0 58.5 77.9  VISCOSITY, AVG & SKIN CP .6397 .8761 1.1369 .8881  PRESSURE JN & DESIGN PSIA 50.00 165.00 50.00 165.00  PRESSURE DROP, TOT & ALLOWED PSI .04 10.00 .01 10.00  VELOCITY, CALC & MAX ALLOWED FT/S .39 10.00 .01 10.00  FOULING RESISTANCE HR-FT2-F/BTU .00010 .00010  FILM COEFFICIENT BTU/HR-FT2-F 208.76 256.11  TOTAL HEAT DUTY REQUIRED MEGETU/HR  EFF TEMP DIF, DEGF (LMTD- 47.7,F- 78, BYPASS94, BAFF=1.00) 35.2  OVERALL COEFF REQUIRED BTU/HR-FT2-F 105.18 103.05  CLEAN & FOULED COEFF BTU/HR-FT2-F 105.18 7.1  PASSES, SHELL 1 TUBE 4 EFFECTIVE AREA FT2 7.1  PASSES, SHELL 1 TUBE 4 EFFECTIVE AREA FT2 7.1  PASSES, SHELL 1 TUBE 4 EFFECTIVE AREA FT2/SHELL 7.1  SHELLS IN SERIES 1 PARALLEL 1 TOTAL EFF AREA FT2 7.1  PASSES, SHELL 1 TUBE 4 EFFECTIVE AREA FT2 7.1  PASSES, SHELL 1 TUBE 4 EFFECTIVE AREA FT2/SHELL 7.1  SHELLS DIAMETER IN. 4.309 BAFFLE CUT, PCT SHELL FASS 4  SAPACING, CENTRAL IN. 4.309 BAFFLE CUT, PCT SHELL FASS 4  SAPACING, CENTRAL IN. 4.309 BAFFLE CUT, PCT SHELL FASS 4  SAPACING, CENTRAL IN. 4.309 BAFFLE CUT, PCT SHELL FASS 4  SAPACING, CENTRAL IN. 4.309 BAFFLE CUT, PCT SHELL FASS 4  SAPACING, OUTLET IN. 4.309  BAFFLE						= 42.6
TUBE NOZZLE DATA IN OUT WEIGHT PER SHELL, LB  VELOCITY FT/S		-S2 14 15	OUTLET	NOZZLE		= 40.2
VELOCITY	BUND RHO*VSQ LB/FT	-S2 10 10	ı			
VELOCITY						
VELOCITY	TUBE NOZZLE DATA	. IN OUT	WEIGH	T PER SHELI	L, LB	
DENSITY LB/FT3	VELOCITY FT/S	.59 .58	DRY			150.
PRESS. DROP	DENSITY LB/FT3	61.291 62.159	WET			
Common model F302DY4P   September   Sept	PRESS DROP %	6 6 4 1				100.
Young model F302DY4P  SIZE 4- 18 TYPE BEM, MULTI-PASS FLOW, SEGMENTAL BAFFLES, RATING  **Tube** Shell**  **SENSIBLE LIQ** SENSIBLE LIQ**  **SENSIBLE LIQ** SENSIBLE LIQ**  **Tube** Shell**  **SENSIBLE LIQ** SENSIBLE LIQ**  **Total Flow Rate** KLB/HR** .400 .700  **Total Flow Rate** KLB/HR** .400 .700  **Total Flow Rate** KLB/HR** .400 .75.1** 40.0 .76.9**  **DENSITY** LB/FT3** 61.2913 62.1959 62.5352 62.1754  **VISCOSITY** CP** .4726 .9185 1.4791 .8983  **SPECIFIC HEAT** BTU/LB-F** .9973 1.0009 1.0058 1.0007  **THERMAL COND.** BTU/HR-FT-F** .3723 .3568 .3466 .3573  **MOLAR MASS** LB/LBMOL** 18.02 .18.02  **TEMP, AVG & SKIN** DEGF** 107.5 .79.0 .58.5 .77.9  **VISCOSITY**, AVG & SKIN** CP** .6397 .8761 1.1369 .8881  **PRESSURE, IN & DESIGN PSIA** 50.00 165.00  **PRESSURE, IN & DESIGN PSIA** 50.00 165.00  **PRESSURE DROP, TOT & ALLOWED PSI** .04 10.00 .01 10.00  **VELOCITY**, CALC & MAX ALLOWED FT/S** .39 10.00 .11 10.00  **VELOCITY**, CALC & MAX ALLOWED FT/S** .39 10.00 .11 10.00  **POULING RESISTANCE** HR-FT2-F/BTU** .00010 .0010  **FILM COEFFICIENT** BTU/HR-FT2-F** 208.76 .256.11  **TOTAL HEAT DUTY REQUIRED MEGBTU/HR**  **FOULING RESISTANCE** HR-FT2-F/BTU** .00010 .0010  **FILM COEFFICIENT** BTU/HR-FT2-F** 105.18 .102.50  **SHELLS IN SERIES** 1 PARALLEL 1 TOTAL EFF AREA FT2 .7.1  **PASSES, SHELL** 1 TUBE** 4 EFFECTIVE AREA FT2 .7.1  **PASSES, SHELL** 1 TUBE** 4 EFFECTIVE AREA FT2/SHELL** 7.1  **SHELLS IN SERIES** 1 PARALLEL 1 TOTAL EFF AREA FT2 .7.1  **PASSES, SHELL** 1 TUBE** 4 EFFECTIVE AREA FT2/SHELL** 7.1  **SHELLS IN SERIES** 1 PARALLEL 1 TOTAL EFF AREA FT2 .7.1  **PASSES, SHELL** 1 TUBE** 4 EFFECTIVE AREA FT2/SHELL** 7.1  **SHELL DIAMETER IN.** 3.820 TEMA SHELL TYPE F.** REAR HEAD FXTS  **PACING, OUTLET** IN. 4.309 BAFFLE CUT, PCT SHELL I.D. 30.00  **SPACING, INLET** IN. 4.309 BAFFLE CUT, PCT SHELL I.D. 30.00  **SPACING, OUTLET** IN. 4.309  **BAFFLE TYPE** HORZ SEGMENTL CROSS PASSES PER SHELL PASS A PACING, OUTLET** IN. 4.309  **BAFFLE TYPE** HORZ SEGMENTL CROSS PASSES PER SHELL PASS A PACING, OUTLET** IN.				er evnerim	ant	E0002 P 60
SIZE 4- 18 TYPE BEM, MULTI-PASS FLOW, SEGMENTAL BAFFLES, RATING  Tube  Tube  SENSIBLE LIQ  SENSIBLE LIQ  SENSIBLE LIQ  TOTAL FLOW RATE  KLB/HR  A000  TOTAL FLOW RATE  A000  TEMPERATURE  DEGF  140.0  TOTAL FLOW RATE  LB/FT3  61.2913  62.1959  62.5352  62.1754  VISCOSITY  CP  4726  9185  1.4791  8983  SPECIFIC HEAT  BTU/LB-F  9973  1.0009  1.0058  1.0007  THERMAL COND.  BTU/HR-FT-F  3723  3568  3466  3573  MOLAR MASS  LB/LEMOL  18.02  TEMP, AVG & SKIN  DEGF  107.5  79.0  58.5  77.9  VISCOSITY, AVG & SKIN  CP  6397  6397  78761  1.1369  8881  PRESSURE, IN & DESIGN PSIA  50.00  165.00  PRESSURE DROP, TOT & ALLOWED PSI  0.4  10.00  VELOCITY, CALC & MAX ALLOWED FT/S  39  10.00  FOULING RESISTANCE  HR-FT2-F/BTU  00010  FOULING RESISTANCE  HR-FT2-F/BTU  100.00  11  10.00  FOULING RESISTANCE  HR-FT2-F/BTU  100.00  10  10  10  FOULING RESISTANCE  HR-FT2-F/BTU  100.00  10  10  10  10  FOULING RESISTANCE  HR-FT2-F/BTU  10  10  10  10  10  10  10  10  10  1	=	<del>-</del>	ac exemany	CI CAPCIIM		
SIZE 4- 18 TYPE BEM, MULTI-PASS FLOW, SEGMENTAL BAFFLES, RATING	roung moder rough	41				
HOT TUBE SIDE	CT7F /_ 10 TVDF DF	M MIITTT_DACC E	TOW CECME	אותאד באביביו	TO DATING	
Tube SENSIBLE LIQ SENSIBLE LIQ SENSIBLE LIQ SENSIBLE LIQ SENSIBLE LIQ SENSIBLE LIQ TOTAL FLOW RATE KLB/HR	SIZE 4- IO IIFE DE	M, MOLII-FASS F				
TOTAL FLOW RATE KLB/HR .400 .700  TEMPERATURE DEGF 140.0 75.1* 40.0 76.9*  DENSITY LB/FT3 61.2913 62.1959 62.5352 62.1754  VISCOSITY CP .4726 .9185 1.4791 .8983  SPECIFIC HEAT BTU/LB-F .9973 1.0009 1.0058 1.0007  THERMAL COND. BTU/HR-FT-F .3723 .3568 .3466 .3573  MOLAR MASS LB/LBMOL 18.02 18.02  TEMP, AVG & SKIN DEGF 107.5 79.0 58.5 77.9  VISCOSITY, AVG & SKIN CP .6397 .8761 1.1369 .8981  PRESSURE, IN & DESIGN PSIA 50.00 165.00 50.00 165.00  PRESSURE, IN & DESIGN PSIA 50.00 165.00 50.00 165.00  PRESSURE DROP, TOT & ALLOWED PSI .04 10.00 .01 10.00  VELOCITY, CALC & MAX ALLOWED FT/S .39 10.00 .11 10.00  FOULING RESISTANCE HR-FT2-F/BTU .00010 .00010  FILM COEFFICIENT BTU/HR-FT2-F 208.76 256.11  TOTAL HEAT DUTY REQUIRED MEGBTU/HR  EFF TEMP DIF, DEGF (LMTD= 47.7,F= .78, BYPASS= .94, BAFF=1.00) 35.2  OVERALL COEFF REQUIRED BTU/HR-FT2-F 105.18 102.50  SHELLS IN SERIES 1 PARALLEL 1 TOTAL EFF AREA FT2 7.1  PASSES, SHELL 1 TUBE 4 EFFECTIVE AREA FT2/SHELL 7.1  SHELLS IN SERIES 1 PARALLEL 1 TOTAL EFF AREA FT2/SHELL 7.1  SHELLS IN SERIES 1 PARALLEL 1 CROSS PASSES PER SHELL PASS 4  SPACING, CENTRAL IN. 4.309 BAFFLE CUT, PCT SHELL I.D. 30.00  SPACING, CENTRAL IN. 4.309 BAFFLE CUT, PCT SHELL I.D. 30.00  SPACING, OUTLET IN. 4.309  BAFFLE TYPE HORZ SEGMENTL CROSS PASSES PER SHELL PASS 4  SPACING, CENTRAL IN. 4.309  BAFFLE THICKNESS IN. 125 IMPINGEMENT BAFFLE INCLUDED NO  PAIRS OF SEALING DEVICES 1 TUBESHEET BLANK AREA, % .0			HOI IU	BE SIDE	COTD 21	IETT SIDE
TEMPERATURE DEGF 140.0 75.1* 40.0 76.9* DENSITY LB/FT3 61.2913 62.1959 62.5352 62.1754 VISCOSITY CP .4726 .9185 1.4791 .8983 SPECIFIC HEAT BTU/LB-F .9973 1.0009 1.0058 1.0007 THERMAL COND. BTU/HR-FTF .3723 .3568 .3466 .3573 MOLAR MASS LB/LBMOL 18.02 18.02  TEMP, AVG & SKIN DEGF 107.5 79.0 58.5 77.9 VISCOSITY, AVG & SKIN CP .6397 .8761 1.1369 .8881 PRESSURE, IN & DESIGN PSIA 50.00 165.00 50.00 165.00  PRESSURE DROP, TOT & ALLOWED PSI .04 10.00 .01 10.00 VELOCITY, CALC & MAX ALLOWED FT/S .39 10.00 .11 10.00  FOULING RESISTANCE HR-FT2-F/BTU .00010 .00010 FILM COEFFICIENT BTU/HR-FT2-F 208.76 256.11  TOTAL HEAT DUTY REQUIRED MEGBTU/HR .025917 EFF TEMP DIF, DEGF (LMTD= 47.7,F=.78, BYPASS= .94, BAFF=1.00) 35.2 OVERALL COEFF REQUIRED BTU/HR-FT2-F 105.18 102.50  SHELLS IN SERIES 1 PARALLEL 1 TOTAL EFF AREA FT2 7.1 PASSES, SHELL 1 TUBE 4 EFFECTIVE AREA FT2/SHELL 7.1 SHELL DIAMETER IN. 3.820 TEMA SHELL TYPE E ; REAR HEAD FXTS  BAFFLE TYPE HORZ SEGMENTL CROSS PASSES PER SHELL PASS 4 SPACING, CENTRAL IN. 4.309 BAFFLE CUT, PCT SHELL I.D. 30.00 SPACING, INLET IN. 4.309 BAFFLE TOT SHELL I.D. 30.00 SPACING, OUTLET IN. 4.309 BAFFLE THICKNESS IN125 IMPINGEMENT BAFFLE INCLUDED NO PAIRS OF SEALING DEVICES 1 TUBESHEET BLANK AREA, % .0			Tube		Shell	L
TEMPERATURE DEGF 140.0 75.1* 40.0 76.9* DENSITY LB/FT3 61.2913 62.1959 62.5352 62.1754 VISCOSITY CP .4726 .9185 1.4791 .8983 SPECIFIC HEAT BTU/LB-F .9973 1.0009 1.0058 1.0007 THERMAL COND. BTU/HR-FTF .3723 .3568 .3466 .3573 MOLAR MASS LB/LBMOL 18.02 18.02  TEMP, AVG & SKIN DEGF 107.5 79.0 58.5 77.9 VISCOSITY, AVG & SKIN CP .6397 .8761 1.1369 .8881 PRESSURE, IN & DESIGN PSIA 50.00 165.00 50.00 165.00  PRESSURE DROP, TOT & ALLOWED PSI .04 10.00 .01 10.00 VELOCITY, CALC & MAX ALLOWED FT/S .39 10.00 .11 10.00  FOULING RESISTANCE HR-FT2-F/BTU .00010 .00010 FILM COEFFICIENT BTU/HR-FT2-F 208.76 256.11  TOTAL HEAT DUTY REQUIRED MEGBTU/HR .025917 EFF TEMP DIF, DEGF (LMTD= 47.7,F=.78, BYPASS= .94, BAFF=1.00) 35.2 OVERALL COEFF REQUIRED BTU/HR-FT2-F 105.18 102.50  SHELLS IN SERIES 1 PARALLEL 1 TOTAL EFF AREA FT2 7.1 PASSES, SHELL 1 TUBE 4 EFFECTIVE AREA FT2/SHELL 7.1 SHELL DIAMETER IN. 3.820 TEMA SHELL TYPE E ; REAR HEAD FXTS  BAFFLE TYPE HORZ SEGMENTL CROSS PASSES PER SHELL PASS 4 SPACING, CENTRAL IN. 4.309 BAFFLE CUT, PCT SHELL I.D. 30.00 SPACING, INLET IN. 4.309 BAFFLE TOT SHELL I.D. 30.00 SPACING, OUTLET IN. 4.309 BAFFLE THICKNESS IN125 IMPINGEMENT BAFFLE INCLUDED NO PAIRS OF SEALING DEVICES 1 TUBESHEET BLANK AREA, % .0		,	SENSI	BLE LIQ	SENS	IBLE LIQ
TEMPERATURE DEGF 140.0 75.1* 40.0 76.9* DENSITY LB/FT3 61.2913 62.1959 62.5352 62.1754 VISCOSITY CP .4726 .9185 1.4791 .8983 SPECIFIC HEAT BTU/LB-F .9973 1.0009 1.0058 1.0007 THERMAL COND. BTU/HR-FTF .3723 .3568 .3466 .3573 MOLAR MASS LB/LBMOL 18.02 18.02  TEMP, AVG & SKIN DEGF 107.5 79.0 58.5 77.9 VISCOSITY, AVG & SKIN CP .6397 .8761 1.1369 .8881 PRESSURE, IN & DESIGN PSIA 50.00 165.00 50.00 165.00  PRESSURE DROP, TOT & ALLOWED PSI .04 10.00 .01 10.00 VELOCITY, CALC & MAX ALLOWED FT/S .39 10.00 .11 10.00  FOULING RESISTANCE HR-FT2-F/BTU .00010 .00010 FILM COEFFICIENT BTU/HR-FT2-F 208.76 256.11  TOTAL HEAT DUTY REQUIRED MEGBTU/HR .025917 EFF TEMP DIF, DEGF (LMTD= 47.7,F=.78, BYPASS= .94, BAFF=1.00) 35.2 OVERALL COEFF REQUIRED BTU/HR-FT2-F 105.18 102.50  SHELLS IN SERIES 1 PARALLEL 1 TOTAL EFF AREA FT2 7.1 PASSES, SHELL 1 TUBE 4 EFFECTIVE AREA FT2/SHELL 7.1 SHELL DIAMETER IN. 3.820 TEMA SHELL TYPE E ; REAR HEAD FXTS  BAFFLE TYPE HORZ SEGMENTL CROSS PASSES PER SHELL PASS 4 SPACING, CENTRAL IN. 4.309 BAFFLE CUT, PCT SHELL I.D. 30.00 SPACING, INLET IN. 4.309 BAFFLE TOT SHELL I.D. 30.00 SPACING, OUTLET IN. 4.309 BAFFLE THICKNESS IN125 IMPINGEMENT BAFFLE INCLUDED NO PAIRS OF SEALING DEVICES 1 TUBESHEET BLANK AREA, % .0	TOTAL FLOW RATE	KLB/HR		.400		.700
DENSITY LB/FT3 61.2913 62.1959 62.5352 62.1754 VISCOSITY CP .4726 .9185 1.4791 .8983 SPECIFIC HEAT BTU/LB-F .9973 1.0009 1.0058 1.0007 THERMAL COND. BTU/HR-FT-F .3723 .3568 .3466 .3573 MOLAR MASS LB/LBMOL 18.02 18.02  TEMP, AVG & SKIN DEGF 107.5 79.0 58.5 77.9 VISCOSITY, AVG & SKIN CP .6397 .8761 1.1369 .8881 PRESSURE, IN & DESIGN PSIA 50.00 165.00 50.00 165.00  PRESSURE DROP, TOT & ALLOWED PSI .04 10.00 .01 10.00 VELOCITY, CALC & MAX ALLOWED FT/S .39 10.00 .11 10.00  FOULING RESISTANCE HR-FT2-F/BTU .00010 .00010 FILM COEFFICIENT BTU/HR-FT2-F 208.76 256.11  TOTAL HEAT DUTY REQUIRED MEGBTU/HR .025917 EFF TEMP DIF, DEGF (LMTD= 47.7,F= .78,BYPASS= .94,BAFF=1.00) 35.2 OVERALL COEFF REQUIRED BTU/HR-FT2-F 103.05 CLEAN & FOULED COEFF BTU/HR-FT2-F 105.18 102.50  SHELLS IN SERIES 1 PARALLEL 1 TOTAL EFF AREA FT2 7.1 PASSES, SHELL 1 TUBE 4 EFFECTIVE AREA FT2/SHELL 7.1 SHELL DIAMETER IN. 3.820 TEMA SHELL TYPE E ; REAR HEAD FXTS  BAFFLE TYPE HORZ SEGMENTL CROSS PASSES PER SHELL PASS 4 SPACING, INLET IN. 4.309 GUT DISTANCE FROM CENTER, IN764 SPACING, OUTLET IN. 4.309 BAFFLE THICKNESS IN125 IMPINGEMENT BAFFLE INCLUDED NO PAIRS OF SEALING DEVICES 1 TUBESHEET BLANK AREA, % .0			ΙN	OO.I.	ΙN	OUT
VISCOSITY CP .4726 .9185 1.4791 .8983  SPECIFIC HEAT BTU/LB-F .9973 1.0009 1.0058 1.0007  THERMAL COND. BTU/HR-FT-F .3723 .3568 .3466 .3573  MOLAR MASS LB/LBMOL 18.02  TEMP, AVG & SKIN DEGF 107.5 79.0 58.5 77.9  VISCOSITY, AVG & SKIN CP .6397 .8761 1.1369 .8881  PRESSURE, IN & DESIGN PSIA 50.00 165.00 50.00 165.00  PRESSURE DROP, TOT & ALLOWED PSI .04 10.00 .01 10.00  VELOCITY, CALC & MAX ALLOWED FT/S .39 10.00 .11 10.00  FOULING RESISTANCE HR-FT2-F/BTU .00010 .00010  FILM COEFFICIENT BTU/HR-FT2-F 208.76 256.11  TOTAL HEAT DUTY REQUIRED MEGBTU/HR .025917  EFF TEMP DIF, DEGF (LMTD= 47.7,F= .78,BYPASS= .94,BAFF=1.00) 35.2  OVERALL COEFF REQUIRED BTU/HR-FT2-F 105.18 102.50  SHELLS IN SERIES 1 PARALLEL 1 TOTAL EFF AREA FT2 7.1  PASSES, SHELL 1 TUBE 4 EFFECTIVE AREA FT2/SHELL 7.1  SHELL DIAMETER IN. 3.820 TEMA SHELL TYPE E ; REAR HEAD FXTS  BAFFLE TYPE HORZ SEGMENTL CROSS PASSES PER SHELL PASS 4  SPACING, CENTRAL IN. 4.309 BAFFLE CUT, PCT SHELL I.D. 30.00  SPACING, INLET IN. 4.309 CUT DISTANCE FROM CENTER, IN764  SPACING, OUTLET IN. 4.309  BAFFLE THICKNESS IN125 IMPINGEMENT BAFFLE INCLUDED NO  PAIRS OF SEALING DEVICES 1 TUBESHEET BLANK AREA, % .0		DEGF	140.0	75.1*	40.0	76.9*
## SPECIFIC HEAT BTU/LB-F	DENSITY		61.2913	62.1959	62.5352	62.1754
MOLAR MASS  LB/LBMOL  18.02  18.02  TEMP, AVG & SKIN  DEGF  107.5  79.0  58.5  77.9  VISCOSITY, AVG & SKIN  CP  .6397 .8761  1.1369 .8881  PRESSURE, IN & DESIGN PSIA  50.00  165.00  DRESSURE DROP, TOT & ALLOWED PSI .04  10.00  VELOCITY, CALC & MAX ALLOWED PT/S .39  10.00  .01  FOULING RESISTANCE  HR-FT2-F/BTU .00010  FOULING RESISTANCE  HR-FT2-F/BTU .00010  FOULING RESISTANCE  HR-FT2-F  208.76  256.11  TOTAL HEAT DUTY REQUIRED MEGBTU/HR  COEFFICIENT  BTU/HR-FT2-F  103.05  CLEAN & FOULED COEFF  BTU/HR-FT2-F  105.18  102.50  SHELLS IN SERIES  1 PARALLEL  1 TOTAL EFF AREA  FT2  7.1  PASSES, SHELL  1 TUBE  4 EFFECTIVE AREA  FT2/SHELL  7.1  SHELL DIAMETER IN.  3.820  TEMA SHELL TYPE  HORZ  SEGMENTL  CROSS PASSES PER SHELL  PASS  4  SPACING, CENTRAL  IN.  4.309  BAFFLE TYPE  HORZ  SEGMENTL  CROSS PASSES PER SHELL  PASS  4  SPACING, OUTLET  IN.  4.309  BAFFLE TYPE  BAFFLE TYPE  HORZ  SEGMENTL  CROSS PASSES PER SHELL  PASS  A  SPACING, OUTLET  IN.  4.309  BAFFLE THICKNESS  IN.  125  IMPINGEMENT BAFFLE INCLUDED  NO  PAIRS OF SEALING DEVICES  1 TUBESHEET BLANK AREA, %  .0	VISCOSITY	CP	.4726	.9185	1.4791	.8983
MOLAR MASS  LB/LBMOL  18.02  18.02  TEMP, AVG & SKIN  DEGF  107.5  79.0  58.5  77.9  VISCOSITY, AVG & SKIN  CP  .6397 .8761  1.1369 .8881  PRESSURE, IN & DESIGN PSIA  50.00  165.00  DRESSURE DROP, TOT & ALLOWED PSI .04  10.00  VELOCITY, CALC & MAX ALLOWED PT/S .39  10.00  .01  FOULING RESISTANCE  HR-FT2-F/BTU .00010  FOULING RESISTANCE  HR-FT2-F/BTU .00010  FOULING RESISTANCE  HR-FT2-F  208.76  256.11  TOTAL HEAT DUTY REQUIRED MEGBTU/HR  COEFFICIENT  BTU/HR-FT2-F  103.05  CLEAN & FOULED COEFF  BTU/HR-FT2-F  105.18  102.50  SHELLS IN SERIES  1 PARALLEL  1 TOTAL EFF AREA  FT2  7.1  PASSES, SHELL  1 TUBE  4 EFFECTIVE AREA  FT2/SHELL  7.1  SHELL DIAMETER IN.  3.820  TEMA SHELL TYPE  HORZ  SEGMENTL  CROSS PASSES PER SHELL  PASS  4  SPACING, CENTRAL  IN.  4.309  BAFFLE TYPE  HORZ  SEGMENTL  CROSS PASSES PER SHELL  PASS  4  SPACING, OUTLET  IN.  4.309  BAFFLE TYPE  BAFFLE TYPE  HORZ  SEGMENTL  CROSS PASSES PER SHELL  PASS  A  SPACING, OUTLET  IN.  4.309  BAFFLE THICKNESS  IN.  125  IMPINGEMENT BAFFLE INCLUDED  NO  PAIRS OF SEALING DEVICES  1 TUBESHEET BLANK AREA, %  .0	SPECIFIC HEAT	BTU/LB-F	.9973	1.0009	1.0058	1.0007
TEMP, AVG & SKIN DEGF 107.5 79.0 58.5 77.9 VISCOSITY, AVG & SKIN CP .6397 .8761 1.1369 .8881 PRESSURE, IN & DESIGN PSIA 50.00 165.00 50.00 165.00  PRESSURE DROP, TOT & ALLOWED PSI .04 10.00 .01 10.00 VELOCITY, CALC & MAX ALLOWED FT/S .39 10.00 .11 10.00  FOULING RESISTANCE HR-FT2-F/BTU .00010 .00010 FILM COEFFICIENT BTU/HR-FT2-F 208.76 256.11  TOTAL HEAT DUTY REQUIRED MEGBTU/HR EFF TEMP DIF, DEGF (LMTD= 47.7,F= .78,BYPASS= .94,BAFF=1.00) 35.2 OVERALL COEFF REQUIRED BTU/HR-FT2-F 103.05 CLEAN & FOULED COEFF BTU/HR-FT2-F 105.18 102.50  SHELLS IN SERIES 1 PARALLEL 1 TOTAL EFF AREA FT2 7.1 PASSES, SHELL 1 TUBE 4 EFFECTIVE AREA FT2/SHELL 7.1 SHELL DIAMETER IN. 3.820 TEMA SHELL TYPE E ; REAR HEAD FXTS  BAFFLE TYPE HORZ SEGMENTL CROSS PASSES PER SHELL PASS 4 SPACING, CENTRAL IN. 4.309 BAFFLE CUT, PCT SHELL I.D. 30.00 SPACING, INLET IN. 4.309 BAFFLE CUT, PCT SHELL I.D. 30.00 SPACING, INLET IN. 4.309 BAFFLE THICKNESS IN125 IMPINGEMENT BAFFLE INCLUDED NO PAIRS OF SEALING DEVICES 1 TUBESHEET BLANK AREA, % .0	THERMAL COND.	BTU/HR-FT-F	.3723	.3568	.3466	.3573
TEMP, AVG & SKIN DEGF 107.5 79.0 58.5 77.9 VISCOSITY, AVG & SKIN CP .6397 .8761 1.1369 .8881 PRESSURE, IN & DESIGN PSIA 50.00 165.00 50.00 165.00  PRESSURE DROP, TOT & ALLOWED PSI .04 10.00 .01 10.00 VELOCITY, CALC & MAX ALLOWED FT/S .39 10.00 .11 10.00  FOULING RESISTANCE HR-FT2-F/BTU .00010 .00010 FILM COEFFICIENT BTU/HR-FT2-F 208.76 256.11  TOTAL HEAT DUTY REQUIRED MEGBTU/HR EFF TEMP DIF, DEGF (LMTD= 47.7,F= .78,BYPASS= .94,BAFF=1.00) 35.2 OVERALL COEFF REQUIRED BTU/HR-FT2-F 103.05 CLEAN & FOULED COEFF BTU/HR-FT2-F 105.18 102.50  SHELLS IN SERIES 1 PARALLEL 1 TOTAL EFF AREA FT2 7.1 PASSES, SHELL 1 TUBE 4 EFFECTIVE AREA FT2/SHELL 7.1 SHELL DIAMETER IN. 3.820 TEMA SHELL TYPE E ; REAR HEAD FXTS  BAFFLE TYPE HORZ SEGMENTL CROSS PASSES PER SHELL PASS 4 SPACING, CENTRAL IN. 4.309 BAFFLE CUT, PCT SHELL I.D. 30.00 SPACING, INLET IN. 4.309 BAFFLE CUT, PCT SHELL I.D. 30.00 SPACING, INLET IN. 4.309 BAFFLE THICKNESS IN125 IMPINGEMENT BAFFLE INCLUDED NO PAIRS OF SEALING DEVICES 1 TUBESHEET BLANK AREA, % .0	MOLAR MASS	LB/LBMOL		18.02		18.02
VISCOSITY, AVG & SKIN CP .6397 .8761 1.1369 .8881 PRESSURE, IN & DESIGN PSIA 50.00 165.00 50.00 165.00  PRESSURE DROP, TOT & ALLOWED PSI .04 10.00 .01 10.00 VELOCITY, CALC & MAX ALLOWED FT/S .39 10.00 .11 10.00  FOULING RESISTANCE HR-FT2-F/BTU .00010 .00010 FILM COEFFICIENT BTU/HR-FT2-F 208.76 256.11  TOTAL HEAT DUTY REQUIRED MEGBTU/HR EFF TEMP DIF, DEGF (LMTD= 47.7,F= .78,BYPASS= .94,BAFF=1.00) 35.2 COVERALL COEFF REQUIRED BTU/HR-FT2-F 103.05 CLEAN & FOULED COEFF BTU/HR-FT2-F 105.18 102.50  SHELLS IN SERIES 1 PARALLEL 1 TOTAL EFF AREA FT2 7.1 PASSES, SHELL 1 TUBE 4 EFFECTIVE AREA FT2/SHELL 7.1 SHELL DIAMETER IN. 3.820 TEMA SHELL TYPE E ; REAR HEAD FXTS  BAFFLE TYPE HORZ SEGMENTL CROSS PASSES PER SHELL PASS 4 SPACING, CENTRAL IN. 4.309 BAFFLE CUT, PCT SHELL I.D. 30.00 SPACING, INLET IN. 4.309 BAFFLE THICKNESS IN125 IMPINGEMENT BAFFLE INCLUDED NO PAIRS OF SEALING DEVICES 1 TUBESHEET BLANK AREA, % .0						
PRESSURE DROP, TOT & ALLOWED PSI .04 10.00 .01 10.00 VELOCITY, CALC & MAX ALLOWED FT/S .39 10.00 .11 10.00 FOULING RESISTANCE HR-FT2-F/BTU .00010 .00010 FILM COEFFICIENT BTU/HR-FT2-F 208.76 256.11  TOTAL HEAT DUTY REQUIRED MEGBTU/HR .025917 EFF TEMP DIF, DEGF (LMTD= 47.7,F= .78,BYPASS= .94,BAFF=1.00) 35.2 OVERALL COEFF REQUIRED BTU/HR-FT2-F 103.05 CLEAN & FOULED COEFF BTU/HR-FT2-F 105.18 102.50 SHELLS IN SERIES 1 PARALLEL 1 TOTAL EFF AREA FT2 7.1 PASSES, SHELL 1 TUBE 4 EFFECTIVE AREA FT2/SHELL 7.1 SHELL DIAMETER IN. 3.820 TEMA SHELL TYPE E ; REAR HEAD FXTS BAFFLE TYPE HORZ SEGMENTL CROSS PASSES PER SHELL PASS 4 SPACING, CENTRAL IN. 4.309 BAFFLE CUT, PCT SHELL I.D. 30.00 SPACING, INLET IN. 4.309 CUT DISTANCE FROM CENTER, IN764 SPACING, OUTLET IN. 4.309 BAFFLE THICKNESS IN125 IMPINGEMENT BAFFLE INCLUDED NO PAIRS OF SEALING DEVICES 1 TUBESHEET BLANK AREA, % .0	TEMP, AVG & SKIN	DEGF	107.5	79.0	58.5	77.9
PRESSURE DROP, TOT & ALLOWED PSI .04 10.00 .01 10.00 VELOCITY, CALC & MAX ALLOWED FT/S .39 10.00 .11 10.00 FOULING RESISTANCE HR-FT2-F/BTU .00010 .00010 FILM COEFFICIENT BTU/HR-FT2-F 208.76 256.11  TOTAL HEAT DUTY REQUIRED MEGBTU/HR .025917 EFF TEMP DIF, DEGF (LMTD= 47.7,F= .78,BYPASS= .94,BAFF=1.00) 35.2 OVERALL COEFF REQUIRED BTU/HR-FT2-F 103.05 CLEAN & FOULED COEFF BTU/HR-FT2-F 105.18 102.50 SHELLS IN SERIES 1 PARALLEL 1 TOTAL EFF AREA FT2 7.1 PASSES, SHELL 1 TUBE 4 EFFECTIVE AREA FT2/SHELL 7.1 SHELL DIAMETER IN. 3.820 TEMA SHELL TYPE E ; REAR HEAD FXTS BAFFLE TYPE HORZ SEGMENTL CROSS PASSES PER SHELL PASS 4 SPACING, CENTRAL IN. 4.309 BAFFLE CUT, PCT SHELL I.D. 30.00 SPACING, INLET IN. 4.309 CUT DISTANCE FROM CENTER, IN764 SPACING, OUTLET IN. 4.309 BAFFLE THICKNESS IN125 IMPINGEMENT BAFFLE INCLUDED NO PAIRS OF SEALING DEVICES 1 TUBESHEET BLANK AREA, % .0	VISCOSITY, AVG & S	KIN CP	.6397	.8761	1.1369	.8881
PRESSURE DROP, TOT & ALLOWED PSI .04 10.00 .01 10.00 VELOCITY, CALC & MAX ALLOWED FT/S .39 10.00 .11 10.00 FOULING RESISTANCE HR-FT2-F/BTU .00010 .00010 FILM COEFFICIENT BTU/HR-FT2-F 208.76 256.11  TOTAL HEAT DUTY REQUIRED MEGBTU/HR .025917 EFF TEMP DIF, DEGF (LMTD= 47.7,F= .78,BYPASS= .94,BAFF=1.00) 35.2 OVERALL COEFF REQUIRED BTU/HR-FT2-F 103.05 CLEAN & FOULED COEFF BTU/HR-FT2-F 105.18 102.50 SHELLS IN SERIES 1 PARALLEL 1 TOTAL EFF AREA FT2 7.1 PASSES, SHELL 1 TUBE 4 EFFECTIVE AREA FT2/SHELL 7.1 SHELL DIAMETER IN. 3.820 TEMA SHELL TYPE E ; REAR HEAD FXTS BAFFLE TYPE HORZ SEGMENTL CROSS PASSES PER SHELL PASS 4 SPACING, CENTRAL IN. 4.309 BAFFLE CUT, PCT SHELL I.D. 30.00 SPACING, INLET IN. 4.309 CUT DISTANCE FROM CENTER, IN764 SPACING, OUTLET IN. 4.309 BAFFLE THICKNESS IN125 IMPINGEMENT BAFFLE INCLUDED NO PAIRS OF SEALING DEVICES 1 TUBESHEET BLANK AREA, % .0	PRESSURE, IN & DES	IGN PSIA	50.00	165.00	50.00	165.00
VELOCITY, CALC & MAX ALLOWED FT/S .39 10.00 .11 10.00  FOULING RESISTANCE HR-FT2-F/BTU .00010 .00010  FILM COEFFICIENT BTU/HR-FT2-F 208.76 .256.11  TOTAL HEAT DUTY REQUIRED MEGBTU/HR .025917  EFF TEMP DIF, DEGF (LMTD= 47.7,F= .78,BYPASS= .94,BAFF=1.00) 35.2  OVERALL COEFF REQUIRED BTU/HR-FT2-F .103.05  CLEAN & FOULED COEFF BTU/HR-FT2-F .105.18 .102.50  SHELLS IN SERIES 1 PARALLEL 1 TOTAL EFF AREA FT2 .7.1  PASSES, SHELL 1 TUBE 4 EFFECTIVE AREA FT2/SHELL 7.1  SHELL DIAMETER IN. 3.820 TEMA SHELL TYPE E ; REAR HEAD FXTS  BAFFLE TYPE HORZ SEGMENTL CROSS PASSES PER SHELL PASS 4  SPACING, CENTRAL IN. 4.309 BAFFLE CUT, PCT SHELL I.D. 30.00  SPACING, INLET IN. 4.309 CUT DISTANCE FROM CENTER, IN764  SPACING, OUTLET IN. 4.309  BAFFLE THICKNESS IN125 IMPINGEMENT BAFFLE INCLUDED NO  PAIRS OF SEALING DEVICES 1 TUBESHEET BLANK AREA, % .0						
FOULING RESISTANCE HR-FT2-F/BTU .00010 .00010 FILM COEFFICIENT BTU/HR-FT2-F 208.76 256.11  TOTAL HEAT DUTY REQUIRED MEGBTU/HR .025917 EFF TEMP DIF, DEGF (LMTD= 47.7,F= .78,BYPASS= .94,BAFF=1.00) 35.2 OVERALL COEFF REQUIRED BTU/HR-FT2-F 103.05 CLEAN & FOULED COEFF BTU/HR-FT2-F 105.18 102.50  SHELLS IN SERIES 1 PARALLEL 1 TOTAL EFF AREA FT2 7.1 PASSES, SHELL 1 TUBE 4 EFFECTIVE AREA FT2/SHELL 7.1 SHELL DIAMETER IN. 3.820 TEMA SHELL TYPE E; REAR HEAD FXTS  BAFFLE TYPE HORZ SEGMENTL CROSS PASSES PER SHELL PASS 4 SPACING, CENTRAL IN. 4.309 BAFFLE CUT, PCT SHELL I.D. 30.00 SPACING, INLET IN. 4.309 CUT DISTANCE FROM CENTER, IN764 SPACING, OUTLET IN. 4.309 BAFFLE THICKNESS IN125 IMPINGEMENT BAFFLE INCLUDED NO PAIRS OF SEALING DEVICES 1 TUBESHEET BLANK AREA, % .0	PRESSURE DROP, TOT	& ALLOWED PSI	.04	10.00	.01	10.00
FOULING RESISTANCE HR-FT2-F/BTU .00010 .00010 FILM COEFFICIENT BTU/HR-FT2-F 208.76 256.11  TOTAL HEAT DUTY REQUIRED MEGBTU/HR .025917 EFF TEMP DIF, DEGF (LMTD= 47.7,F= .78,BYPASS= .94,BAFF=1.00) 35.2 OVERALL COEFF REQUIRED BTU/HR-FT2-F 103.05 CLEAN & FOULED COEFF BTU/HR-FT2-F 105.18 102.50  SHELLS IN SERIES 1 PARALLEL 1 TOTAL EFF AREA FT2 7.1 PASSES, SHELL 1 TUBE 4 EFFECTIVE AREA FT2/SHELL 7.1 SHELL DIAMETER IN. 3.820 TEMA SHELL TYPE E; REAR HEAD FXTS  BAFFLE TYPE HORZ SEGMENTL CROSS PASSES PER SHELL PASS 4 SPACING, CENTRAL IN. 4.309 BAFFLE CUT, PCT SHELL I.D. 30.00 SPACING, INLET IN. 4.309 CUT DISTANCE FROM CENTER, IN764 SPACING, OUTLET IN. 4.309 BAFFLE THICKNESS IN125 IMPINGEMENT BAFFLE INCLUDED NO PAIRS OF SEALING DEVICES 1 TUBESHEET BLANK AREA, % .0	VELOCITY, CALC & M	AX ALLOWED FT/	s .39	10.00	.11	10.00
TOTAL HEAT DUTY REQUIRED MEGBTU/HR  FILM COEFFICIENT  BTU/HR-FT2-F  208.76  256.11  TOTAL HEAT DUTY REQUIRED MEGBTU/HR  EFF TEMP DIF, DEGF (LMTD= 47.7,F= .78,BYPASS= .94,BAFF=1.00)  35.2  OVERALL COEFF REQUIRED BTU/HR-FT2-F  103.05  CLEAN & FOULED COEFF  BTU/HR-FT2-F  105.18  102.50  SHELLS IN SERIES 1 PARALLEL 1 TOTAL EFF AREA FT2  7.1  PASSES, SHELL 1 TUBE 4 EFFECTIVE AREA FT2/SHELL 7.1  SHELL DIAMETER IN. 3.820 TEMA SHELL TYPE E; REAR HEAD FXTS  BAFFLE TYPE HORZ SEGMENTL CROSS PASSES PER SHELL PASS 4  SPACING, CENTRAL IN. 4.309 BAFFLE CUT, PCT SHELL I.D. 30.00  SPACING, INLET IN. 4.309 CUT DISTANCE FROM CENTER, IN764  SPACING, OUTLET IN. 4.309  BAFFLE THICKNESS IN125 IMPINGEMENT BAFFLE INCLUDED NO PAIRS OF SEALING DEVICES 1 TUBESHEET BLANK AREA, % .0						
TOTAL HEAT DUTY REQUIRED MEGBTU/HR  FILM COEFFICIENT  TOTAL HEAT DUTY REQUIRED MEGBTU/HR  FIF TEMP DIF, DEGF (LMTD= 47.7,F= .78,BYPASS= .94,BAFF=1.00)  OVERALL COEFF REQUIRED  BTU/HR-FT2-F  OVERALL COEFF REQUIRED  BTU/HR-FT2-F  SHELLS IN SERIES 1 PARALLEL 1 TOTAL EFF AREA FT2  SHELLS IN SERIES 1 PARALLEL 1 TOTAL EFF AREA FT2  SHELL DIAMETER IN.  3.820 TEMA SHELL TYPE E; REAR HEAD FXTS  BAFFLE TYPE HORZ SEGMENTL CROSS PASSES PER SHELL PASS  SPACING, CENTRAL IN.  4.309 BAFFLE CUT, PCT SHELL I.D.  SPACING, INLET IN.  4.309 CUT DISTANCE FROM CENTER, IN.  7.64  SPACING, OUTLET IN.  4.309  BAFFLE THICKNESS IN.  1.125 IMPINGEMENT BAFFLE INCLUDED  NO PAIRS OF SEALING DEVICES  1 TUBESHEET BLANK AREA, %  .0	FOULING RESISTANCE	HR-FT2-F/B	TU .0	0010	. (	00010
TOTAL HEAT DUTY REQUIRED MEGBTU/HR  EFF TEMP DIF, DEGF (LMTD= 47.7,F= .78,BYPASS= .94,BAFF=1.00) 35.2  OVERALL COEFF REQUIRED BTU/HR-FT2-F 103.05  CLEAN & FOULED COEFF BTU/HR-FT2-F 105.18 102.50  SHELLS IN SERIES 1 PARALLEL 1 TOTAL EFF AREA FT2 7.1  PASSES, SHELL 1 TUBE 4 EFFECTIVE AREA FT2/SHELL 7.1  SHELL DIAMETER IN. 3.820 TEMA SHELL TYPE E ; REAR HEAD FXTS  BAFFLE TYPE HORZ SEGMENTL CROSS PASSES PER SHELL PASS 4  SPACING, CENTRAL IN. 4.309 BAFFLE CUT, PCT SHELL I.D. 30.00  SPACING, INLET IN. 4.309 CUT DISTANCE FROM CENTER, IN764  SPACING, OUTLET IN. 4.309  BAFFLE THICKNESS IN125 IMPINGEMENT BAFFLE INCLUDED NO  PAIRS OF SEALING DEVICES 1 TUBESHEET BLANK AREA, % .0	FILM COEFFICIENT	BTU/HR-FT2	-F 20	8.76		
OVERALL COEFF REQUIRED BTU/HR-FT2-F 103.05 CLEAN & FOULED COEFF BTU/HR-FT2-F 105.18 102.50  SHELLS IN SERIES 1 PARALLEL 1 TOTAL EFF AREA FT2 7.1 PASSES, SHELL 1 TUBE 4 EFFECTIVE AREA FT2/SHELL 7.1 SHELL DIAMETER IN. 3.820 TEMA SHELL TYPE E ; REAR HEAD FXTS  BAFFLE TYPE HORZ SEGMENTL CROSS PASSES PER SHELL PASS 4 SPACING, CENTRAL IN. 4.309 BAFFLE CUT, PCT SHELL I.D. 30.00 SPACING, INLET IN. 4.309 CUT DISTANCE FROM CENTER, IN764 SPACING, OUTLET IN. 4.309 BAFFLE THICKNESS IN125 IMPINGEMENT BAFFLE INCLUDED NO PAIRS OF SEALING DEVICES 1 TUBESHEET BLANK AREA, % .0						
OVERALL COEFF REQUIRED BTU/HR-FT2-F 103.05 CLEAN & FOULED COEFF BTU/HR-FT2-F 105.18 102.50  SHELLS IN SERIES 1 PARALLEL 1 TOTAL EFF AREA FT2 7.1 PASSES, SHELL 1 TUBE 4 EFFECTIVE AREA FT2/SHELL 7.1 SHELL DIAMETER IN. 3.820 TEMA SHELL TYPE E ; REAR HEAD FXTS  BAFFLE TYPE HORZ SEGMENTL CROSS PASSES PER SHELL PASS 4 SPACING, CENTRAL IN. 4.309 BAFFLE CUT, PCT SHELL I.D. 30.00 SPACING, INLET IN. 4.309 CUT DISTANCE FROM CENTER, IN764 SPACING, OUTLET IN. 4.309 BAFFLE THICKNESS IN125 IMPINGEMENT BAFFLE INCLUDED NO PAIRS OF SEALING DEVICES 1 TUBESHEET BLANK AREA, % .0	TOTAL HEAT DUTY RE	OUIRED MEGBTU/H	IR			.025917
OVERALL COEFF REQUIRED BTU/HR-FT2-F 103.05 CLEAN & FOULED COEFF BTU/HR-FT2-F 105.18 102.50  SHELLS IN SERIES 1 PARALLEL 1 TOTAL EFF AREA FT2 7.1 PASSES, SHELL 1 TUBE 4 EFFECTIVE AREA FT2/SHELL 7.1 SHELL DIAMETER IN. 3.820 TEMA SHELL TYPE E ; REAR HEAD FXTS  BAFFLE TYPE HORZ SEGMENTL CROSS PASSES PER SHELL PASS 4 SPACING, CENTRAL IN. 4.309 BAFFLE CUT, PCT SHELL I.D. 30.00 SPACING, INLET IN. 4.309 CUT DISTANCE FROM CENTER, IN764 SPACING, OUTLET IN. 4.309 BAFFLE THICKNESS IN125 IMPINGEMENT BAFFLE INCLUDED NO PAIRS OF SEALING DEVICES 1 TUBESHEET BLANK AREA, % .0	EFF TEMP DIF. DEGF	(LMTD= 47.7.F	'= .78.BYPA	SS= .94.BAI	FF=1.00)	35.2
CLEAN & FOULED COEFF BTU/HR-FT2-F 105.18 102.50  SHELLS IN SERIES 1 PARALLEL 1 TOTAL EFF AREA FT2 7.1  PASSES, SHELL 1 TUBE 4 EFFECTIVE AREA FT2/SHELL 7.1  SHELL DIAMETER IN. 3.820 TEMA SHELL TYPE E ; REAR HEAD FXTS  BAFFLE TYPE HORZ SEGMENTL CROSS PASSES PER SHELL PASS 4  SPACING, CENTRAL IN. 4.309 BAFFLE CUT, PCT SHELL I.D. 30.00  SPACING, INLET IN. 4.309 CUT DISTANCE FROM CENTER, IN764  SPACING, OUTLET IN. 4.309  BAFFLE THICKNESS IN125 IMPINGEMENT BAFFLE INCLUDED NO  PAIRS OF SEALING DEVICES 1 TUBESHEET BLANK AREA, % .0	OMEDATI COPPE DECII	דספר סייוו/טס_פ	יחי 2 _ כי			
SHELLS IN SERIES 1 PARALLEL 1 TOTAL EFF AREA FT2 7.1 PASSES, SHELL 1 TUBE 4 EFFECTIVE AREA FT2/SHELL 7.1 SHELL DIAMETER IN. 3.820 TEMA SHELL TYPE E ; REAR HEAD FXTS  BAFFLE TYPE HORZ SEGMENTL CROSS PASSES PER SHELL PASS 4 SPACING, CENTRAL IN. 4.309 BAFFLE CUT, PCT SHELL I.D. 30.00 SPACING, INLET IN. 4.309 CUT DISTANCE FROM CENTER, IN764 SPACING, OUTLET IN. 4.309 BAFFLE THICKNESS IN125 IMPINGEMENT BAFFLE INCLUDED NO PAIRS OF SEALING DEVICES 1 TUBESHEET BLANK AREA, % .0	CLEAN & FOILED COE	FF BTII/HR-F	T2 - F	105 18	3	
BAFFLE TYPE HORZ SEGMENTL CROSS PASSES PER SHELL PASS 4 SPACING, CENTRAL IN. 4.309 BAFFLE CUT, PCT SHELL I.D. 30.00 SPACING, INLET IN. 4.309 CUT DISTANCE FROM CENTER, IN764 SPACING, OUTLET IN. 4.309 BAFFLE THICKNESS IN125 IMPINGEMENT BAFFLE INCLUDED NO PAIRS OF SEALING DEVICES 1 TUBESHEET BLANK AREA, % .0	CHEMIN & LOCHED COL	II DIO/IIICI	12 1	100.10		102.00
BAFFLE TYPE HORZ SEGMENTL CROSS PASSES PER SHELL PASS 4 SPACING, CENTRAL IN. 4.309 BAFFLE CUT, PCT SHELL I.D. 30.00 SPACING, INLET IN. 4.309 CUT DISTANCE FROM CENTER, IN764 SPACING, OUTLET IN. 4.309 BAFFLE THICKNESS IN125 IMPINGEMENT BAFFLE INCLUDED NO PAIRS OF SEALING DEVICES 1 TUBESHEET BLANK AREA, % .0	CHELLS IN CERTES	1 PARAT.T.FT. 1	TOTAL FFF	ARFA	FT2	7 1
BAFFLE TYPE HORZ SEGMENTL CROSS PASSES PER SHELL PASS 4 SPACING, CENTRAL IN. 4.309 BAFFLE CUT, PCT SHELL I.D. 30.00 SPACING, INLET IN. 4.309 CUT DISTANCE FROM CENTER, IN764 SPACING, OUTLET IN. 4.309 BAFFLE THICKNESS IN125 IMPINGEMENT BAFFLE INCLUDED NO PAIRS OF SEALING DEVICES 1 TUBESHEET BLANK AREA, % .0	DACCEC CUEII	1 TANADUED 1	TOTAL EFF	ALUA ALUA	בוב	7 • ± 7 1
BAFFLE TYPE HORZ SEGMENTL CROSS PASSES PER SHELL PASS 4 SPACING, CENTRAL IN. 4.309 BAFFLE CUT, PCT SHELL I.D. 30.00 SPACING, INLET IN. 4.309 CUT DISTANCE FROM CENTER, IN764 SPACING, OUTLET IN. 4.309 BAFFLE THICKNESS IN125 IMPINGEMENT BAFFLE INCLUDED NO PAIRS OF SEALING DEVICES 1 TUBESHEET BLANK AREA, % .0	CUEII DIAMETED IN	3 830	TELECTIVE	T TYPE F	• DEND U	7 T T T T T T T T T T T T T T T T T T T
SPACING, CENTRAL IN. 4.309 BAFFLE CUT, PCT SHELL I.D. 30.00 SPACING, INLET IN. 4.309 CUT DISTANCE FROM CENTER, IN764 SPACING, OUTLET IN. 4.309 BAFFLE THICKNESS IN125 IMPINGEMENT BAFFLE INCLUDED NO PAIRS OF SEALING DEVICES 1 TUBESHEET BLANK AREA, % .0	SHELL DIAMETER IN.	3.020	TEMA SHEL	T IIEE E	, KEAR HI	TAD FAIS
SPACING, CENTRAL IN. 4.309 BAFFLE CUT, PCT SHELL I.D. 30.00 SPACING, INLET IN. 4.309 CUT DISTANCE FROM CENTER, IN764 SPACING, OUTLET IN. 4.309 BAFFLE THICKNESS IN125 IMPINGEMENT BAFFLE INCLUDED NO PAIRS OF SEALING DEVICES 1 TUBESHEET BLANK AREA, % .0		OD7 CECMENTI	CDOCC DAC	CEC DED CUI	ZII DACC	4
PAIRS OF SEALING DEVICES 1 TUBESHEET BLANK AREA, % .0	CDACING CENTERS	OUT SEGMENIT	CKUSS FAS	DOM CITT	T T D	20 00
PAIRS OF SEALING DEVICES 1 TUBESHEET BLANK AREA, % .0	SPACING, CENTRAL	1 4 3 0 9	DAFFLE CU	I, FUI SHE	THE TABLE	30.00
PAIRS OF SEALING DEVICES 1 TUBESHEET BLANK AREA, % .0	SPACING, INLET	IN. 4.309	CUT DISTA	NCE FROM CI	INTEK, IN.	. / 64
PAIRS OF SEALING DEVICES 1 TUBESHEET BLANK AREA, % .0	DARRIE THE CONTRACT	IN. 4.309	TMDTNOON	NIM D.	INGI IIDED	37.0
	BAFFLE THICKNESS	IN125	IMPINGEME	NT BAFFLE	LNCLUDED	NO
TUBE TYPE PLAIN MATERIAL ELECTROLYTIC COPPER NO. OF TUBES/SHELL 76 EST MAX TUBE COUNT 36 TUBE LGTH, OVERALL FT 1.500 TUBE PITCH IN3125	PAIRS OF SEALING D	EVICES 1	TUBESHEET	BLANK AREA	A, 8	. 0
TUBE TYPE PLAIN MATERIAL ELECTROLYTIC COPPER  NO. OF TUBES/SHELL 76 EST MAX TUBE COUNT 36  TUBE LGTH, OVERALL FT 1.500 TUBE PITCH IN3125		<b>-</b>				
NO. OF TUBES/SHELL 76 EST MAX TUBE COUNT 36  TUBE LGTH, OVERALL FT 1.500 TUBE PITCH IN3125	TUBE TYPE	PLAIN	MATERIAL	E1	LECTROLYTI(	COPPER
TUBE LGTH, OVERALL FT 1.500 TUBE PITCH IN3125	NO. OF TUBES/SHELL	76	EST MAX T	UBE COUNT		36
	TUBE LGTH, OVERALL	FT 1.500	TUBE PITC	Н	IN.	.3125

TUBE LGTH, EFF FT TUBE LAYOUT DEG PITCH RATIO SHL NOZZ ID, IN&OUT 1.0	1.436 T 60 T 1.250 T	UBE INSIDE DIAM UBE SURFACE RATIO, O	IN. UT/IN	.214 1.184
* CALCULATED ITEMHEAT CHARACTER CONTROL TO			t	E0002 P 61 9/23/ 3 CASE 30
S U P P L E M E N	T A R	Y RESUL	T S	
HT PARAMETERS SHELL WALL CORRECTION 1.035 PRANDTL NUMBER 7.8 RYNLD NO, AVG 232. RYNLD NO, IN BUN 178. RYNLD NO,OUT BUN 294.	.000 4.2 985. 1334. 686.	SHELLSIDE PERFORM NOMINAL VEL, X-FLOW NOMINAL VEL, WINDOW CROSSFLOW COEF BTO WINDOW COEF BTO	FT/S FT/S U/HR-FT2: U/HR-FT2:	.18 -F 257.1 -F 258.8
FOULNG LAYER IN0014		SHELLSIDE FLOW, % HEAT TRANSFER X-FLOW		
THERMAL RESISTANCE, % OF SHELL TUBE FOULING M 39.57 58.13 2.22 PCT OVER DESIGN TOT FOUL RESIST DIFF RESIST	TOTAL (ETAL .07 53 .000217	TUBE TO BAFFLE LEAK MAIN CROSSFLOW BUNDLE TO SHELL BYP BAFFLE TO SHELL LEAK	AGE A B ASS C KAGE E	= 3.37 = 66.49 = 14.38 = 15.75
DIAMETRAL CLEARANCES		SHELLSIDE HEAT TR		
DIAMETRAL CLEARANCES BUNDLE TO SHELL IN. TUBE TO BAFFLE HOLE IN. BAFFLE TO SHELL IN.	.5000 .0284	BETA (BAFF CUT FACT	TOR) RY EFCT)	= .920 = .715
SHELL NOZZLE DATA I				
HT UNDR NOZ IN2 HT OPP NOZ IN2 VELOCITY FT/S .5 DENSITY LB/FT3 62.53	5	WINDOW		= 8.8
HT OPP NOZ IN2	5 57	END ZONE		= 4.2
DENSITY LB/FT3 62.53	5 62.175	INLET NOZZLE		= 42.7
NOZZ RHO*VSQ LB/FT-SZ Z	0 20 3 13	OUTLET NOZZLE		= 40.6
TUBE NOZZLE DATA I	N OUT	WEIGHT PER SHELL,	LB	
VELOCITY FT/S .5 DENSITY LB/FT3 61.29 PRESS. DROP % 6.	1 62.196		=	150. 165.
□□Washington University C Young model F302DY4P		exchanger experimen	t	E0002 P 62 9/23/ 3 CASE 31
SIZE 4- 18 TYPE BEM, MULT	I-PASS FLC	HOT TUBE SIDE Tube	COLD SI	1
TOTAL FLOW RATE KLB/HR		SENSIBLE LIQ .400		.800
TEMPERATURE DEGF		IN OUT 140.0 72.7*		OUT 73.5*

		che433b(	40) OUT		
DENSITY	T.B / FT 3	61 2913	62 2226	62 5352	62 2135
VISCOSITY	CP	4726	9462	1 4791	. 9366
SPECIFIC HEAT	BTU/LB-F	. 9973	1.0012	1.0058	1.0011
THERMAL COND	BTU/HR-FT-F	. 3723	.3561	.3466	.3563
MOLAR MASS	I.B/I.BMOI.	.0720	18 02	.0100	18 02
DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS	LD/ LDIIOL				
TEMP, AVG & SKIN VISCOSITY, AVG & PRESSURE, IN & DE	DEGF	106.3	76.6	56.7	75.4
VISCOSITY, AVG &	SKIN CP	.6476	.9021	1.1636	.9151
PRESSURE, IN & DE	SIGN PSIA	50.00	165.00	50.00	165.00
PRESSURE DROP, TO VELOCITY, CALC &	T & ALLOWED PS	.04	10.00	.01	10.00
VELOCITY, CALC &	MAX ALLOWED FT	'/S .39	10.00	.12	10.00
FOULING RESISTANCE FILM COEFFICIENT	E HR-FT2-F/	BTU .(	00010	. (	00010
FILM COEFFICIENT					78.00
TOTAL HEAT DUTY F EFF TEMP DIF, DEG OVERALL COEFF REQ	EQUIRED MEGBTU/	HR			.026883
EFF TEMP DIF, DEG	F (LMTD= 47.6,	F = .80, BYPA	ASS= .94,BA	FF=1.00)	35.7
OVERALL COEFF REQ	UIRED BTU/HR-	FT2-F			
CLEAN & FOULED CO	EFF BTU/HR-	FT2-F	108.6	8	105.79
					7 1
SHELLS IN SERIES PASSES, SHELL SHELL DIAMETER IN	1 MIDE 4	TOTAL EFF	: AKLA	L 1 7	/ • <u>1</u>
PASSES, SHELL	T TUBE 4	EFFECTIVE	L AKLA	FIZ/SHELL	1.\ D. D. D
SHELL DIAMETER IN	3.820	TEMA SHEI	T TYPE E	; KEAK HE	LAD FXTS
BAFFLE TYPE	HORZ SEGMENTI	CROSS PAS	SSES PER SH	IELL PASS	4
CDACING CENTRAL	TM 4 200	DARRIE CI	тт ретець	ידד ד ד	20 00
SPACING, CENTRAL SPACING, INLET SPACING, OUTLET BAFFLE THICKNESS	TN 4 309	CIIT DIST	NCE FROM C	ENTER IN	764
SDACING, INDEE	IN. 4.309	COI DIDII	MCD INON C	DIVIDIT, IN.	. 704
BAFFIF THICKNESS	IN. 4.303	TMDTNCEME	יאים ארבידר	TNCTIDED	NO
PAIRS OF SEALING	DEVICES 1	THETTHOUSE	אמג אואגזם י	INCHODED  A  P	.0
TUBE TYPE NO. OF TUBES/SHEI TUBE LGTH, OVERAL TUBE LGTH, EFF	PLAIN	MATERIAL	E	LECTROLYTIC	C COPPER
NO. OF TUBES/SHEI	L 76	EST MAX 1	UBE COUNT		36
TUBE LGTH, OVERAL	L FT 1.500	TUBE PITO	CH	IN.	.3125
TUBE LGTH. EFF	FT 1.436	TUBE OUTS	SIDE DTAM	IN.	.250
TUBE LAYOUT	DEG 60	TUBE TNS	DE DIAM	IN.	.214
PITCH RATIO		TUBE SURE			1.184
SHL NOZZ ID, IN&C					
,,	1.0 1.0	1000			• •
* CALCULATED IT	EMHEAT BALANC	E CODE = 8			
□□Washington Univ			ger experim	nent	E0002 P 63
Young model F302D		-	-		9/23/ 3
, <del></del>					CASE 31
S U P P L E	M E N T A	R Y F	RESU	L T S	
HT PARAMETERS			SIDE PERFO	RMANCE	
WALL CORRECTION	1.034 .000	NOMINAI	VEL, X-FLC	W FT/S	.10
PRANDTL NUMBER	8.0 4.3	NOMINAI	L VEL, WINDO	W FT/S	.20
RYNLD NO, AVG	259. 973.	CROSSFI	LOW COEF	BTU/HR-FT2-	-F 279.1
RYNID NO. IN BUN	204. 1334.	WINDOW	COEF	BTU/HR-FT2-	-F 280.8
RYNLD NO, OUT BUN	322. 666.				
FOULNG LAYER IN.			LSIDE FLOW.	% OF TOTAL	J
		211111	,		

		·) dccF9110	ANSFER X-FI	OT:T	01 50
		HEAT TR	ANSFER X-FI	10W	81.56
THERMAL RESISTANCE, % C SHELL TUBE FOULING 37.63 60.00 2.29	OF TOTAL	TUBE TO	BAFFLE LEA	KAGE A	. = 3.50
SHELL TUBE FOULING	ME'I'AL	MAIN CR	OSSFLOW	В	= 65.86
37.63 60.00 2.29	.08	BUNDLE	TO SHELL BY	PASS C	= 14.99
PCT OVER DESIGN	.33	BAFFLE	TO SHELL LE	AKAGE E	= 15.65
PCT OVER DESIGN TOT FOUL RESIST DIFF RESIST	.000217	TUBE PA	SSLANE BYPA	ASS F	= .00
DIFF RESIST	.000031				
			SIDE HEAT T		
DIAMETRAL CLEARANCES		TOTAL =	(BETA) (GAMM	MA) (FIN)	= .672
BUNDLE TO SHELL IN	15000	BETA (	BAFF CUT FA	ACTOR)	= .920
TUBE TO BAFFLE HOLE IN	10284	GAMMA (	TUBE ROW EN	ITRY EFCT)	= .731
BAFFLE TO SHELL IN	11000	END (	HT LOSS IN	END ZONE)	= .994
OUDIT NORTH DAWN	TN OUT	OHDI I		NDOD 0 0E	
SHELL NOZZLE DATA HT UNDR NOZ IN.	0.5				
HT UNDR NOZ IN.	.25	WINDOW	_		= 8.8
HT OPP NOZ IN.	.25	END ZON	E		= 4.0
HT UNDR NOZ IN. HT OPP NOZ IN. VELOCITY FT/S	.65 .65	CROSS F	'LOW		= 3.5
DENOTIL TR/LIO 07.	,333 62.214	TNTET N			= 42.8 = 40.9
NOZZ RHO*VSQ LB/FT-S2	26 26	OUTLET	NOZZLE		= 40.9
BUND RHO*VSQ LB/FT-S2	18 18				
TUBE NOZZLE DATA	IN OUT	WEIGH	T PER SHELI	. LB	
TUBE NOZZLE DATA VELOCITY FT/S	.59 .58	DRY		= =	150.
DENSITY LB/FT3 61.	.291 62.223	WET		=	
PRESS. DROP %	6 4 4 0	*****			100.
□□Washington University		t exchand	er experime	nt	E0002 P 64
Young model F302DY4P	, 0112100 1104	e chemany	CI CIPCIIMO		9/23/ 3
-	II.TT-PASS FI.	OW SEGME	NTAI. BAFFI.F	S RATING	CASE 32
SIZE 4- 18 TYPE BEM, MU	JLTI-PASS FL				CASE 32
-		HOT TU	BE SIDE	COLD S	CASE 32 HELL SIDE
SIZE 4- 18 TYPE BEM, MU		HOT TU	BE SIDE	COLD S	CASE 32 HELL SIDE
SIZE 4- 18 TYPE BEM, MU		HOT TU	BE SIDE	COLD S	CASE 32 HELL SIDE
-		HOT TU	BE SIDE	COLD S	CASE 32 HELL SIDE
SIZE 4- 18 TYPE BEM, MU TOTAL FLOW RATE KLB/	/HR	HOT TU Tube SENSI	BE SIDE BLE LIQ .400 OUT	COLD S Shel SENS IN	CASE 32 HELL SIDE 1 IBLE LIQ .900 OUT
SIZE 4- 18 TYPE BEM, MU TOTAL FLOW RATE KLB/	/HR	HOT TU Tube SENSI	BE SIDE BLE LIQ .400 OUT	COLD S Shel SENS IN	CASE 32 HELL SIDE 1 IBLE LIQ .900 OUT
SIZE 4- 18 TYPE BEM, MU  TOTAL FLOW RATE KLB/  TEMPERATURE DEGE DENSITY LB/F	/HR	HOT TU Tube SENSI	BE SIDE BLE LIQ .400 OUT	COLD S Shel SENS IN	CASE 32 HELL SIDE 1 IBLE LIQ .900 OUT
TOTAL FLOW RATE KLB/ TEMPERATURE DEGE DENSITY LB/F VISCOSITY CP	/HR F TT3	HOT TU Tube SENSI IN 140.0 61.2913 .4726	BE SIDE  BLE LIQ .400 OUT 70.4* 62.2469 .9730	COLD S Shel SENS IN 40.0 62.5352 1.4791	CASE 32  HELL SIDE  1  IBLE LIQ  .900  OUT  70.8*  62.2434  .9690
TOTAL FLOW RATE KLB/ TEMPERATURE DEGE DENSITY LB/F VISCOSITY CP SPECIFIC HEAT BTU/	/HR F FT3 /LB-F	HOT TU Tube SENSI IN 140.0 61.2913 .4726 .9973	BLE LIQ .400 OUT 70.4* 62.2469 .9730 1.0015	COLD S	CASE 32  HELL SIDE  1  IBLE LIQ     .900      OUT      70.8* 62.2434     .9690     1.0014
SIZE 4- 18 TYPE BEM, MU  TOTAL FLOW RATE KLB/  TEMPERATURE DEGE DENSITY LB/F VISCOSITY CP SPECIFIC HEAT BTU/ THERMAL COND. BTU/	/HR F FT3 /LB-F /HR-FT-F	HOT TU Tube SENSI IN 140.0 61.2913 .4726 .9973	BLE LIQ .400 OUT 70.4* 62.2469 .9730 1.0015 .3555	COLD S	CASE 32  HELL SIDE  1  IBLE LIQ  .900  OUT  70.8*  62.2434  .9690  1.0014 .3556
TOTAL FLOW RATE KLB/ TEMPERATURE DEGE DENSITY LB/F VISCOSITY CP SPECIFIC HEAT BTU/	/HR F FT3 /LB-F /HR-FT-F	HOT TU Tube SENSI IN 140.0 61.2913 .4726 .9973 .3723	BLE LIQ .400 OUT 70.4* 62.2469 .9730 1.0015	COLD S Shel SENS IN 40.0 62.5352 1.4791 1.0058 .3466	CASE 32  HELL SIDE  1  IBLE LIQ     .900      OUT      70.8* 62.2434     .9690     1.0014
SIZE 4- 18 TYPE BEM, MU  TOTAL FLOW RATE KLB/  TEMPERATURE DEGE DENSITY LB/F VISCOSITY CP SPECIFIC HEAT BTU/ THERMAL COND. BTU/	/HR F FT3 /LB-F /HR-FT-F LBMOL	HOT TU Tube SENSI  IN 140.0 61.2913 .4726 .9973 .3723	BLE LIQ .400 OUT 70.4* 62.2469 .9730 1.0015 .3555 18.02	COLD S Shel SENS  IN 40.0 62.5352 1.4791 1.0058 .3466	CASE 32  HELL SIDE  1  IBLE LIQ .900  OUT 70.8* 62.2434 .9690 1.0014 .3556 18.02 73.3
SIZE 4- 18 TYPE BEM, MU  TOTAL FLOW RATE KLB/  TEMPERATURE DEGE DENSITY LB/F VISCOSITY CP SPECIFIC HEAT BTU/ THERMAL COND. BTU/ MOLAR MASS LB/I	/HR F FT3 /LB-F /HR-FT-F LBMOL DEGF	HOT TU Tube SENSI IN 140.0 61.2913 .4726 .9973 .3723	BLE LIQ .400 OUT 70.4* 62.2469 .9730 1.0015 .3555 18.02	COLD S Shel SENS  IN 40.0 62.5352 1.4791 1.0058 .3466 55.4 1.1855	CASE 32  HELL SIDE  1  IBLE LIQ
TOTAL FLOW RATE KLB/ TEMPERATURE DEGE DENSITY LB/F VISCOSITY CP SPECIFIC HEAT BTU/ THERMAL COND. BTU/ MOLAR MASS LB/I TEMP, AVG & SKIN	'HR FT3 'LB-F 'HR-FT-F LBMOL DEGF CP	HOT TU Tube SENSI IN 140.0 61.2913 .4726 .9973 .3723	BLE LIQ .400 OUT 70.4* 62.2469 .9730 1.0015 .3555 18.02	COLD S Shel SENS  IN 40.0 62.5352 1.4791 1.0058 .3466 55.4 1.1855	CASE 32  HELL SIDE  1  IBLE LIQ
TOTAL FLOW RATE KLB/ TEMPERATURE DEGE DENSITY LB/F VISCOSITY CP SPECIFIC HEAT BTU/ THERMAL COND. BTU/ MOLAR MASS LB/I  TEMP, AVG & SKIN VISCOSITY, AVG & SKIN PRESSURE, IN & DESIGN	/HR FT3 /LB-F /HR-FT-F LBMOL DEGF CP PSIA	HOT TU Tube SENSI  IN 140.0 61.2913 .4726 .9973 .3723 105.2 .6551 50.00	BE SIDE  BLE LIQ .400 OUT 70.4* 62.2469 .9730 1.0015 .3555 18.02 74.5 .9257 165.00	COLD S	CASE 32  HELL SIDE  1  IBLE LIQ .900 OUT 70.8* 62.2434 .9690 1.0014 .3556 18.02 73.3 .9396 165.00
TOTAL FLOW RATE KLB/ TEMPERATURE DEGE DENSITY LB/F VISCOSITY CP SPECIFIC HEAT BTU/ THERMAL COND. BTU/ MOLAR MASS LB/I  TEMP, AVG & SKIN VISCOSITY, AVG & SKIN PRESSURE, IN & DESIGN  PRESSURE DROP, TOT & AI	HR  TT3  LB-F  HR-FT-F  LBMOL  DEGF  CP  PSIA	HOT TU Tube SENSI  IN 140.0 61.2913 .4726 .9973 .3723 105.2 .6551 50.00	BE SIDE  BLE LIQ .400 OUT 70.4* 62.2469 .9730 1.0015 .3555 18.02 74.5 .9257 165.00	COLD S	CASE 32  HELL SIDE  1  IBLE LIQ .900  OUT 70.8* 62.2434 .9690 1.0014 .3556 18.02 73.3 .9396 165.00
TOTAL FLOW RATE KLB/ TEMPERATURE DEGE DENSITY LB/F VISCOSITY CP SPECIFIC HEAT BTU/ THERMAL COND. BTU/ MOLAR MASS LB/I  TEMP, AVG & SKIN VISCOSITY, AVG & SKIN PRESSURE, IN & DESIGN	HR  TT3  LB-F  HR-FT-F  LBMOL  DEGF  CP  PSIA	HOT TU Tube SENSI  IN 140.0 61.2913 .4726 .9973 .3723 105.2 .6551 50.00	BE SIDE  BLE LIQ .400 OUT 70.4* 62.2469 .9730 1.0015 .3555 18.02 74.5 .9257 165.00	COLD S	CASE 32  HELL SIDE  1  IBLE LIQ .900  OUT 70.8* 62.2434 .9690 1.0014 .3556 18.02 73.3 .9396 165.00
TOTAL FLOW RATE KLB/ TEMPERATURE DEGRED DENSITY LB/F VISCOSITY CP SPECIFIC HEAT BTU/ THERMAL COND. BTU/ MOLAR MASS LB/I  TEMP, AVG & SKIN VISCOSITY, AVG & SKIN PRESSURE, IN & DESIGN  PRESSURE DROP, TOT & AI VELOCITY, CALC & MAX AI  FOULING RESISTANCE	/HR FT3 /LB-F /HR-FT-F LBMOL  DEGF CP PSIA LLOWED PSI LLOWED FT/S  HR-FT2-F/BT	HOT TU Tube SENSI  IN 140.0 61.2913 .4726 .9973 .3723 105.2 .6551 50.00 .04 .39	BE SIDE  BLE LIQ .400 OUT 70.4* 62.2469 .9730 1.0015 .3555 18.02 74.5 .9257 165.00 10.00 10.00	COLD S	CASE 32  HELL SIDE  1  IBLE LIQ .900  OUT 70.8* 62.2434 .9690 1.0014 .3556 18.02 73.3 .9396 165.00
TOTAL FLOW RATE KLB/ TEMPERATURE DEGE DENSITY LB/F VISCOSITY CP SPECIFIC HEAT BTU/ THERMAL COND. BTU/ MOLAR MASS LB/I  TEMP, AVG & SKIN VISCOSITY, AVG & SKIN PRESSURE, IN & DESIGN  PRESSURE DROP, TOT & AI VELOCITY, CALC & MAX AI	/HR FT3 /LB-F /HR-FT-F LBMOL  DEGF CP PSIA LLOWED PSI LLOWED FT/S  HR-FT2-F/BT	HOT TU Tube SENSI  IN 140.0 61.2913 .4726 .9973 .3723 105.2 .6551 50.00 .04 .39	BE SIDE  BLE LIQ .400 OUT 70.4* 62.2469 .9730 1.0015 .3555 18.02 74.5 .9257 165.00 10.00 10.00	COLD S	CASE 32  HELL SIDE  1  IBLE LIQ .900  OUT 70.8* 62.2434 .9690 1.0014 .3556 18.02 73.3 .9396 165.00  10.00 10.00
TOTAL FLOW RATE KLB/ TEMPERATURE DEGE DENSITY LB/F VISCOSITY CP SPECIFIC HEAT BTU/ THERMAL COND. BTU/ MOLAR MASS LB/I  TEMP, AVG & SKIN VISCOSITY, AVG & SKIN PRESSURE, IN & DESIGN  PRESSURE DROP, TOT & AI VELOCITY, CALC & MAX AI  FOULING RESISTANCE FILM COEFFICIENT	/HR FT3 /LB-F /HR-FT-F LBMOL  DEGF CP PSIA  LLOWED PSI LLOWED FT/S  HR-FT2-F/BT BTU/HR-FT2-	HOT TU Tube SENSI  IN 140.0 61.2913 .4726 .9973 .3723 105.2 .6551 50.00 .04 .39  U .0 F .20	BE SIDE  BLE LIQ .400 OUT 70.4* 62.2469 .9730 1.0015 .3555 18.02 74.5 .9257 165.00 10.00 10.00 0010 8.61	COLD S	CASE 32  HELL SIDE  1  IBLE LIQ .900 OUT 70.8* 62.2434 .9690 1.0014 .3556 18.02 73.3 .9396 165.00  10.00 10.00 00010 99.76
TOTAL FLOW RATE KLB/ TEMPERATURE DEGE DENSITY LB/F VISCOSITY CP SPECIFIC HEAT BTU/ THERMAL COND. BTU/ MOLAR MASS LB/I  TEMP, AVG & SKIN VISCOSITY, AVG & SKIN PRESSURE, IN & DESIGN  PRESSURE DROP, TOT & AI VELOCITY, CALC & MAX AI  FOULING RESISTANCE FILM COEFFICIENT	/HR FT3 /LB-F /HR-FT-F LBMOL  DEGF CP PSIA  LLOWED PSI LLOWED FT/S  HR-FT2-F/BT BTU/HR-FT2-ED MEGBTU/HR	HOT TU Tube SENSI  IN 140.0 61.2913 .4726 .9973 .3723 105.2 .6551 50.00 .04 .39  U .0 F .20	BE SIDE  BLE LIQ .400 OUT 70.4* 62.2469 .9730 1.0015 .3555 18.02 74.5 .9257 165.00 10.00 10.00 0010 8.61	COLD S	CASE 32  HELL SIDE  1  IBLE LIQ .900 OUT 70.8* 62.2434 .9690 1.0014 .3556 18.02 73.3 .9396 165.00  10.00 10.00 00010 99.76 .027780

		che433b(40).OUT	
OVERALL COEFF REQUIRED			
CLEAN & FOULED COEFF	BTU/HR-F	Γ2-F 111.82 108.72	
	·		
SHELLS IN SERIES 1 PARAI	т ст 1	TOTAL EFF AREA FT2 7.1	
		EFFECTIVE AREA FT2/SHELL 7.1	
SHELL DIAMETER IN.	3.820	TEMA SHELL TYPE E ; REAR HEAD FXTS	
BAFFLE TYPE HORZ SE	GMENTL	CROSS PASSES PER SHELL PASS 4	
SPACING, CENTRAL IN.	4.309	BAFFLE CUT, PCT SHELL I.D. 30.00	
SPACING, INLET IN.		CUT DISTANCE FROM CENTER, IN764	
		COI DIDIANCE INON CENTER, IN	
SPACING, OUTLET IN.		TARTHER PARTY TARTED IN THE TA	
BAFFLE THICKNESS IN.		IMPINGEMENT BAFFLE INCLUDED NO	
PAIRS OF SEALING DEVICES	1	TUBESHEET BLANK AREA, % .0	
TUBE TYPE	PLAIN	MATERIAL ELECTROLYTIC COPPER	
NO. OF TUBES/SHELL	76	EST MAX TUBE COUNT 36	
TUBE LGTH, OVERALL FT		TUBE PITCH IN3125	
TUBE LGTH, EFF FT		TUBE OUTSIDE DIAM IN250	
TUBE LAYOUT DEG		TUBE INSIDE DIAM IN214	
PITCH RATIO		TUBE SURFACE RATIO, OUT/IN 1.184	
SHL NOZZ ID, IN&OUT 1.0	1.0	TUBE NOZZ ID, IN&OUT IN8 .8	
* CALCULATED ITEMHEAT	BALANCE	CODE = 8	
		at exchanger experiment E0002 P 65	
	TIE433 He		
Young model F302DY4P		9/23/ 3	
		CASE 32	
SUPPLEMEN	I T A 1	R Y R E S U L T S	
HT PARAMETERS SHELL	TUBE	SHELLSIDE PERFORMANCE	
WALL CORRECTION 1.033	.000	NOMINAL VEL, X-FLOW FT/S .12	
PRANDTL NUMBER 8.2	4.3		
RYNLD NO, AVG 286.			
RYNLD NO, IN BUN 229.			
RYNLD NO, OUT BUN 350.			
FOULNG LAYER IN0014	.0014	SHELLSIDE FLOW, % OF TOTAL	
		HEAT TRANSFER X-FLOW 81.55	
THERMAL RESISTANCE, % OF	ТОТЪТ.	TUBE TO BAFFLE LEAKAGE A = 3.63	
CUETT THE TOTAL N			
	1ETAL	MAIN CROSSFLOW B = 65.45	
35.86 61.70 2.36	METAL .08	MAIN CROSSFLOW $B = 65.45$ BUNDLE TO SHELL BYPASS $C = 15.37$	
35.86 61.70 2.36 PCT OVER DESIGN	1ETAL .08 19	MAIN CROSSFLOW B = 65.45 BUNDLE TO SHELL BYPASS C = 15.37 BAFFLE TO SHELL LEAKAGE E = 15.55	
35.86 61.70 2.36 PCT OVER DESIGN	1ETAL .08 19	MAIN CROSSFLOW $B = 65.45$ BUNDLE TO SHELL BYPASS $C = 15.37$	
35.86 61.70 2.36 PCT OVER DESIGN	.08 19	MAIN CROSSFLOW B = 65.45 BUNDLE TO SHELL BYPASS C = 15.37 BAFFLE TO SHELL LEAKAGE E = 15.55 TUBE PASSLANE BYPASS F = .00	
35.86 61.70 2.36 PCT OVER DESIGN TOT FOUL RESIST DIFF RESIST	.08 19 .000217 000017	MAIN CROSSFLOW B = 65.45 BUNDLE TO SHELL BYPASS C = 15.37 BAFFLE TO SHELL LEAKAGE E = 15.55 TUBE PASSLANE BYPASS F = .00  SHELLSIDE HEAT TRANSFER FACTORS	
35.86 61.70 2.36 PCT OVER DESIGN TOT FOUL RESIST DIFF RESIST	.08 19 .000217 000017	MAIN CROSSFLOW B = 65.45 BUNDLE TO SHELL BYPASS C = 15.37 BAFFLE TO SHELL LEAKAGE E = 15.55 TUBE PASSLANE BYPASS F = .00  SHELLSIDE HEAT TRANSFER FACTORS	
35.86 61.70 2.36 PCT OVER DESIGN TOT FOUL RESIST DIFF RESIST DIAMETRAL CLEARANCES	.08 19 .000217 000017	MAIN CROSSFLOW B = 65.45 BUNDLE TO SHELL BYPASS C = 15.37 BAFFLE TO SHELL LEAKAGE E = 15.55 TUBE PASSLANE BYPASS F = .00  SHELLSIDE HEAT TRANSFER FACTORS TOTAL = (BETA) (GAMMA) (FIN) = .687	
35.86 61.70 2.36 PCT OVER DESIGN TOT FOUL RESIST DIFF RESIST  DIAMETRAL CLEARANCES BUNDLE TO SHELL IN.	.08 19 .000217 000017	MAIN CROSSFLOW B = 65.45 BUNDLE TO SHELL BYPASS C = 15.37 BAFFLE TO SHELL LEAKAGE E = 15.55 TUBE PASSLANE BYPASS F = .00  SHELLSIDE HEAT TRANSFER FACTORS TOTAL = (BETA) (GAMMA) (FIN) = .687 BETA (BAFF CUT FACTOR) = .920	
35.86 61.70 2.36  PCT OVER DESIGN  TOT FOUL RESIST  DIFF RESIST  DIAMETRAL CLEARANCES  BUNDLE TO SHELL IN.  TUBE TO BAFFLE HOLE IN.	.08 19 .000217 000017	MAIN CROSSFLOW B = 65.45 BUNDLE TO SHELL BYPASS C = 15.37 BAFFLE TO SHELL LEAKAGE E = 15.55 TUBE PASSLANE BYPASS F = .00  SHELLSIDE HEAT TRANSFER FACTORS TOTAL = (BETA) (GAMMA) (FIN) = .687 BETA (BAFF CUT FACTOR) = .920 GAMMA (TUBE ROW ENTRY EFCT) = .747	
35.86 61.70 2.36  PCT OVER DESIGN  TOT FOUL RESIST  DIFF RESIST  DIAMETRAL CLEARANCES  BUNDLE TO SHELL IN.  TUBE TO BAFFLE HOLE IN.	.08 19 .000217 000017	MAIN CROSSFLOW B = 65.45 BUNDLE TO SHELL BYPASS C = 15.37 BAFFLE TO SHELL LEAKAGE E = 15.55 TUBE PASSLANE BYPASS F = .00  SHELLSIDE HEAT TRANSFER FACTORS TOTAL = (BETA) (GAMMA) (FIN) = .687 BETA (BAFF CUT FACTOR) = .920	
35.86 61.70 2.36  PCT OVER DESIGN  TOT FOUL RESIST  DIFF RESIST  DIAMETRAL CLEARANCES  BUNDLE TO SHELL IN.  TUBE TO BAFFLE HOLE IN.	.08 19 .000217 000017	MAIN CROSSFLOW B = 65.45 BUNDLE TO SHELL BYPASS C = 15.37 BAFFLE TO SHELL LEAKAGE E = 15.55 TUBE PASSLANE BYPASS F = .00  SHELLSIDE HEAT TRANSFER FACTORS TOTAL = (BETA) (GAMMA) (FIN) = .687 BETA (BAFF CUT FACTOR) = .920 GAMMA (TUBE ROW ENTRY EFCT) = .747	
35.86 61.70 2.36  PCT OVER DESIGN  TOT FOUL RESIST  DIFF RESIST  DIAMETRAL CLEARANCES  BUNDLE TO SHELL IN.  TUBE TO BAFFLE HOLE IN.  BAFFLE TO SHELL IN.	.08 19 .000217 000017 .5000 .0284 .1000	MAIN CROSSFLOW  B = 65.45  BUNDLE TO SHELL BYPASS C = 15.37  BAFFLE TO SHELL LEAKAGE E = 15.55  TUBE PASSLANE BYPASS F = .00  SHELLSIDE HEAT TRANSFER FACTORS  TOTAL = (BETA) (GAMMA) (FIN) = .687  BETA (BAFF CUT FACTOR) = .920  GAMMA (TUBE ROW ENTRY EFCT) = .747  END (HT LOSS IN END ZONE) = .994	
35.86 61.70 2.36  PCT OVER DESIGN  TOT FOUL RESIST  DIFF RESIST  DIAMETRAL CLEARANCES  BUNDLE TO SHELL IN.  TUBE TO BAFFLE HOLE IN.  BAFFLE TO SHELL IN.	.08 19 .000217 000017 .5000 .0284 .1000	MAIN CROSSFLOW  B = 65.45  BUNDLE TO SHELL BYPASS C = 15.37  BAFFLE TO SHELL LEAKAGE E = 15.55  TUBE PASSLANE BYPASS F = .00  SHELLSIDE HEAT TRANSFER FACTORS  TOTAL = (BETA) (GAMMA) (FIN) = .687  BETA (BAFF CUT FACTOR) = .920  GAMMA (TUBE ROW ENTRY EFCT) = .747  END (HT LOSS IN END ZONE) = .994  SHELL PRESSURE DROP, % OF TOTAL	
35.86 61.70 2.36  PCT OVER DESIGN  TOT FOUL RESIST  DIFF RESIST  DIAMETRAL CLEARANCES  BUNDLE TO SHELL IN.  TUBE TO BAFFLE HOLE IN.  BAFFLE TO SHELL IN.  SHELL NOZZLE DATA  HT UNDR NOZ IN	.08 19 .000217 000017 .5000 .0284 .1000	MAIN CROSSFLOW  B = 65.45  BUNDLE TO SHELL BYPASS C = 15.37  BAFFLE TO SHELL LEAKAGE E = 15.55  TUBE PASSLANE BYPASS F = .00  SHELLSIDE HEAT TRANSFER FACTORS  TOTAL = (BETA) (GAMMA) (FIN) = .687  BETA (BAFF CUT FACTOR) = .920  GAMMA (TUBE ROW ENTRY EFCT) = .747  END (HT LOSS IN END ZONE) = .994  SHELL PRESSURE DROP, % OF TOTAL  WINDOW = 8.8	
35.86 61.70 2.36  PCT OVER DESIGN  TOT FOUL RESIST  DIFF RESIST  DIAMETRAL CLEARANCES  BUNDLE TO SHELL IN.  TUBE TO BAFFLE HOLE IN.  BAFFLE TO SHELL IN.  SHELL NOZZLE DATA  HT UNDR NOZ IN	.08 19 .000217 000017 .5000 .0284 .1000	MAIN CROSSFLOW  B = 65.45  BUNDLE TO SHELL BYPASS C = 15.37  BAFFLE TO SHELL LEAKAGE E = 15.55  TUBE PASSLANE BYPASS F = .00  SHELLSIDE HEAT TRANSFER FACTORS  TOTAL = (BETA) (GAMMA) (FIN) = .687  BETA (BAFF CUT FACTOR) = .920  GAMMA (TUBE ROW ENTRY EFCT) = .747  END (HT LOSS IN END ZONE) = .994  SHELL PRESSURE DROP, % OF TOTAL  WINDOW = 8.8  END ZONE = 3.8	
35.86 61.70 2.36  PCT OVER DESIGN  TOT FOUL RESIST  DIFF RESIST  DIAMETRAL CLEARANCES  BUNDLE TO SHELL IN.  TUBE TO BAFFLE HOLE IN.  BAFFLE TO SHELL IN.  SHELL NOZZLE DATA  HT UNDR NOZ IN	.08 19 .000217 .000017 .5000 .0284 .1000	MAIN CROSSFLOW  B = 65.45  BUNDLE TO SHELL BYPASS C = 15.37  BAFFLE TO SHELL LEAKAGE E = 15.55  TUBE PASSLANE BYPASS F = .00  SHELLSIDE HEAT TRANSFER FACTORS  TOTAL = (BETA) (GAMMA) (FIN) = .687  BETA (BAFF CUT FACTOR) = .920  GAMMA (TUBE ROW ENTRY EFCT) = .747  END (HT LOSS IN END ZONE) = .994  SHELL PRESSURE DROP, % OF TOTAL  WINDOW = 8.8  END ZONE = 3.8  CROSS FLOW = 3.4	
35.86 61.70 2.36  PCT OVER DESIGN  TOT FOUL RESIST  DIFF RESIST  DIAMETRAL CLEARANCES  BUNDLE TO SHELL IN.  TUBE TO BAFFLE HOLE IN.  BAFFLE TO SHELL IN.  SHELL NOZZLE DATA  HT UNDR NOZ IN	.08 19 .000217 .000017 .5000 .0284 .1000	MAIN CROSSFLOW  B = 65.45  BUNDLE TO SHELL BYPASS C = 15.37  BAFFLE TO SHELL LEAKAGE E = 15.55  TUBE PASSLANE BYPASS F = .00  SHELLSIDE HEAT TRANSFER FACTORS  TOTAL = (BETA) (GAMMA) (FIN) = .687  BETA (BAFF CUT FACTOR) = .920  GAMMA (TUBE ROW ENTRY EFCT) = .747  END (HT LOSS IN END ZONE) = .994  SHELL PRESSURE DROP, % OF TOTAL  WINDOW = 8.8  END ZONE = 3.8  CROSS FLOW = 3.4	

		che433b(	40).OUT		
NOZZ RHO*VSQ LB/FI	-s2 33 33				= 41.2
BUND RHO*VSQ LB/FI					
~					
TUBE NOZZLE DATA	. IN OUT	T WEIGH	T PER SHELI	L, LB	
VELOCITY FT/S					150.
DENSITY LB/FT3					165.
PRESS. DROP %					100.
□□Washington Unive			er experime	ant	E0002 P 66
Young model F302DY		cae exemang	CI CAPCIIMO	511.6	9/23/ 3
roung moder rough	11				CASE 33
SIZE 4- 18 TYPE BE	M MIITTT_DACC E	TIOM CECME	יאייאי סארידי	C DATING	
512E 4- 10 11FE BE	M, MULII-PASS F				
		Tube	BE SIDE		
				Shell	
	/		BLE LIQ		
TOTAL FLOW RATE			.500		.200
			OUT		
TEMPERATURE					
DENSITY					
VISCOSITY			.6263		
SPECIFIC HEAT					
THERMAL COND.		.3723	.3656		
MOLAR MASS	LB/LBMOL		18.02		18.02
TEMP, AVG & SKIN	DEGF	124.8	105.0	77.8	104.2
VISCOSITY, AVG & S	KIN CP	.5410	.6566	.8884	.6621
PRESSURE, IN & DES	IGN PSIA	50.00	165.00	50.00	165.00
PRESSURE DROP, TOI	& ALLOWED PSI	.05	10.00	.00	10.00
VELOCITY, CALC & M	AX ALLOWED FT/	'S .49	10.00	.03	10.00
FOULING RESISTANCE					00010
FILM COEFFICIENT	BTU/HR-FT2	2-F 21	4.29	1:	34.73
TOTAL HEAT DUTY RE	QUIRED MEGBTU/H	IR			.015146
EFF TEMP DIF, DEGF	(LMTD= 43.1, F	r = .71, BYPA	SS= .90, BAI	FF=1.00)	27.8
OVERALL COEFF REQU	IRED BTU/HR-F	TT2-F			76.27
CLEAN & FOULED COE	FF BTU/HR-F	TT2-F	77.63	3	76.41
SHELLS IN SERIES	1 PARALLEL 1	TOTAL EFF	' AREA	FT2	7.1
PASSES, SHELL	1 TUBE 4	EFFECTIVE	AREA	FT2/SHELL	7.1
SHELL DIAMETER IN.	3.820	TEMA SHEI	L TYPE E	; REAR H	EAD FXTS
BAFFLE TYPE H	ORZ SEGMENTL	CROSS PAS	SES PER SHE	ELL PASS	4
SPACING, CENTRAL					
SPACING, INLET			NCE FROM CE		
	IN. 4.309			,	
	IN. 4.309		NT BAFFI.E.	INCLUDED	NO
BAFFLE THICKNESS	IN. 4.309 IN125	IMPINGEME			
	IN. 4.309 IN125	IMPINGEME			
BAFFLE THICKNESS PAIRS OF SEALING D	IN. 4.309 IN125 EVICES 1	IMPINGEME TUBESHEET	' BLANK ARE <i>l</i>	A, %	.0
BAFFLE THICKNESS PAIRS OF SEALING D TUBE TYPE	IN. 4.309 IN125 EVICES 1 PLAIN	IMPINGEME TUBESHEET MATERIAL	BLANK AREA	A, % LECTROLYTIO	.0 C COPPER
BAFFLE THICKNESS PAIRS OF SEALING D TUBE TYPE NO. OF TUBES/SHELL	IN. 4.309 IN125 EVICES 1 PLAIN 76	IMPINGEME TUBESHEET MATERIAL EST MAX T	BLANK AREA EI UBE COUNT	A, %	.0 C COPPER 36
BAFFLE THICKNESS PAIRS OF SEALING D TUBE TYPE	IN. 4.309 IN125 EVICES 1  PLAIN 76 FT 1.500	IMPINGEME TUBESHEET MATERIAL EST MAX T TUBE PITC	BLANK AREA UBE COUNT	A, % LECTROLYTIC IN.	.0 C COPPER 36 .3125

PITCH RATIO	1	60 . 250	che433b(40).OUT TUBE INSIDE DIAM IN. TUBE SURFACE RATIO, OUT/I TUBE NOZZ ID, IN&OUT IN.	N 1.184
* CALCULATED ITE UNIVERSE TO Washington Universe Young model F302DY	rsity ChE	_	CODE = 8 t exchanger experiment	E0002 P 67 9/23/ 3 CASE 33
S U P P L E	M E N	T A R	Y RESULT	S
RYNLD NO, IN BUN RYNLD NO,OUT BUN	1.042 6.0 83. 50. 125.	.000 3.5 1456. 1667. 1258.	,	S .03 S .05 -FT2-F 136.1 -FT2-F 133.2
THERMAL RESISTANCE SHELL TUBE FOU 56.07 42.21 1 PCT OVER DESIGN	, % OF TC LING MET .66 .	OTAL CAL 05	HEAT TRANSFER X-FLOW TUBE TO BAFFLE LEAKAGE MAIN CROSSFLOW BUNDLE TO SHELL BYPASS BAFFLE TO SHELL LEAKAGE TUBE PASSLANE BYPASS	80.05 A = 2.57 B = 68.56 C = 10.97 E = 17.90
DIAMETRAL CLEARA BUNDLE TO SHELL TUBE TO BAFFLE HOL BAFFLE TO SHELL	NCES IN. E IN.		BETA (BAFF CUT FACTOR)	N) = .598 = .920 FCT) = .650
HT UNDR NOZ IN. HT OPP NOZ IN. VELOCITY FT/S DENSITY LB/FT3	.25 .25 .16 62.535 -S2 1	.17 61.673	END ZONE CROSS FLOW	= 9.7 = 7.5 = 5.8 = 40.9
VELOCITY FT/S DENSITY LB/FT3 PRESS. DROP %	.74 61.291 8.4 rsity ChE	.73 61.760 5.3	WET	= 150. = 165. E0002 P 68 9/23/3 CASE 34
SIZE 4- 18 TYPE BE	M, MULTI-	-PASS FL		TING LD SHELL SIDE Shell
TOTAL FLOW RATE	KLB/HR			.300
TEMPERATURE DENSITY			IN OUT 140.0 100.8* 4 61.2913 61.8803 62.5	0.0 105.0*

VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS	CP BTU/LB-F BTU/HR-FT-F	.9973 .3723	.6857 .9986 .3635	1.4791 1.0058 .3466	.9983 .3645
TEMP, AVG & SKIN VISCOSITY, AVG & S PRESSURE, IN & DES	KIN CP	120.4 .5637	98.2	.9480	97.3
PRESSURE DROP, TOT VELOCITY, CALC & M					10.00
FOULING RESISTANCE FILM COEFFICIENT		-F 214	.13		0010 9.77
TOTAL HEAT DUTY RE EFF TEMP DIF, DEGE OVERALL COEFF REQU CLEAN & FOULED COE	QUIRED MEGBTU/H (LMTD= 46.7,F IRED BTU/HR-F	TR '= .75,BYPAS 'T2-F	S= .93,BAE	FF=1.00)	83.95
SHELLS IN SERIES PASSES, SHELL SHELL DIAMETER IN.	1 TUBE 4	EFFECTIVE A	AREA	FT2/SHELL	7.1
BAFFLE TYPE SPACING, CENTRAL SPACING, INLET SPACING, OUTLET BAFFLE THICKNESS PAIRS OF SEALING I	IN. 4.309 IN. 4.309 IN. 4.309 IN125	BAFFLE CUT CUT DISTANG IMPINGEMEN	, PCT SHEI CE FROM CE I BAFFLE I	L I.D. ENTER, IN.	30.00 .764 NO
TUBE TYPE NO. OF TUBES/SHELI TUBE LGTH, OVERALI TUBE LGTH, EFF TUBE LAYOUT PITCH RATIO SHL NOZZ ID, IN&OU	76 FT 1.500 FT 1.436 DEG 60 1.250	TUBE PITCH TUBE OUTSI TUBE INSID TUBE SURFA	BE COUNT  DE DIAM  E DIAM  CE RATIO,	IN. IN. IN. OUT/IN	36 .3125 .250 .214 1.184
* CALCULATED ITE	rsity ChE433 he	at exchange			E0002 P 69 9/23/ 3 CASE 34
HT PARAMETERS WALL CORRECTION PRANDTL NUMBER RYNLD NO, AVG RYNLD NO, IN BUN RYNLD NO,OUT BUN FOULNG LAYER IN.	SHELL TUBE 1.041 .000 6.5 3.7 119. 1398. 76. 1667. 172. 1149.	SHELLS NOMINAL NOMINAL CROSSFLO WINDOW CO	IDE PERFORVEL,X-FLOWVEL,WINDOWW COEF E	RMANCE I FT/S I FT/S BTU/HR-FT2- BTU/HR-FT2- % OF TOTAL	F 161.2

SHELL TUBE FOU 51.83 46.30 C PCT OVER DESIGN TOT FOUL RESIST DIFF RESIST	1.82 .06 25 .000217	MAIN CH BUNDLE BAFFLE TUBE PA	ROSSFLOW TO SHELL BY TO SHELL LE	B TPASS C TAKAGE E	= 69.49 = 11.23 = 16.59
5111 1.20101			LSIDE HEAT T	RANSFER F	ACTORS
DIAMETRAL CLEAR	ANCES	TOTAL =	=(BETA)(GAMM	IA) (FIN)	= 599
BUNDLE TO SHELL	TN5000	BETA	(BAFF CUT FA	CTOR)	= .920
TUBE TO BAFFLE HOI					
BAFFLE TO SHELL					
SHELL NOZZLE DA	TA IN OUT	SHEL	L PRESSURE D	ROP, % OF	TOTAL
IIM IINDD NOG TN	2.5	TAT NIDOM			_ 0 2
HT OPP NOZ IN.	. 25	END ZOI	VE.		= 5.9
VELOCITY FT/S	.24 .25	CROSS I	FLOW		= 4.7
DENSITY LB/FT3	62.535 61.823	INLET 1	NOZZLE		= 42.0
VELOCITY FT/S DENSITY LB/FT3 NOZZ RHO*VSQ LB/F	r-s2 3 3	OUTLET	NOZZLE		= 38.0
BUND RHO*VSQ LB/F	T-S2 2 2				
TUBE NOZZLE DATA	TIIO NT A	WEIG	HT PER SHELL	T.B	
VELOCITY FT/S					150.
DENSITY LB/FT3					165.
PRESS. DROP %					
□□Washington Unive			ger experime	ent	E0002 P 70
Young model F302D			J 1		9/23/ 3
3					CASE 35
STZE 4- 18 TYPE BE	EM, MULTI-PASS F	TOW. SEGME	ENTAL BAFFLE	S. RATING	
0100 1 10 1110 D					
	•		UBE SIDE		
		HOT TU Tube	UBE SIDE	COLD S Shel	HELL SIDE 1
		HOT TU Tube SENSI	UBE SIDE IBLE LIQ	COLD S. Shel SENS	HELL SIDE l IBLE LIQ
TOTAL FLOW RATE	KLB/HR	HOT TU Tube SENS:	UBE SIDE IBLE LIQ .500	COLD S Shel SENS	HELL SIDE 1 IBLE LIQ .400
TOTAL FLOW RATE	KLB/HR	HOT TU Tube SENS:	UBE SIDE IBLE LIQ .500	COLD S Shel SENS	HELL SIDE 1 IBLE LIQ .400
TOTAL FLOW RATE TEMPERATURE	KLB/HR DEGF	HOT TUDE SENS: IN 140.0	UBE SIDE  IBLE LIQ  .500  OUT  94.3*	COLD S Shel SENS IN 40.0	HELL SIDE  1 IBLE LIQ .400 OUT 96.8*
TOTAL FLOW RATE TEMPERATURE DENSITY	KLB/HR DEGF LB/FT3	HOT TO Tube SENS:  IN 140.0 61.2913	UBE SIDE  IBLE LIQ .500 OUT 94.3* 61.9651	COLD S. Shel SENS IN 40.0 62.5352	HELL SIDE  1 IBLE LIQ .400 OUT 96.8* 61.9330
TOTAL FLOW RATE TEMPERATURE DENSITY VISCOSITY	KLB/HR DEGF LB/FT3 CP	HOT TO Tube SENS:  IN 140.0 61.2913 .4726	UBE SIDE  IBLE LIQ .500 OUT 94.3* 61.9651 .7351	COLD S. Shel SENS IN 40.0 62.5352 1.4791	HELL SIDE  1  IBLE LIQ  .400  OUT  96.8*  61.9330  .7156
TOTAL FLOW RATE  TEMPERATURE  DENSITY  VISCOSITY  SPECIFIC HEAT	KLB/HR  DEGF LB/FT3 CP BTU/LB-F	HOT TUDE SENS:  IN 140.0 61.2913 .4726 .9973	UBE SIDE  IBLE LIQ .500 OUT 94.3* 61.9651 .7351 .9991	COLD S Shel SENS  IN 40.0 62.5352 1.4791 1.0058	HELL SIDE  1  IBLE LIQ .400 OUT 96.8* 61.9330 .7156 .9989
TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND.	KLB/HR  DEGF LB/FT3 CP BTU/LB-F BTU/HR-FT-F	HOT TU Tube SENS: IN 140.0 61.2913 .4726 .9973 .3723	UBE SIDE  IBLE LIQ .500 OUT 94.3* 61.9651 .7351 .9991 .3618	COLD S Shel SENS  IN 40.0 62.5352 1.4791 1.0058 .3466	HELL SIDE  1  IBLE LIQ  .400  OUT  96.8*  61.9330  .7156  .9989  .3625
TOTAL FLOW RATE  TEMPERATURE  DENSITY  VISCOSITY  SPECIFIC HEAT	KLB/HR  DEGF LB/FT3 CP BTU/LB-F BTU/HR-FT-F	HOT TU Tube SENS: IN 140.0 61.2913 .4726 .9973 .3723	UBE SIDE  IBLE LIQ .500 OUT 94.3* 61.9651 .7351 .9991 .3618	COLD S Shel SENS  IN 40.0 62.5352 1.4791 1.0058 .3466	HELL SIDE  1  IBLE LIQ  .400  OUT  96.8*  61.9330  .7156  .9989  .3625
TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS  TEMP, AVG & SKIN	KLB/HR  DEGF  LB/FT3  CP  BTU/LB-F  BTU/HR-FT-F  LB/LBMOL  DEGF	HOT TUDE SENS:  IN 140.0 61.2913 .4726 .9973 .3723	UBE SIDE  IBLE LIQ .500 OUT 94.3* 61.9651 .7351 .9991 .3618 18.02	COLD S Shel SENS  IN 40.0 62.5352 1.4791 1.0058 .3466	HELL SIDE  1  IBLE LIQ .400 OUT 96.8* 61.9330 .7156 .9989 .3625 18.02 91.8
TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS	KLB/HR  DEGF  LB/FT3  CP  BTU/LB-F  BTU/HR-FT-F  LB/LBMOL  DEGF	HOT TUDE SENS:  IN 140.0 61.2913 .4726 .9973 .3723	UBE SIDE  IBLE LIQ .500 OUT 94.3* 61.9651 .7351 .9991 .3618 18.02	COLD S Shel SENS  IN 40.0 62.5352 1.4791 1.0058 .3466	HELL SIDE  1  IBLE LIQ .400 OUT 96.8* 61.9330 .7156 .9989 .3625 18.02 91.8
TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS  TEMP, AVG & SKIN	KLB/HR  DEGF  LB/FT3  CP  BTU/LB-F  BTU/HR-FT-F  LB/LBMOL  DEGF  SKIN CP	HOT TUDE SENS:  IN 140.0 61.2913 .4726 .9973 .3723	UBE SIDE  IBLE LIQ .500  OUT 94.3* 61.9651 .7351 .9991 .3618 18.02 92.8 .7482	COLD S Shel SENS  IN 40.0 62.5352 1.4791 1.0058 .3466  68.4 .9980	HELL SIDE  1  IBLE LIQ .400 OUT 96.8* 61.9330 .7156 .9989 .3625 18.02 91.8 .7564
TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS  TEMP, AVG & SKIN VISCOSITY, AVG & S PRESSURE, IN & DES	KLB/HR  DEGF LB/FT3 CP BTU/LB-F BTU/HR-FT-F LB/LBMOL  DEGF SKIN CP SIGN PSIA	HOT TUDE SENS:  IN 140.0 61.2913 .4726 .9973 .3723	UBE SIDE  IBLE LIQ .500  OUT 94.3* 61.9651 .7351 .9991 .3618 18.02 92.8 .7482 165.00	COLD S     Shel     SENS  IN     40.0 62.5352 1.4791 1.0058 .3466 68.4 .9980 50.00	HELL SIDE  1  IBLE LIQ .400  OUT 96.8* 61.9330 .7156 .9989 .3625 18.02 91.8 .7564 165.00
TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS  TEMP, AVG & SKIN VISCOSITY, AVG & S	KLB/HR  DEGF LB/FT3 CP BTU/LB-F BTU/HR-FT-F LB/LBMOL  DEGF SKIN CP SIGN PSIA	HOT TU Tube SENS:  IN 140.0 61.2913 .4726 .9973 .3723  117.2 .5815 50.00 .05	UBE SIDE  IBLE LIQ .500  OUT 94.3* 61.9651 .7351 .9991 .3618 18.02 92.8 .7482 165.00	COLD S     Shel     SENS  IN     40.0 62.5352 1.4791 1.0058 .3466 68.4 .9980 50.00	HELL SIDE  IBLE LIQ .400 OUT 96.8* 61.9330 .7156 .9989 .3625 18.02 91.8 .7564 165.00
TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS  TEMP, AVG & SKIN VISCOSITY, AVG & S PRESSURE, IN & DES  PRESSURE DROP, TOTAL	KLB/HR  DEGF LB/FT3 CP BTU/LB-F BTU/HR-FT-F LB/LBMOL  DEGF SKIN CP SIGN PSIA  F & ALLOWED PSI MAX ALLOWED FT/	HOT TU Tube SENS:  IN 140.0 61.2913 .4726 .9973 .3723 117.2 .5815 50.00 .05 s .49	UBE SIDE  IBLE LIQ .500  OUT 94.3* 61.9651 .7351 .9991 .3618 18.02 92.8 .7482 165.00  10.00 10.00	COLD S	HELL SIDE  I IBLE LIQ .400 OUT 96.8* 61.9330 .7156 .9989 .3625 18.02 91.8 .7564 165.00  10.00 10.00
TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS  TEMP, AVG & SKIN VISCOSITY, AVG & S PRESSURE, IN & DES	KLB/HR  DEGF LB/FT3 CP BTU/LB-F BTU/HR-FT-F LB/LBMOL  DEGF SKIN CP SIGN PSIA F & ALLOWED PSI MAX ALLOWED FT/	HOT TU  Tube SENS:  IN 140.0 61.2913 .4726 .9973 .3723 117.2 .5815 50.00 .05 S .49	UBE SIDE  IBLE LIQ .500  OUT 94.3* 61.9651 .7351 .9991 .3618 18.02 92.8 .7482 165.00  10.00 10.00	COLD S     Shel     SENS  IN     40.0 62.5352 1.4791 1.0058 .3466 68.4 .9980 50.00 .00 .06	HELL SIDE  I IBLE LIQ .400 OUT 96.8* 61.9330 .7156 .9989 .3625 18.02 91.8 .7564 165.00  10.00 10.00
TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS  TEMP, AVG & SKIN VISCOSITY, AVG & S PRESSURE, IN & DES  PRESSURE DROP, TOTAL VELOCITY, CALC & ME  FOULING RESISTANCE FILM COEFFICIENT	KLB/HR  DEGF LB/FT3 CP BTU/LB-F BTU/HR-FT-F LB/LBMOL  DEGF SKIN CP SIGN PSIA  F & ALLOWED PSI MAX ALLOWED FT/ E HR-FT2-F/B BTU/HR-FT2	HOT TU Tube SENS:  IN 140.0 61.2913 .4726 .9973 .3723 117.2 .5815 50.00 .05 S .49  TU .0 -F .22	UBE SIDE  IBLE LIQ .500  OUT 94.3* 61.9651 .7351 .9991 .3618 18.02 92.8 .7482 165.00  10.00 10.00 10.00	COLD S     Shel     SENS  IN     40.0 62.5352 1.4791 1.0058 .3466 68.4 .9980 50.00 .00 .06	HELL SIDE  IBLE LIQ .400 OUT 96.8* 61.9330 .7156 .9989 .3625 18.02 91.8 .7564 165.00  10.00 10.00 00010 87.10
TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS  TEMP, AVG & SKIN VISCOSITY, AVG & S PRESSURE, IN & DES  PRESSURE DROP, TOTAL FOULING RESISTANCE FILM COEFFICIENT  TOTAL HEAT DUTY RE	KLB/HR  DEGF LB/FT3 CP BTU/LB-F BTU/HR-FT-F LB/LBMOL  DEGF SKIN CP SIGN PSIA  F & ALLOWED PSI MAX ALLOWED FT/ E HR-FT2-F/B BTU/HR-FT2	HOT TU Tube SENS:  IN 140.0 61.2913 .4726 .9973 .3723  117.2 .5815 50.00  .05 S .49  TU .0 -F .23	UBE SIDE  IBLE LIQ .500 OUT 94.3* 61.9651 .7351 .9991 .3618 18.02 92.8 .7482 165.00 10.00 10.00 10.00	COLD S	HELL SIDE  IBLE LIQ .400 OUT 96.8* 61.9330 .7156 .9989 .3625 18.02 91.8 .7564 165.00  10.00 10.00 10.00 00010 87.10
TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS  TEMP, AVG & SKIN VISCOSITY, AVG & S PRESSURE, IN & DES  PRESSURE DROP, TOTAL VELOCITY, CALC & ME  FOULING RESISTANCE FILM COEFFICIENT	KLB/HR  DEGF LB/FT3 CP BTU/LB-F BTU/HR-FT-F LB/LBMOL  DEGF SKIN CP SIGN PSIA  F & ALLOWED PSI MAX ALLOWED FT/ E HR-FT2-F/B BTU/HR-FT2	HOT TU Tube SENS:  IN 140.0 61.2913 .4726 .9973 .3723  117.2 .5815 50.00  .05 S .49  TU .0 -F .2: -R -R -78,BYP2	UBE SIDE  IBLE LIQ .500 OUT 94.3* 61.9651 .7351 .9991 .3618 18.02 92.8 .7482 165.00 10.00 10.00 10.00	COLD S	HELL SIDE  IBLE LIQ .400 OUT 96.8* 61.9330 .7156 .9989 .3625 18.02 91.8 .7564 165.00  10.00 10.00 10.00 00010 87.10

		che433b(40).OUT	
CLEAN & FOULED COEFF E	BTU/HR-FT2	-F 92.53	90.60
SHELLS IN SERIES 1 PARALI	LEL 1 T	OTAL EFF AREA FT2	7.1
PASSES, SHELL 1 TUBE	4 E	FFECTIVE AREA FT2/SHELL	7.1
SHELL DIAMETER IN.	3.820 T	EMA SHELL TYPE E ; REAR HEAD	FXTS
		DOGG DAGGEG DED GUELL DAGG	4
BAFFLE TIPE HORZ SEC	MENTL C	ROSS PASSES PER SHELL PASS	30 00
SPACING, CENTRAL IN.	4.309 B	AFFLE CUT, PCT SHELL I.D.	764
SPACING, OUTLET IN.	4.309 C	UT DISTANCE FROM CENTER, IN.	. 704
BAFFLE THICKNESS IN	125 T	MPINGEMENT BAFFLE INCLUDED	NO
PAIRS OF SEALING DEVICES	1 T	UBESHEET BLANK AREA, %	0
TUBE TYPE	PLAIN M	ATERIAL ELECTROLYTIC CO ST MAX TUBE COUNT UBE PITCH IN. UBE OUTSIDE DIAM IN.	OPPER
NO. OF TUBES/SHELL	76 E	ST MAX TUBE COUNT	36
TUBE LGTH, OVERALL FT	1.500 T	UBE PITCH IN.	.3125
,			. –
TUBE LAYOUT DEG	60 T	UBE INSIDE DIAM IN. UBE SURFACE RATIO, OUT/IN	.214
PITCH RATIO	1.250 T	UBE SURFACE RATIO, OUT/IN	1.184
SHL NOZZ ID, IN&OUT 1.0	1.0 T	UBE NOZZ ID, IN&OUT IN8	.8
* CALCULATED ITEMHEAT			
	nE433 heat	exchanger experiment E00	
Young model F302DY4P			/23/ 3
	ш л Б		ASE 35
	T A R	Y RESULTS	
HT DADAMETEDS SHETT	TIBE	SHELLSIDE DEBEODMANCE	
WALL CORRECTION 1 040	000	SHELLSIDE PERFORMANCE NOMINAL VEL,X-FLOW FT/S	0.5
PRANDTL NUMBER 6.8	3 8	NOMINAL VEL, WINDOW FT/S	.10
RYNLD NO. AVG 151.	1355.	CROSSFLOW COEF BTU/HR-FT2-F	
RYNLD NO, IN BUN 102.	1667.	WINDOW COEF BTU/HR-FT2-F	188.9
	4 0 = 0		
FOULNG LAYER IN0014			
	.0014	SHELLSIDE FLOW, % OF TOTAL	
	.0014	SHELLSIDE FLOW, % OF TOTAL HEAT TRANSFER X-FLOW	81.40
	.0014	HEAI IRANSPER A-PLOW	
	.0014	TUBE TO BAFFLE LEAKAGE A =	
THERMAL RESISTANCE, % OF T SHELL TUBE FOULING ME 47.88 50.09 1.96	.0014 COTAL CTAL .07	TUBE TO BAFFLE LEAKAGE A =  MAIN CROSSFLOW B =  BUNDLE TO SHELL BYPASS C =	2.91 68.54 12.27
THERMAL RESISTANCE, % OF T SHELL TUBE FOULING ME 47.88 50.09 1.96	.0014 COTAL CTAL .07	TUBE TO BAFFLE LEAKAGE A =  MAIN CROSSFLOW B =  BUNDLE TO SHELL BYPASS C =	2.91 68.54 12.27
THERMAL RESISTANCE, % OF T SHELL TUBE FOULING ME 47.88 50.09 1.96 PCT OVER DESIGN TOT FOUL RESIST	.0014 COTAL ETAL .07 .03	TUBE TO BAFFLE LEAKAGE A = MAIN CROSSFLOW B =	2.91 68.54 12.27
THERMAL RESISTANCE, % OF T SHELL TUBE FOULING ME 47.88 50.09 1.96	.0014 COTAL ETAL .07 .03	TUBE TO BAFFLE LEAKAGE A =  MAIN CROSSFLOW B =  BUNDLE TO SHELL BYPASS C =  BAFFLE TO SHELL LEAKAGE E =  TUBE PASSLANE BYPASS F =	2.91 68.54 12.27 16.28
THERMAL RESISTANCE, % OF TO SHELL TUBE FOULING ME 47.88 50.09 1.96 PCT OVER DESIGN TOT FOUL RESIST DIFF RESIST	.0014 COTAL CTAL .07 .03 000217 000004	TUBE TO BAFFLE LEAKAGE A =  MAIN CROSSFLOW B =  BUNDLE TO SHELL BYPASS C =  BAFFLE TO SHELL LEAKAGE E =  TUBE PASSLANE BYPASS F =  SHELLSIDE HEAT TRANSFER FACTO	2.91 68.54 12.27 16.28 .00
THERMAL RESISTANCE, % OF TO SHELL TUBE FOULING ME 47.88 50.09 1.96 PCT OVER DESIGN TOT FOUL RESIST DIFF RESIST	.0014 COTAL CTAL .07 .03 000217 000004	TUBE TO BAFFLE LEAKAGE A =  MAIN CROSSFLOW B =  BUNDLE TO SHELL BYPASS C =  BAFFLE TO SHELL LEAKAGE E =  TUBE PASSLANE BYPASS F =  SHELLSIDE HEAT TRANSFER FACTO	2.91 68.54 12.27 16.28 .00
THERMAL RESISTANCE, % OF TO SHELL TUBE FOULING ME 47.88 50.09 1.96  PCT OVER DESIGN TOT FOUL RESIST  DIAMETRAL CLEARANCES BUNDLE TO SHELL IN.	.0014 COTAL ETAL .07 .03 .000217 .000004	TUBE TO BAFFLE LEAKAGE A =  MAIN CROSSFLOW B =  BUNDLE TO SHELL BYPASS C =  BAFFLE TO SHELL LEAKAGE E =  TUBE PASSLANE BYPASS F =  SHELLSIDE HEAT TRANSFER FACTO  TOTAL = (BETA) (GAMMA) (FIN) =  BETA (BAFF CUT FACTOR) =	2.91 68.54 12.27 16.28 .00 DRS .615 .920
THERMAL RESISTANCE, % OF TO SHELL TUBE FOULING ME 47.88 50.09 1.96  PCT OVER DESIGN  TOT FOUL RESIST  DIAMETRAL CLEARANCES  BUNDLE TO SHELL IN  TUBE TO BAFFLE HOLE IN.	.0014 COTAL ETAL .07 .03 .000217 .000004	TUBE TO BAFFLE LEAKAGE A =  MAIN CROSSFLOW B =  BUNDLE TO SHELL BYPASS C =  BAFFLE TO SHELL LEAKAGE E =  TUBE PASSLANE BYPASS F =  SHELLSIDE HEAT TRANSFER FACTO  TOTAL = (BETA) (GAMMA) (FIN) =  BETA (BAFF CUT FACTOR) =  GAMMA (TUBE ROW ENTRY EFCT) =	2.91 68.54 12.27 16.28 .00 DRS .615 .920 .669
THERMAL RESISTANCE, % OF TO SHELL TUBE FOULING ME 47.88 50.09 1.96  PCT OVER DESIGN  TOT FOUL RESIST  DIAMETRAL CLEARANCES  BUNDLE TO SHELL IN  TUBE TO BAFFLE HOLE IN.	.0014 COTAL ETAL .07 .03 .000217 .000004	TUBE TO BAFFLE LEAKAGE A =  MAIN CROSSFLOW B =  BUNDLE TO SHELL BYPASS C =  BAFFLE TO SHELL LEAKAGE E =  TUBE PASSLANE BYPASS F =  SHELLSIDE HEAT TRANSFER FACTO  TOTAL = (BETA) (GAMMA) (FIN) =  BETA (BAFF CUT FACTOR) =	2.91 68.54 12.27 16.28 .00 DRS .615 .920 .669
THERMAL RESISTANCE, % OF TO SHELL TUBE FOULING ME 47.88 50.09 1.96 PCT OVER DESIGN TOT FOUL RESIST DIAMETRAL CLEARANCES BUNDLE TO SHELL IN. TUBE TO BAFFLE HOLE IN. BAFFLE TO SHELL IN.	.0014 COTAL CTAL .07 .03 .000217 .000004 .5000 .0284 .1000	TUBE TO BAFFLE LEAKAGE A =  MAIN CROSSFLOW B =  BUNDLE TO SHELL BYPASS C =  BAFFLE TO SHELL LEAKAGE E =  TUBE PASSLANE BYPASS F =  SHELLSIDE HEAT TRANSFER FACTO  TOTAL = (BETA) (GAMMA) (FIN) =  BETA (BAFF CUT FACTOR) =  GAMMA (TUBE ROW ENTRY EFCT) =  END (HT LOSS IN END ZONE) =	2.91 68.54 12.27 16.28 .00 ORS .615 .920 .669 .994
THERMAL RESISTANCE, % OF TO SHELL TUBE FOULING ME 47.88 50.09 1.96  PCT OVER DESIGN  TOT FOUL RESIST  DIAMETRAL CLEARANCES  BUNDLE TO SHELL IN.  TUBE TO BAFFLE HOLE IN.  BAFFLE TO SHELL IN.  SHELL NOZZLE DATA IN	.0014 COTAL CTAL .07 .03 .000217 .000004 .5000 .0284 .1000	TUBE TO BAFFLE LEAKAGE A =  MAIN CROSSFLOW B =  BUNDLE TO SHELL BYPASS C =  BAFFLE TO SHELL LEAKAGE E =  TUBE PASSLANE BYPASS F =  SHELLSIDE HEAT TRANSFER FACTO  TOTAL = (BETA) (GAMMA) (FIN) =  BETA (BAFF CUT FACTOR) =  GAMMA (TUBE ROW ENTRY EFCT) =  END (HT LOSS IN END ZONE) =  SHELL PRESSURE DROP, % OF TOTAL	2.91 68.54 12.27 16.28 .00 ORS .615 .920 .669 .994
THERMAL RESISTANCE, % OF TO SHELL TUBE FOULING ME 47.88 50.09 1.96  PCT OVER DESIGN  TOT FOUL RESIST  DIFF RESIST  DIAMETRAL CLEARANCES  BUNDLE TO SHELL IN.  TUBE TO BAFFLE HOLE IN.  BAFFLE TO SHELL IN.  SHELL NOZZLE DATA IN HT UNDR NOZ IN25	.0014 COTAL CTAL .07 .03 .000217 .000004 .5000 .0284 .1000	TUBE TO BAFFLE LEAKAGE A =  MAIN CROSSFLOW B =  BUNDLE TO SHELL BYPASS C =  BAFFLE TO SHELL LEAKAGE E =  TUBE PASSLANE BYPASS F =  SHELLSIDE HEAT TRANSFER FACTO  TOTAL = (BETA) (GAMMA) (FIN) =  BETA (BAFF CUT FACTOR) =  GAMMA (TUBE ROW ENTRY EFCT) =  END (HT LOSS IN END ZONE) =  SHELL PRESSURE DROP, % OF TOTAL  WINDOW =	2.91 68.54 12.27 16.28 .00 ORS .615 .920 .669 .994
THERMAL RESISTANCE, % OF TO SHELL TUBE FOULING ME 47.88 50.09 1.96 PCT OVER DESIGN TOT FOUL RESIST DIFF RESIST DIAMETRAL CLEARANCES BUNDLE TO SHELL IN. TUBE TO BAFFLE HOLE IN. BAFFLE TO SHELL IN.  SHELL NOZZLE DATA IN HT UNDR NOZ IN25 HT OPP NOZ IN25	.0014 COTAL ETAL .07 .03 .000217 .000004 .5000 .0284 .1000	TUBE TO BAFFLE LEAKAGE A =  MAIN CROSSFLOW B =  BUNDLE TO SHELL BYPASS C =  BAFFLE TO SHELL LEAKAGE E =  TUBE PASSLANE BYPASS F =  SHELLSIDE HEAT TRANSFER FACTO  TOTAL = (BETA) (GAMMA) (FIN) =  BETA (BAFF CUT FACTOR) =  GAMMA (TUBE ROW ENTRY EFCT) =  END (HT LOSS IN END ZONE) =  SHELL PRESSURE DROP, % OF TOTO  WINDOW =  END ZONE =	2.91 68.54 12.27 16.28 .00 ORS .615 .920 .669 .994
THERMAL RESISTANCE, % OF TO SHELL TUBE FOULING ME 47.88 50.09 1.96  PCT OVER DESIGN TOT FOUL RESIST DIFF RESIST  DIAMETRAL CLEARANCES BUNDLE TO SHELL IN. TUBE TO BAFFLE HOLE IN. BAFFLE TO SHELL IN. SHELL NOZZLE DATA HT UNDR NOZ IN25 HT OPP NOZ IN25 VELOCITY FT/S .33	.0014 COTAL ETAL .07 .03 .000217 .000004 .5000 .0284 .1000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .0000 .	TUBE TO BAFFLE LEAKAGE A =  MAIN CROSSFLOW B =  BUNDLE TO SHELL BYPASS C =  BAFFLE TO SHELL LEAKAGE E =  TUBE PASSLANE BYPASS F =  SHELLSIDE HEAT TRANSFER FACTO  TOTAL = (BETA) (GAMMA) (FIN) =  BETA (BAFF CUT FACTOR) =  GAMMA (TUBE ROW ENTRY EFCT) =  END (HT LOSS IN END ZONE) =  SHELL PRESSURE DROP, % OF TOTAL  WINDOW =  END ZONE =  CROSS FLOW =	2.91 68.54 12.27 16.28 .00 ORS .615 .920 .669 .994
THERMAL RESISTANCE, % OF TO SHELL TUBE FOULING ME 47.88 50.09 1.96 PCT OVER DESIGN TOT FOUL RESIST DIFF RESIST DIAMETRAL CLEARANCES BUNDLE TO SHELL IN. TUBE TO BAFFLE HOLE IN. BAFFLE TO SHELL IN.  SHELL NOZZLE DATA IN HT UNDR NOZ IN25 HT OPP NOZ IN25	.0014 COTAL CTAL .07 .03 .000217 .000004  .5000 .0284 .1000  .1000  .1000  .1000  .1000	TUBE TO BAFFLE LEAKAGE A =  MAIN CROSSFLOW B =  BUNDLE TO SHELL BYPASS C =  BAFFLE TO SHELL LEAKAGE E =  TUBE PASSLANE BYPASS F =  SHELLSIDE HEAT TRANSFER FACTO  TOTAL = (BETA) (GAMMA) (FIN) =  BETA (BAFF CUT FACTOR) =  GAMMA (TUBE ROW ENTRY EFCT) =  END (HT LOSS IN END ZONE) =  SHELL PRESSURE DROP, % OF TOTO  WINDOW =  END ZONE =  CROSS FLOW =  INLET NOZZLE =	2.91 68.54 12.27 16.28 .00 ORS .615 .920 .669 .994 FAL 9.1 5.2 4.3 42.4

che433b(40).OUT
BUND RHO*VSQ LB/FT-S2 4 4

TUBE NOZZLE DATA VELOCITY FT/S DENSITY LB/FT3	.74 61.291 61.	.73 965	DRY		L, LB = =	
PRESS. DROP %  Unive Young model F302DY	rsity ChE433		exchang	er experim		E0002 P 72 9/23/ 3 CASE 36
SIZE 4- 18 TYPE BE	M, MULTI-PAS			NTAL BAFFLI BE SIDE	ES, RATING	
			SENSI	BLE LIQ	SENSI	BLE LIQ
TOTAL FLOW RATE	KLB/HR			.500		
				OUT		
TEMPERATURE						
DENSITY						
VISCOSITY SPECIFIC HEAT						
THERMAL COND.						
MOLAR MASS				18.02		18.02
MOLIAN MASS	пр/ прыоп			10.02		
TEMP, AVG & SKIN	DEGE					
VISCOSITY, AVG & ST						
PRESSURE, IN & DES				165.00		
,						
PRESSURE DROP, TOT	& ALLOWED	PSI	.05	10.00	.01	10.00
VELOCITY, CALC & M						
FOULING RESISTANCE	HR-FT2-	F/BTU	.0	0010	. (	00010
FILM COEFFICIENT	BTU/HR-	FT2-F	21	4.05	21	2.31
TOTAL HEAT DUTY RE						.025248
EFF TEMP DIF, DEGF				SS= .94,BA	FF=1.00)	
OVERALL COEFF REQU						95.84
CLEAN & FOULED COE	FF BTU/H	R-FT2-	-F	98.2	8	96.04
0	1	1			770	7 1
SHELLS IN SERIES						
PASSES, SHELL SHELL DIAMETER IN.						
SUPPL DIWMPIPK IN.	3.02	0 11	THA SUEL		, KLAK HE	TAD FAIS
BAFFLE TYPE H	ORZ SEGMENT	'I. CE	ROSS PAS	SES PER SHI	ELL PASS	4
SPACING, CENTRAL						
SPACING, INLET						
SPACING, OUTLET						
BAFFLE THICKNESS			4PINGEME	NT BAFFLE	INCLUDED	NO
PAIRS OF SEALING D						.0
TUBE TYPE	PLAI					COPPER
NO. OF TUBES/SHELL	7	6 ES	ST MAX T	UBE COUNT		36
TUBE LGTH, OVERALL						.3125
TUBE LGTH, EFF						
TUBE LAYOUT	DEG 6	UT 0	JBE INSI	DE DIAM	IN.	.214

		UBE SURFACE RATIO, OUT/IN UBE NOZZ ID, IN&OUT IN.	
* CALCULATED ITEMH \( \subseteq \text{Washington Universit} \) Young model F302DY4P		DDE = 8 exchanger experiment	E0002 P 73 9/23/ 3 CASE 36
S U P P L E M E	N T A R	Y RESULTS	
WALL CORRECTION 1.0 PRANDTL NUMBER 7 RYNLD NO, AVG 18 RYNLD NO, IN BUN 12 RYNLD NO, OUT BUN 24	38 .000 .1 3.9 1. 1323. 7. 1667. 5. 1014.	SHELLSIDE PERFORMANCE NOMINAL VEL,X-FLOW FT/S NOMINAL VEL,WINDOW FT/S CROSSFLOW COEF BTU/HR-FT WINDOW COEF BTU/HR-FT	.13 22-F 213.2 22-F 214.5
THERMAL RESISTANCE, % SHELL TUBE FOULING 44.73 53.12 2.08 PCT OVER DESIGN	OF TOTAL METAL .07 .21 .000217	SHELLSIDE FLOW, % OF TOT HEAT TRANSFER X-FLOW TUBE TO BAFFLE LEAKAGE MAIN CROSSFLOW BUNDLE TO SHELL BYPASS BAFFLE TO SHELL LEAKAGE TUBE PASSLANE BYPASS	81.48 A = 3.10 B = 67.74 C = 13.12 E = 16.04
TUBE TO BAFFLE HOLE I	N5000 N0284	SHELLSIDE HEAT TRANSFER TOTAL = (BETA) (GAMMA) (FIN) BETA (BAFF CUT FACTOR) GAMMA (TUBE ROW ENTRY EFCT END (HT LOSS IN END ZONE	= .631 = .920 () = .686
	.25 .25 .41 .41 .535 62.015 10 10	SHELL PRESSURE DROP, % CWINDOW END ZONE CROSS FLOW INLET NOZZLE OUTLET NOZZLE	
TUBE NOZZLE DATA  VELOCITY FT/S  DENSITY LB/FT3 61  PRESS. DROP %  DWashington Universit  Young model F302DY4P	IN OUT .74 .73 .291 62.028 8.1 5.1 y ChE433 heat		190.
		Tube She	G SHELL SIDE 11 SIBLE LIQ
TOTAL FLOW RATE KLB  TEMPERATURE DEG  DENSITY LB/  VISCOSITY CP	F	.500 IN OUT IN 140.0 85.5* 40.0 1.2913 62.0751 62.5352 .4726 .8119 1.4791	62.0785

SPECIFIC HEAT THERMAL COND. MOLAR MASS	BTU/LB-F BTU/HR-FT-F	.3723	.9999		.3595
TEMP, AVG & SKIN VISCOSITY, AVG & SK PRESSURE, IN & DESI	IN CP	112.7 .6072	84.8 .8181	62.6 1.0759	83.7 .8289
PRESSURE DROP, TOT VELOCITY, CALC & MA					
FOULING RESISTANCE FILM COEFFICIENT	BTU/HR-FT2	-F 21	3.96		
TOTAL HEAT DUTY REQ EFF TEMP DIF, DEGF OVERALL COEFF REQUI CLEAN & FOULED COEF	(LMTD= 50.0,F=RED BTU/HR-F=	R = .81,BYPA T2-F	SS= .94,BA	AFF=1.00)	100.44
SHELLS IN SERIES 1 PASSES, SHELL 1 SHELL DIAMETER IN.	TUBE 4	EFFECTIVE	AREA	FT2/SHELL	7.1
BAFFLE TYPE HO SPACING, CENTRAL I SPACING, INLET I SPACING, OUTLET I BAFFLE THICKNESS I	N. 4.309 N. 4.309 N. 4.309	BAFFLE CU CUT DISTA	T, PCT SHI	ELL I.D. CENTER, IN.	30.00 .764
PAIRS OF SEALING DE	VICES 1				
NO. OF TUBES/SHELL TUBE LGTH, OVERALL TUBE LGTH, EFF TUBE LAYOUT PITCH RATIO SHL NOZZ ID, IN&OUT	76 FT 1.500 FT 1.436 DEG 60 1.250	EST MAX TOTUBE PITCOUTS TUBE OUTS TUBE INSI TUBE SURF	UBE COUNT H IDE DIAM DE DIAM ACE RATIO,	IN. IN. IN. OUT/IN	36 .3125 .250 .214 1.184
* CALCULATED ITEM Univer Young model F302DY4	sity ChE433 he		er experin	nent	E0002 P 75 9/23/ 3 CASE 37
S U P P L E M	E N T A	R Y R	E S U	L T S	
HT PARAMETERS WALL CORRECTION PRANDTL NUMBER RYNLD NO, AVG RYNLD NO, IN BUN RYNLD NO,OUT BUN	1.037 .000 7.4 4.0 210. 1298. 153. 1667.	NOMINAL NOMINAL CROSSFL WINDOW	VEL, WINDO	OW FT/S	.15 -F 237.1
FOULNG LAYER IN. THERMAL RESISTANCE,	.0014 .0014	SHELL HEAT TR	ANSFER X-1	, % OF TOTAI FLOW EAKAGE A	81.56

SHELL TUBE FOU 42.10 55.65 2 PCT OVER DESIGN TOT FOUL RESIST DIFF RESIST  DIAMETRAL CLEARA BUNDLE TO SHELL	.18 .07 .13 .000217 .000013	BUNDLE TO BAFFLE TO TUBE PASS SHELLSI TOTAL = (B	SHELL LEAKAGE LANE BYPASS  DE HEAT TRANSFE ETA) (GAMMA) (FIN	C = 13.86 $E = 15.84$ $F = .00$ CR FACTORS $E = .647$
TUBE TO BAFFLE HOL BAFFLE TO SHELL				
SHELL NOZZLE DATA HT UNDR NOZ IN. HT OPP NOZ IN. VELOCITY FT/S DENSITY LB/FT3 NOZZ RHO*VSQ LB/FT BUND RHO*VSQ LB/FT	.25 .49 .49 62.535 62.079 -82 14 15	WINDOW END ZONE CROSS FLO INLET NOZ	W ZLE	= 8.8 = 4.5 = 3.8 = 42.7
TUBE NOZZLE DATA VELOCITY FT/S DENSITY LB/FT3 PRESS. DROP %  UWashington Unive Young model F302DY	61.291 62.075 8.0 5.0 rsity ChE433 heat	DRY WET	experiment	= 150. = 165. E0002 P 76 9/23/3
SIZE 4- 18 TYPE BE		HOT TUBE	AL BAFFLES, RAT SIDE COI	D SHELL SIDE
TOTAL FLOW RATE	KLB/HR	SENSIBL .5	E LIQ S	SENSIBLE LIQ .700
TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS	DEGF LB/FT3 6 CP BTU/LB-F	140.0 1.2913 6 .4726 .9973	82.3* 40 2.1131 62.53 .8425 1.47 1.0002 1.00	81.0* 852 62.1282 891 .8554 958 1.0003
TEMP, AVG & SKIN VISCOSITY, AVG & S PRESSURE, IN & DES	KIN CP	.6168		.8588
PRESSURE DROP, TOT VELOCITY, CALC & M				
FOULING RESISTANCE FILM COEFFICIENT		213.	85	.00010 259.06
TOTAL HEAT DUTY RE EFF TEMP DIF, DEGF OVERALL COEFF REQU CLEAN & FOULED COE	QUIRED MEGBTU/HR (LMTD= 50.2,F= IRED BTU/HR-FT2	.82,BYPASS -F	= .94,BAFF=1.00	.028789 38.6 104.52 104.42

SHELLS IN SERIES 1 PARALLEL 1	TOTAL EFF AREA FT2 7.1
PASSES, SHELL 1 TUBE 4	EFFECTIVE AREA FT2/SHELL 7.1
	TEMA SHELL TYPE E ; REAR HEAD FXTS
	,
BAFFLE TYPE HORZ SEGMENTL	CROSS PASSES PER SHELL PASS 4
SPACING, CENTRAL IN. 4.309	BAFFLE CUT, PCT SHELL I.D. 30.00
SPACING, INLET IN. 4.309	CUT DISTANCE FROM CENTER, IN764
SPACING, OUTLET IN. 4.309	
BAFFLE THICKNESS IN125	IMPINGEMENT BAFFLE INCLUDED NO
PAIRS OF SEALING DEVICES 1	TUBESHEET BLANK AREA, % .0
TUBE TYPE PLAIN NO. OF TUBES/SHELL 76	MATERIAL ELECTROLYTIC COPPER
NO. OF TUBES/SHELL 76	EST MAX TUBE COUNT 36 TUBE PITCH IN3125
TUBE LGTH, OVERALL FT 1.500	TUBE PITCH IN3125
TUBE LGTH, EFF FT 1.436	TUBE OUTSIDE DIAM IN250
TUBE LAYOUT DEG 60	TUBE INSIDE DIAM IN214
	TUBE SURFACE RATIO, OUT/IN 1.184
	TUBE NOZZ ID, IN&OUT IN8 .8
5HE NOZZ 1D, 1NGOOT 1.0 1.0	TODE NOTE ID, INCOOL IN
* CALCULATED ITEMHEAT BALANCE	CODE - 0
	at exchanger experiment E0002 P 77
Young model F302DY4P	9/23/ 3
	CASE 38
SUPPLEMENTA	R Y R E S U L T S
HT PARAMETERS SHELL TUBE	
WALL CORRECTION 1.036 .000	NOMINAL VEL, X-FLOW FT/S .09
PRANDTL NUMBER 7.6 4.1	
	CROSSFLOW COEF BTU/HR-FT2-F 260.1
RYNLD NO, IN BUN 178. 1667.	
RYNLD NO, OUT BUN 308. 935.	
FOULNG LAYER IN0014 .0014	
FOOLING LAILEN IN:	
	HEAT TRANSFER X-FLOW 81.56
	TUBE TO BAFFLE LEAKAGE A = 3.41
	MAIN CROSSFLOW $B = 66.34$
	BUNDLE TO SHELL BYPASS $C = 14.54$
	BAFFLE TO SHELL LEAKAGE E = 15.72
TOT FOUL RESIST .000217	TUBE PASSLANE BYPASS $F = .00$
DIFF RESIST000009	
	SHELLSIDE HEAT TRANSFER FACTORS
DIAMETRAL CLEARANCES	TOTAL = (BETA) (GAMMA) (FIN) = .661
	BETA (BAFF CUT FACTOR) = .920
	GAMMA (TUBE ROW ENTRY EFCT) = .719
	END (HT LOSS IN END ZONE) = .994
EIII IO OIIIIII IIV 1000	THE /III TOOK IN THE MONTH - 1994
CUEIT MO77IE DAMA TM OTIM	CHELL DDECCUDE DDOD 6 OF MOMY
	SHELL PRESSURE DROP, % OF TOTAL
HT UNDR NOZ IN25	
HT OPP NOZ IN25	
VELOCITY FT/S .57 .57	
DENSITY LB/FT3 62.535 62.128	
NOZZ RHO*VSQ LB/FT-S2 20 20	
BUND RHO*VSQ LB/FT-S2 13 13	

VELOCITY FT/S DENSITY LB/FT3 PRESS. DROP %		13 WET	HT PER SHEL	L, LB = =	150. 165.
□□Washington Unive Young model F302DY	rsity ChE433		ger experim		E0002 P 78 9/23/ 3 CASE 39
SIZE 4- 18 TYPE BE	M, MULTI-PASS	FLOW, SEGM	ENTAL BAFFL	ES, RATING	
		HOT T	UBE SIDE	COLD S	HELL SIDE
		Tube	IBLE LIQ	Shel	1
		SENS	IBLE LIQ	SENS	IBLE LIQ
TOTAL FLOW RATE TEMPERATURE DENSITY	KLB/HR		.500		.800
		IN	OUT	IN	OUT
TEMPERATURE	DEGF	140.0	79.7*	40.0	77.5*
DENSITY	LB/FT3	61.2913	62.1434	62.5352	62.168/
VISCOSITY SPECIFIC HEAT	CP	.4/26	.8688 1.0004	1.4/91	.8920
SPECIFIC HEAT	BTU/LB-F	.99/3	1.0004	1.0058	1.000/
THERMAL COND.	BTU/HR-FT-F	5 / / .5	.3580		1000
MOLAR MASS			18.02		18.02
TEMP, AVG & SKIN VISCOSITY, AVG & S	DECE	100 0	70.2	50 0	70 1
MICCOCITY AND C	KIN CD	6249	9727	1 1325	9957
PRESSURE, IN & DES	TON DOTA	50 00	165 00	50 00	165 00
INESSONE, IN & DES	IGN ISIA	30.00	103.00	30.00	103.00
PRESSURE DROP, TOT	& ALLOWED P	SI .05	10.00	.01	10.00
VELOCITY, CALC & M	AX ALLOWED F	T/S .49	10.00	.12	10.00
,		, -			
FOULING RESISTANCE	HR-FT2-F	/BTU .	00010		00010
FOULING RESISTANCE FILM COEFFICIENT	BTU/HR-F	T2-F 2	13.77	2	00010 81.36
FILM COEFFICIENT	BTU/HR-F	T2-F 2	13.77	2	
FILM COEFFICIENT TOTAL HEAT DUTY RE	BTU/HR-F  QUIRED MEGBTU	T2-F 2 / /HR	13.77	2	.030088
FILM COEFFICIENT  TOTAL HEAT DUTY RE  EFF TEMP DIF, DEGF	BTU/HR-F QUIRED MEGBTU (LMTD= 50.2	T2-F 2 /HR ,F= .82,BYP.	13.77	2	.030088 .39.1
TOTAL HEAT DUTY RE EFF TEMP DIF, DEGF OVERALL COEFF REOU	BTU/HR-F QUIRED MEGBTU (LMTD= 50.2 IRED BTU/HR	T2-F 2 /HR ,F= .82,BYP	13.77  ASS= .94,BA	2  FF=1.00)	81.36 .030088 39.1 107.79
FILM COEFFICIENT  TOTAL HEAT DUTY RE  EFF TEMP DIF, DEGF	BTU/HR-F QUIRED MEGBTU (LMTD= 50.2 IRED BTU/HR	T2-F 2 /HR ,F= .82,BYP	13.77  ASS= .94,BA	2  FF=1.00)	.030088 .39.1
TOTAL HEAT DUTY RE EFF TEMP DIF, DEGF OVERALL COEFF REQUIRED COE	BTU/HR-FQUIRED MEGBTU (LMTD= 50.2 IRED BTU/HR FF BTU/HR	T2-F 2 /HR ,F= .82,BYPFT2-F -FT2-F	13.77  ASS= .94,BA 110.7	2 FF=1.00) 9	81.36 .030088 39.1 107.79 107.80
TOTAL HEAT DUTY RE EFF TEMP DIF, DEGF OVERALL COEFF REQU CLEAN & FOULED COE SHELLS IN SERIES	BTU/HR-F QUIRED MEGBTU (LMTD= 50.2 IRED BTU/HR FF BTU/HR 1 PARALLEL 1	T2-F 2 /HR ,F= .82,BYP -FT2-F -FT2-F TOTAL EF	13.77  ASS= .94,BA 110.7 F AREA	2  FF=1.00) 9 FT2	81.36 .030088 39.1 107.79 107.80
FILM COEFFICIENT  TOTAL HEAT DUTY RE EFF TEMP DIF, DEGF OVERALL COEFF REQU CLEAN & FOULED COE  SHELLS IN SERIES PASSES, SHELL	BTU/HR-F QUIRED MEGBTU (LMTD= 50.2 IRED BTU/HR FF BTU/HR 1 PARALLEL 1 1 TUBE 4	T2-F 2	13.77  ASS= .94,BA 110.7 F AREA E AREA	2 FF=1.00) 9 FT2 FT2/SHELL	81.36 .030088 39.1 107.79 107.80 7.1 7.1
TOTAL HEAT DUTY RE EFF TEMP DIF, DEGF OVERALL COEFF REQU CLEAN & FOULED COE SHELLS IN SERIES	BTU/HR-F QUIRED MEGBTU (LMTD= 50.2 IRED BTU/HR FF BTU/HR 1 PARALLEL 1 1 TUBE 4	T2-F 2	13.77  ASS= .94,BA 110.7 F AREA E AREA	2 FF=1.00) 9 FT2 FT2/SHELL	81.36 .030088 39.1 107.79 107.80 7.1 7.1
TOTAL HEAT DUTY RE EFF TEMP DIF, DEGF OVERALL COEFF REQU CLEAN & FOULED COE SHELLS IN SERIES PASSES, SHELL SHELL DIAMETER IN.	BTU/HR-F QUIRED MEGBTU (LMTD= 50.2 IRED BTU/HR FF BTU/HR 1 PARALLEL 1 1 TUBE 4 3.820	T2-F 2 /HR ,F= .82,BYPFT2-F -FT2-F TOTAL EF EFFECTIVE TEMA SHE	13.77 	2 FF=1.00) 9 FT2 FT2/SHELL ; REAR H	81.36 .030088 39.1 107.79 107.80 7.1 7.1 EAD FXTS
TOTAL HEAT DUTY RE EFF TEMP DIF, DEGF OVERALL COEFF REQU CLEAN & FOULED COE SHELLS IN SERIES PASSES, SHELL SHELL DIAMETER IN. BAFFLE TYPE	BTU/HR-FQUIRED MEGBTU (LMTD= 50.2 IRED BTU/HR FF BTU/HR 1 PARALLEL 1 1 TUBE 4 3.820 ORZ SEGMENTL	T2-F 2 /HR ,F= .82,BYPFT2-F -FT2-F  TOTAL EF EFFECTIVE TEMA SHE  CROSS PA	13.77 ASS= .94,BA 110.7 F AREA E AREA LL TYPE E SSES PER SH	2 FF=1.00) 9 FT2 FT2/SHELL ; REAR H	81.36 .030088 39.1 107.79 107.80 7.1 7.1 EAD FXTS
TOTAL HEAT DUTY RE EFF TEMP DIF, DEGF OVERALL COEFF REQU CLEAN & FOULED COE SHELLS IN SERIES PASSES, SHELL SHELL DIAMETER IN. BAFFLE TYPE SPACING, CENTRAL	BTU/HR-FQUIRED MEGBTU (LMTD= 50.2 IRED BTU/HR FF BTU/HR 1 PARALLEL 1 1 TUBE 4 3.820 ORZ SEGMENTL IN. 4.309	T2-F 2 /HR ,F= .82,BYP -FT2-F -FT2-F  TOTAL EF EFFECTIV TEMA SHE  CROSS PA BAFFLE C	13.77 ASS= .94,BA 110.7 F AREA E AREA LL TYPE E SSES PER SH UT, PCT SHE	2 FF=1.00) 9 FT2 FT2/SHELL ; REAR H: ELL PASS LL I.D.	81.36 .030088 39.1 107.79 107.80 7.1 7.1 EAD FXTS
TOTAL HEAT DUTY RE EFF TEMP DIF, DEGF OVERALL COEFF REQU CLEAN & FOULED COE  SHELLS IN SERIES PASSES, SHELL SHELL DIAMETER IN.  BAFFLE TYPE H SPACING, CENTRAL SPACING, INLET	BTU/HR-FQUIRED MEGBTU (LMTD= 50.2 IRED BTU/HR FF BTU/HR 1 PARALLEL 1 1 TUBE 4 3.820 ORZ SEGMENTL IN. 4.309 IN. 4.309	T2-F 2 /HR ,F= .82,BYP -FT2-F -FT2-F  TOTAL EF EFFECTIV TEMA SHE  CROSS PA BAFFLE C CUT DIST	13.77 ASS= .94,BA 110.7 F AREA E AREA LL TYPE E SSES PER SH UT, PCT SHE	2 FF=1.00) 9 FT2 FT2/SHELL ; REAR H: ELL PASS LL I.D.	81.36 .030088 39.1 107.79 107.80 7.1 7.1 EAD FXTS
FILM COEFFICIENT  TOTAL HEAT DUTY RE EFF TEMP DIF, DEGF OVERALL COEFF REQU CLEAN & FOULED COE  SHELLS IN SERIES PASSES, SHELL SHELL DIAMETER IN.  BAFFLE TYPE H SPACING, CENTRAL SPACING, INLET SPACING, OUTLET	BTU/HR-F	T2-F 2 /HR ,F= .82,BYP -FT2-F -FT2-F  TOTAL EF EFFECTIV TEMA SHE  CROSS PA BAFFLE C CUT DIST	13.77 ASS= .94,BA 110.7 F AREA E AREA LL TYPE E SSES PER SH UT, PCT SHE ANCE FROM C	FF=1.00)  FT2 FT2/SHELL ; REAR H: ELL PASS LL I.D. ENTER, IN.	81.36 .030088 .39.1 107.79 107.80 7.1 7.1 EAD FXTS 4 30.00 .764
TOTAL HEAT DUTY RE EFF TEMP DIF, DEGF OVERALL COEFF REQU CLEAN & FOULED COE  SHELLS IN SERIES PASSES, SHELL SHELL DIAMETER IN.  BAFFLE TYPE H SPACING, CENTRAL SPACING, INLET SPACING, OUTLET BAFFLE THICKNESS	BTU/HR-F	T2-F 2  /HR ,F= .82,BYPFT2-F  TOTAL EF EFFECTIV. TEMA SHE  CROSS PA BAFFLE C' CUT DIST.	13.77 ASS= .94,BA 110.7 F AREA E AREA LL TYPE E SSES PER SH UT, PCT SHE ANCE FROM C ENT BAFFLE	FF=1.00)  FT2 FT2/SHELL ; REAR HI ELL PASS LL I.D. ENTER, IN. INCLUDED	81.36 .030088 39.1 107.79 107.80 7.1 7.1 EAD FXTS 4 30.00 .764
TOTAL HEAT DUTY RE EFF TEMP DIF, DEGF OVERALL COEFF REQU CLEAN & FOULED COE  SHELLS IN SERIES PASSES, SHELL SHELL DIAMETER IN.  BAFFLE TYPE H SPACING, CENTRAL SPACING, INLET SPACING, OUTLET BAFFLE THICKNESS PAIRS OF SEALING D	BTU/HR-F	T2-F 2	13.77 ASS= .94,BA 110.7  F AREA E AREA LL TYPE E  SSES PER SH UT, PCT SHE ANCE FROM C ENT BAFFLE T BLANK ARE	FF=1.00)  FT2 FT2/SHELL ; REAR HI  ELL PASS LL I.D. ENTER, IN.  INCLUDED A, %	81.36 .030088 39.1 107.79 107.80 7.1 7.1 EAD FXTS 4 30.00 .764
TOTAL HEAT DUTY RE EFF TEMP DIF, DEGF OVERALL COEFF REQU CLEAN & FOULED COE  SHELLS IN SERIES PASSES, SHELL SHELL DIAMETER IN.  BAFFLE TYPE H SPACING, CENTRAL SPACING, INLET SPACING, OUTLET BAFFLE THICKNESS PAIRS OF SEALING D	BTU/HR-F	T2-F 2	13.77 ASS= .94,BA 110.7  F AREA E AREA LL TYPE E  SSES PER SH UT, PCT SHE ANCE FROM C ENT BAFFLE T BLANK ARE	FF=1.00)  FT2 FT2/SHELL ; REAR HI  ELL PASS LL I.D. ENTER, IN.  INCLUDED A, %	81.36 .030088 39.1 107.79 107.80 7.1 7.1 EAD FXTS 4 30.00 .764 NO .0
TOTAL HEAT DUTY RE EFF TEMP DIF, DEGF OVERALL COEFF REQU CLEAN & FOULED COE  SHELLS IN SERIES PASSES, SHELL SHELL DIAMETER IN.  BAFFLE TYPE H SPACING, CENTRAL SPACING, INLET SPACING, OUTLET BAFFLE THICKNESS PAIRS OF SEALING D	BTU/HR-F	T2-F 2	13.77 ASS= .94,BA 110.7  F AREA E AREA LL TYPE E  SSES PER SH UT, PCT SHE ANCE FROM C ENT BAFFLE T BLANK ARE	FF=1.00)  FT2 FT2/SHELL ; REAR HI  ELL PASS LL I.D. ENTER, IN.  INCLUDED A, %	81.36 .030088 39.1 107.79 107.80  7.1 7.1 EAD FXTS  4 30.00 .764  NO .0  C COPPER 36
TOTAL HEAT DUTY RE EFF TEMP DIF, DEGF OVERALL COEFF REQU CLEAN & FOULED COE  SHELLS IN SERIES PASSES, SHELL SHELL DIAMETER IN.  BAFFLE TYPE H SPACING, CENTRAL SPACING, INLET SPACING, OUTLET BAFFLE THICKNESS PAIRS OF SEALING D	BTU/HR-F	T2-F 2	13.77 ASS= .94,BA 110.7  F AREA E AREA LL TYPE E  SSES PER SH UT, PCT SHE ANCE FROM C ENT BAFFLE T BLANK ARE	FF=1.00)  FT2 FT2/SHELL ; REAR HI  ELL PASS LL I.D. ENTER, IN.  INCLUDED A, %	81.36 .030088 39.1 107.79 107.80 7.1 7.1 EAD FXTS 4 30.00 .764 NO .0 C COPPER 36 .3125
TOTAL HEAT DUTY RE EFF TEMP DIF, DEGF OVERALL COEFF REQU CLEAN & FOULED COE  SHELLS IN SERIES PASSES, SHELL SHELL DIAMETER IN.  BAFFLE TYPE H SPACING, CENTRAL SPACING, INLET SPACING, OUTLET BAFFLE THICKNESS PAIRS OF SEALING D  TUBE TYPE NO. OF TUBES/SHELL TUBE LGTH, OVERALL TUBE LGTH, EFF	BTU/HR-F	T2-F 2	13.77 ASS= .94,BA 110.7  F AREA E AREA LL TYPE E  SSES PER SH UT, PCT SHE ANCE FROM C ENT BAFFLE T BLANK ARE  E TUBE COUNT CH SIDE DIAM	FF=1.00)  FT2 FT2/SHELL ; REAR HI  ELL PASS LL I.D. ENTER, IN.  INCLUDED A, %  LECTROLYTIC IN. IN.	81.36 .030088 .39.1 107.79 107.80  7.1 7.1 EAD FXTS  4 30.00 .764  NO .0  C COPPER .36 .3125 .250
TOTAL HEAT DUTY RE EFF TEMP DIF, DEGF OVERALL COEFF REQU CLEAN & FOULED COE  SHELLS IN SERIES PASSES, SHELL SHELL DIAMETER IN.  BAFFLE TYPE H SPACING, CENTRAL SPACING, INLET SPACING, OUTLET BAFFLE THICKNESS PAIRS OF SEALING D  TUBE TYPE NO. OF TUBES/SHELL TUBE LGTH, OVERALL TUBE LGTH, EFF	BTU/HR-F	T2-F 2	13.77 ASS= .94,BA 110.7  F AREA E AREA LL TYPE E  SSES PER SH UT, PCT SHE ANCE FROM C ENT BAFFLE T BLANK ARE  E TUBE COUNT CH SIDE DIAM	FF=1.00)  FT2 FT2/SHELL ; REAR HI  ELL PASS LL I.D. ENTER, IN.  INCLUDED A, %  LECTROLYTIC IN. IN.	81.36 .030088 .39.1 107.79 107.80  7.1 7.1 EAD FXTS  4 30.00 .764  NO .0  C COPPER .36 .3125 .250
TOTAL HEAT DUTY RE EFF TEMP DIF, DEGF OVERALL COEFF REQU CLEAN & FOULED COE  SHELLS IN SERIES PASSES, SHELL SHELL DIAMETER IN.  BAFFLE TYPE H SPACING, CENTRAL SPACING, INLET SPACING, OUTLET BAFFLE THICKNESS PAIRS OF SEALING D  TUBE TYPE NO. OF TUBES/SHELL TUBE LGTH, OVERALL	BTU/HR-F	T2-F 2	13.77 ASS= .94,BA 110.7  F AREA E AREA LL TYPE E  SSES PER SH UT, PCT SHE ANCE FROM C ENT BAFFLE T BLANK ARE  E TUBE COUNT CH SIDE DIAM	FF=1.00)  FT2 FT2/SHELL ; REAR HI  ELL PASS LL I.D. ENTER, IN. INCLUDED A, % LECTROLYTIC IN. IN. IN.	81.36 .030088 39.1 107.79 107.80  7.1 7.1 EAD FXTS  4 30.00 .764  NO .0  C COPPER 36 .3125 .250 .214

SHL NOZZ ID, IN&OUT 1.0 1.0 TUBE NOZZ ID, IN&OUT IN. .8 .8 * CALCULATED ITEM--HEAT BALANCE CODE = 8 □□Washington University ChE433 heat exchanger experiment E0002 P 79 Young model F302DY4P 9/23/ 3 CASE 39 S U P P L E M E N T A R Y R E S U L T S HT PARAMETERS SHELL TUBE SHELLSIDE PERFORMANCE WALL CORRECTION 1.035 .000 NOMINAL VEL, X-FLOW FT/S WALL CORRECTION 1.035 .000 NOMINAL VEL, X-FLOW FT/S .10
PRANDTL NUMBER 7.8 4.1 NOMINAL VEL, WINDOW FT/S .20
RYNLD NO, AVG 266. 1261. CROSSFLOW COEF BTU/HR-FT2-F 282.5
RYNLD NO, IN BUN 204. 1667. WINDOW COEF BTU/HR-FT2-F 284.2 RYNLD NO, IN BUN 204. 1667.

RYNLD NO, OUT BUN 338. 907.

FOULNG LAYER IN. .0014 .0014 SHELLSIDE FLOW, % OF TOTAL
HEAT TRANSFER X-FLOW 81.57

THERMAL RESISTANCE, % OF TOTAL TUBE TO BAFFLE LEAKAGE A = 3.54
SHELL TUBE FOULING METAL MAIN CROSSFLOW B = 65.75
37.88 59.70 2.34 .08 BUNDLE TO SHELL BYPASS C = 15.10

PCT OVER DESIGN .00 BAFFLE TO SHELL LEAKAGE E = 15.61

TUBE PASSLANE BYPASS F = .00 PCT OVER DESIGN

.00
BAFFLE TO SHELL LEAKAGE E = 15.61
TOT FOUL RESIST

.000217
TUBE PASSLANE BYPASS F = .00
DIFF RESIST

.000000 SHELLSIDE HEAT TRANSFER FACTORS SHELLSIDE HEAT TRANSFER FACTORS

DIAMETRAL CLEARANCES

TOTAL = (BETA) (GAMMA) (FIN) = .676

BUNDLE TO SHELL IN. .5000 BETA (BAFF CUT FACTOR) = .920

TUBE TO BAFFLE HOLE IN. .0284 GAMMA (TUBE ROW ENTRY EFCT) = .735

BAFFLE TO SHELL IN. .1000 END (HT LOSS IN END ZONE) = .994 SHELL NOZZLE DATA IN OUT SHELL PRESSURE DROP, % OF TOTAL HT UNDR NOZ IN. .25 WINDOW = 8 HT OPP NOZ IN. .25 END ZONE = 3 HT OPP NOZ IN. .25 END ZONE
VELOCITY FT/S .65 .66 CROSS FLOW 3.9 DENSITY LB/FT3 62.535 62.169 INLET NOZZLE = 42.9 NOZZ RHO*VSQ LB/FT-S2 26 26 OUTLET NOZZLE BUND RHO*VSQ LB/FT-S2 18 18 TUBE NOZZLE DATA IN OUT WEIGHT PER SHELL, LB VELOCITY FT/S .74 .73 DRY 150. DENSITY LB/FT3 61.291 62.143 WET 165. PRESS. DROP % 7.7 4.9 □□Washington University ChE433 heat exchanger experiment E0002 P 80 Young model F302DY4P 9/23/ 3 CASE 40 SIZE 4- 18 TYPE BEM, MULTI-PASS FLOW, SEGMENTAL BAFFLES, RATING HOT TUBE SIDE COLD SHELL SIDE Shell Tube SENSIBLE LIQ SENSIBLE LIQ
.500 .900
IN OUT IN OUT
140.0 77.5* 40.0 74.6* TOTAL FLOW RATE KLB/HR TEMPERATURE DEGF 140.0 77.5* 40.0 74.6*
DENSITY LB/FT3 61.2913 62.1692 62.5352 62.2016
VISCOSITY CP .4726 .8925 1.4791 .9243
SPECIFIC HEAT BTU/LB-F .9973 1.0007 1.0058 1.0010

THERMAL COND.  MOLAR MASS	BTU/HR-FT-F		.3574 18.02		10 00
TEMP, AVG & SKIN VISCOSITY, AVG & SK PRESSURE, IN & DESI	IN CP	108.7 .6320	77.1 .8961	57.3	75.9 .9101
PRESSURE DROP, TOT VELOCITY, CALC & MA	& ALLOWED PSI X ALLOWED FT/S	.05	10.00	.02	10.00
FOULING RESISTANCE FILM COEFFICIENT		F 213	.66	30	00010
TOTAL HEAT DUTY REQUEST TEMP DIF, DEGFOVERALL COEFF REQUINED COEFF	UIRED MEGBTU/HR (LMTD= 50.2,F=	.83,BYPAS	S= .94,BA	AFF=1.00)	
SHELLS IN SERIES 1 PASSES, SHELL 1 SHELL DIAMETER IN.	TUBE 4	EFFECTIVE	AREA	FT2/SHELL	7.1
BAFFLE TYPE HOS SPACING, CENTRAL IN SPACING, INLET IN SPACING, OUTLET IN BAFFLE THICKNESS IN PAIRS OF SEALING DE	N. 4.309 N. 4.309 N. 4.309 N125	BAFFLE CUT CUT DISTAN IMPINGEMEN	, PCT SHECE FROM C	ELL I.D. EENTER, IN. INCLUDED	30.00 .764 NO
TUBE TYPE NO. OF TUBES/SHELL TUBE LGTH, OVERALL TUBE LGTH, EFF TUBE LAYOUT PITCH RATIO SHL NOZZ ID, IN&OUT  * CALCULATED ITEM:	DEG 60 1.250 1.0 1.0	TUBE OUTSI TUBE INSID TUBE SURFA TUBE NOZZ	DE DIAM E DIAM .CE RATIO,	IN. IN. OUT/IN	.250 .214 1.184
□□Washington Univer Young model F302DY4	sity ChE433 hea		r experim	nent	E0002 P 81 9/23/ 3 CASE 40
RYNLD NO, AVG RYNLD NO, IN BUN RYNLD NO,OUT BUN FOULNG LAYER IN. THERMAL RESISTANCE,	SHELL TUBE 1.034 .000 8.0 4.2 294. 1247. 229. 1667. 367. 8830014 .0014	SHELLS NOMINAL NOMINAL CROSSFLO WINDOW C SHELLS HEAT TRA TUBE TO	IDE PERFO VEL, X-FLO VEL, WINDO W COEF OEF IDE FLOW, NSFER X-E BAFFLE LE	PRMANCE DW FT/S DW FT/S BTU/HR-FT2- BTU/HR-FT2- % OF TOTAL CLOW CAKAGE A	-F 306.5 L 81.55

36.11 61.41 2 PCT OVER DESIGN TOT FOUL RESIST	1	13	BAFFLE	TO SHELL BY TO SHELL LE	EAKAGE E	= 15.52
DIFF RESIST	00001					
				LSIDE HEAT 7		
DIAMETRAL CLEARA			TOTAL =	=(BETA)(GAM	MA) (FIN)	= .692
BUNDLE TO SHELL	IN50	000	BETA	(BAFF CUT FA	ACTOR)	= .920
TUBE TO BAFFLE HOL	E IN02	284	GAMMA	(TUBE ROW EN	NTRY EFCT)	= .752
BAFFLE TO SHELL	IN10	000	END	(HT LOSS IN	END ZONE)	= .994
SHELL NOZZLE DAT	A IN C	TUC	SHELI	L PRESSURE I	OROP, % OF	TOTAL
HT UNDR NOZ IN.	.25		WINDOW			= 8.8
HT OPP NOZ IN.	.25		END ZON	ΝE		= 3.8
VELOCITY FT/S	.73	.74	CROSS E	FLOW		= 3.3
DENSITY LB/FT3	62.535 62.2	202	INLET N	NOZZLE		= 43.0
NOZZ RHO*VSQ LB/FT			OUTLET	NOZZLE		= 41.1
BUND RHO*VSQ LB/FT		22	001111	11011111		11.1
TUBE NOZZLE DATA	IN (	TUC	WEIGH	HT PER SHELI	L, LB	
VELOCITY FT/S			DRY			150.
	61.291 62.1		WET		=	165.
PRESS. DROP %	7.6		WII			100.
□ Washington Unive Young model F302DY	rsity ChE433		exchang	ger experime	ent	E0002 P 82 9/23/ 3
Tourig moder F302D1	41					CASE 41
SIZE 4- 18 TYPE BE	M. MIII.TT-PASS	S FLOV	N. SEGME	NTAL BAFFLE	ES. RATING	
0100 1 10 1110 00	11, 110111 11101	0 110.				
			ויד ידי	IRE SIDE	COLD SI	HELL SIDE
				JBE SIDE		
			Tube		Shel	1
			Tube	IBLE LIQ	Shel	l IBLE LIQ
TOTAL FLOW RATE	KLB/HR		Tube SENSI	IBLE LIQ	Shel SENS	l IBLE LIQ .200
TOTAL FLOW RATE	·		Tube SENSI IN	IBLE LIQ .600 OUT	Shel SENS IN	1 IBLE LIQ .200 OUT
TOTAL FLOW RATE TEMPERATURE	KLB/HR DEGF		Tube SENSI IN	IBLE LIQ	Shel SENS IN	1 IBLE LIQ .200 OUT
	·		Tube SENSI IN 140.0	IBLE LIQ .600 OUT	Shel SENS IN 40.0	I IBLE LIQ .200 OUT 118.1*
TEMPERATURE	DEGF		Tube SENSI IN 140.0	IBLE LIQ .600 OUT 113.9* 61.6988	Shel SENS IN 40.0	l IBLE LIQ .200 OUT 118.1* 61.6366
TEMPERATURE DENSITY	DEGF LB/FT3 CP		Tube SENSI IN 140.0 1.2913 .4726	IBLE LIQ .600 OUT 113.9* 61.6988 .6004	Shel SENS IN 40.0 62.5352	I IBLE LIQ .200 OUT 118.1* 61.6366 .5762
TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT	DEGF LB/FT3 CP BTU/LB-F	61	Tube SENSI IN 140.0 1.2913 .4726 .9973	IBLE LIQ .600 OUT 113.9* 61.6988 .6004 .9979	Shel SENS IN 40.0 62.5352 1.4791 1.0058	1 IBLE LIQ .200 OUT 118.1* 61.6366 .5762 .9977
TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND.	DEGF LB/FT3 CP BTU/LB-F BTU/HR-FT-F	61	Tube SENSI IN 140.0 1.2913 .4726	OUT 113.9* 61.6988 .6004 .9979 .3666	Shel SENS IN 40.0 62.5352 1.4791	1 IBLE LIQ .200 OUT 118.1* 61.6366 .5762 .9977 .3676
TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT	DEGF LB/FT3 CP BTU/LB-F	61	Tube SENSI IN 140.0 1.2913 .4726 .9973	IBLE LIQ .600 OUT 113.9* 61.6988 .6004 .9979	Shel SENS IN 40.0 62.5352 1.4791 1.0058	1 IBLE LIQ .200 OUT 118.1* 61.6366 .5762 .9977
TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND.	DEGF LB/FT3 CP BTU/LB-F BTU/HR-FT-F LB/LBMOL	61	Tube SENSI IN 140.0 1.2913 .4726 .9973 .3723	OUT 113.9* 61.6988 .6004 .9979 .3666	Shel SENS IN 40.0 62.5352 1.4791 1.0058 .3466	1 IBLE LIQ .200 OUT 118.1* 61.6366 .5762 .9977 .3676 18.02
TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS TEMP, AVG & SKIN	DEGF LB/FT3 CP BTU/LB-F BTU/HR-FT-F LB/LBMOL DEGF	62	Tube SENSI IN 140.0 1.2913 .4726 .9973 .3723	OUT 113.9* 61.6988 .6004 .9979 .3666 18.02	Shel SENS IN 40.0 62.5352 1.4791 1.0058 .3466	1 IBLE LIQ .200 OUT 118.1* 61.6366 .5762 .9977 .3676 18.02
TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS	DEGF LB/FT3 CP BTU/LB-F BTU/HR-FT-F LB/LBMOL  DEGF KIN CP	61	Tube SENSI IN 140.0 1.2913 .4726 .9973 .3723	OUT 113.9* 61.6988 .6004 .9979 .3666 18.02	Shel SENS IN 40.0 62.5352 1.4791 1.0058 .3466	1 IBLE LIQ .200 OUT 118.1* 61.6366 .5762 .9977 .3676 18.02 106.1 .6492
TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS  TEMP, AVG & SKIN VISCOSITY, AVG & S PRESSURE, IN & DES	DEGF LB/FT3 CP BTU/LB-F BTU/HR-FT-F LB/LBMOL  DEGF KIN CP IGN PSIA	63	Tube SENSI IN 140.0 1.2913 .4726 .9973 .3723 	OUT 113.9* 61.6988 .6004 .9979 .3666 18.02 106.9 .6437 165.00	Shel SENS IN 40.0 62.5352 1.4791 1.0058 .3466  79.1 .8755 50.00	1 IBLE LIQ .200 OUT 118.1* 61.6366 .5762 .9977 .3676 18.02 106.1 .6492 165.00
TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS  TEMP, AVG & SKIN VISCOSITY, AVG & S PRESSURE, IN & DES  PRESSURE DROP, TOT	DEGF LB/FT3 CP BTU/LB-F BTU/HR-FT-F LB/LBMOL  DEGF KIN CP IGN PSIA	61 PSI	Tube SENSI IN 140.0 1.2913 .4726 .9973 .3723  126.9 .5305 50.00	OUT 113.9* 61.6988 .6004 .9979 .3666 18.02 106.9 .6437 165.00	Shel SENS IN 40.0 62.5352 1.4791 1.0058 .3466  79.1 .8755 50.00	1 IBLE LIQ .200 OUT 118.1* 61.6366 .5762 .9977 .3676 18.02 106.1 .6492 165.00
TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS  TEMP, AVG & SKIN VISCOSITY, AVG & S PRESSURE, IN & DES	DEGF LB/FT3 CP BTU/LB-F BTU/HR-FT-F LB/LBMOL  DEGF KIN CP IGN PSIA	61 PSI	Tube SENSI IN 140.0 1.2913 .4726 .9973 .3723  126.9 .5305 50.00	OUT 113.9* 61.6988 .6004 .9979 .3666 18.02 106.9 .6437 165.00	Shel SENS IN 40.0 62.5352 1.4791 1.0058 .3466  79.1 .8755 50.00	1 IBLE LIQ .200 OUT 118.1* 61.6366 .5762 .9977 .3676 18.02 106.1 .6492 165.00
TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS  TEMP, AVG & SKIN VISCOSITY, AVG & S PRESSURE, IN & DES  PRESSURE DROP, TOT VELOCITY, CALC & M	DEGF LB/FT3 CP BTU/LB-F BTU/HR-FT-F LB/LBMOL  DEGF KIN CP IGN PSIA & ALLOWED IN ANY ALLOWED IN ANY ALLOWED IN ANY ANY ANY ANY ANY ANY ANY ANY ANY AN	6: PSI FT/S	Tube SENSI  IN 140.0 1.2913 .4726 .9973 .3723 126.9 .5305 50.00 .07 .59	OUT 113.9* 61.6988 .6004 .9979 .3666 18.02 106.9 .6437 165.00  10.00 10.00	Shel SENS IN 40.0 62.5352 1.4791 1.0058 .3466 	1 IBLE LIQ .200 OUT 118.1* 61.6366 .5762 .9977 .3676 18.02 106.1 .6492 165.00
TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS  TEMP, AVG & SKIN VISCOSITY, AVG & S PRESSURE, IN & DES  PRESSURE DROP, TOT	DEGF LB/FT3 CP BTU/LB-F BTU/HR-FT-F LB/LBMOL  DEGF KIN CP IGN PSIA & ALLOWED H AX ALLOWED H	PSI FT/S F/BTU	Tube SENSI  IN  140.0 1.2913 .4726 .9973 .3723 126.9 .5305 50.00 .07 .59	OUT 113.9* 61.6988 .6004 .9979 .3666 18.02 106.9 .6437 165.00 10.00 10.00	Shel SENS IN 40.0 62.5352 1.4791 1.0058 .3466  79.1 .8755 50.00	1 IBLE LIQ .200 OUT 118.1* 61.6366 .5762 .9977 .3676 18.02 106.1 .6492 165.00  10.00 10.00
TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS  TEMP, AVG & SKIN VISCOSITY, AVG & S PRESSURE, IN & DES  PRESSURE DROP, TOT VELOCITY, CALC & M  FOULING RESISTANCE FILM COEFFICIENT	DEGF LB/FT3 CP BTU/LB-F BTU/HR-FT-F LB/LBMOL  DEGF KIN CP IGN PSIA & ALLOWED H AX ALLOWED H HR-FT2-H BTU/HR-H	PSI FT/S F/BTU FT2-F	Tube SENSI IN 140.0 1.2913 .4726 .9973 .3723  126.9 .5305 50.00 .07 .59	IBLE LIQ .600 OUT 113.9* 61.6988 .6004 .9979 .3666 18.02 106.9 .6437 165.00  10.00 10.00 00010 18.37	Shel SENS IN 40.0 62.5352 1.4791 1.0058 .3466  79.1 .8755 50.00	1 IBLE LIQ .200 OUT 118.1* 61.6366 .5762 .9977 .3676 18.02 106.1 .6492 165.00 10.00 10.00 00010 35.02
TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS  TEMP, AVG & SKIN VISCOSITY, AVG & S PRESSURE, IN & DES  PRESSURE DROP, TOT VELOCITY, CALC & M  FOULING RESISTANCE	DEGF LB/FT3 CP BTU/LB-F BTU/HR-FT-F LB/LBMOL  DEGF KIN CP IGN PSIA & ALLOWED H AX ALLOWED H HR-FT2-H BTU/HR-H	PSI FT/S F/BTU FT2-F	Tube SENSI IN 140.0 1.2913 .4726 .9973 .3723  126.9 .5305 50.00 .07 .59	IBLE LIQ .600 OUT 113.9* 61.6988 .6004 .9979 .3666 18.02 106.9 .6437 165.00  10.00 10.00 00010 18.37	Shel SENS IN 40.0 62.5352 1.4791 1.0058 .3466  79.1 .8755 50.00	1 IBLE LIQ .200 OUT 118.1* 61.6366 .5762 .9977 .3676 18.02 106.1 .6492 165.00 10.00 10.00
TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS  TEMP, AVG & SKIN VISCOSITY, AVG & S PRESSURE, IN & DES  PRESSURE DROP, TOT VELOCITY, CALC & M  FOULING RESISTANCE FILM COEFFICIENT	DEGF LB/FT3 CP BTU/LB-F BTU/HR-FT-F LB/LBMOL  DEGF KIN CP IGN PSIA & ALLOWED H AX ALLOWED H AX ALLOWED H CONTROL   BTU/HR-H CONTROL   BTU/HR-H CONTROL   BTU/HR-H CONTROL   BTU/HR-H CONTROL   BTU/HR-H CONTROL   BTU/HR-H	PSI FT/S F/BTU FT2-F  U/HR	Tube SENSI  IN 140.0 1.2913 .4726 .9973 .3723 126.9 .5305 50.00 .07 .59	IBLE LIQ .600 OUT 113.9* 61.6988 .6004 .9979 .3666 18.02 106.9 .6437 165.00 10.00 10.00 10.00	Shel SENS IN 40.0 62.5352 1.4791 1.0058 .3466  79.1 .8755 50.00 .00 .03	1 IBLE LIQ .200 OUT 118.1* 61.6366 .5762 .9977 .3676 18.02 106.1 .6492 165.00 10.00 10.00 00010 35.02
TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS  TEMP, AVG & SKIN VISCOSITY, AVG & S PRESSURE, IN & DES  PRESSURE DROP, TOT VELOCITY, CALC & M  FOULING RESISTANCE FILM COEFFICIENT  TOTAL HEAT DUTY RE	DEGF LB/FT3 CP BTU/LB-F BTU/HR-FT-F LB/LBMOL  DEGF KIN CP IGN PSIA & ALLOWED H AX ALLOWED H AX ALLOWED H QUIRED MEGBTU (LMTD= 42.7	PSI FT/S F/BTU FT2-F  U/HR 7,F=	Tube SENSI  IN  140.0 1.2913 .4726 .9973 .3723 126.9 .5305 50.00 .07 .59	IBLE LIQ .600 OUT 113.9* 61.6988 .6004 .9979 .3666 18.02 106.9 .6437 165.00 10.00 10.00 10.00	Shel SENS IN 40.0 62.5352 1.4791 1.0058 .3466  79.1 .8755 50.00 .00 .03	1 IBLE LIQ .200

		che433b(40).OUT	
SHELLS IN SERIES 1 PARALI	EL 1	TOTAL EFF AREA FT2	7.1
PASSES, SHELL 1 TUBE		EFFECTIVE AREA FT2/SHELL	7 1
SHELL DIAMETER IN.		TEMA SHELL TYPE E ; REAR HE	
SHELL DIAMETER IN.	3.020	TEMA SHELL TIPE E , KEAR HE	TAD LVI2
BAFFLE TYPE HORZ SEG		CROSS PASSES PER SHELL PASS	
SPACING, CENTRAL IN.	4.309	BAFFLE CUT, PCT SHELL I.D.	30.00
SPACING, INLET IN.	4.309	CUT DISTANCE FROM CENTER, IN.	.764
SPACING, OUTLET IN.	4.309		
BAFFLE THICKNESS IN.		IMPINGEMENT BAFFLE INCLUDED	NO
PAIRS OF SEALING DEVICES		TUBESHEET BLANK AREA, %	
TAIKS OF SEADING DEVICES	_	TODESHEET BLANK AKEA, *	• 0
	D	W	
		MATERIAL ELECTROLYTIC	
NO. OF TUBES/SHELL		EST MAX TUBE COUNT	
TUBE LGTH, OVERALL FT	1.500	TUBE PITCH IN.	.3125
TUBE LGTH, EFF FT	1.436	TUBE OUTSIDE DIAM IN.	.250
TUBE LAYOUT DEG	60	TUBE INSIDE DIAM IN.	.214
		TUBE SURFACE RATIO, OUT/IN	
SHL NOZZ ID, IN&OUT 1.0			.8 .8
3111 NOZZ 1D, 1N&001 1.0	1.0	TOBE NOZZ ID, INGOOT IN.	.0
	D 3 7 3 3 3 6 7	G077 0	
* CALCULATED ITEMHEAT			
= = = = = = = = = = = = = = = = = = = =	ıE433 hea	t exchanger experiment	
Young model F302DY4P			9/23/ 3
			CASE 41
SUPPLEMEN	T A R	Y RESULTS	
HT PARAMETERS SHELL	THRE	SHELLSIDE PERFORMANCE	
	.000		0.3
	3.5	•	
RYNLD NO, AVG 85.			
RYNLD NO, IN BUN 50.	2000.	WINDOW COEF BTU/HR-FT2-	-F 133.7
RYNLD NO, OUT BUN 128.	1575.		
FOULNG LAYER IN0014	.0014	SHELLSIDE FLOW, % OF TOTAL	
		HEAT TRANSFER X-FLOW	
THERMAL RESISTANCE, % OF I	י ∧ יי ∧ ז		
SHELL TUBE FOULING ME			
		BUNDLE TO SHELL BYPASS C	
PCT OVER DESIGN		BAFFLE TO SHELL LEAKAGE E	
		TUBE PASSLANE BYPASS F	= .00
DIFF RESIST .	000055		
		SHELLSIDE HEAT TRANSFER FA	ACTORS
DIAMETRAL CLEARANCES		TOTAL = (BETA) (GAMMA) (FIN)	= .598
		BETA (BAFF CUT FACTOR)	
		GAMMA (TUBE ROW ENTRY EFCT)	
BAFFLE TO SHELL IN.	.1000	END (HT LOSS IN END ZONE)	= .998
		SHELL PRESSURE DROP, % OF	TOTAL
HT UNDR NOZ IN25	· )	WINDOW	= 9.7
HT OPP NOZ IN25			= 7.4
VELOCITY FT/S .16			= 5.7
DENSITY LB/FT3 62.535			= 41.0
NOZZ RHO*VSQ LB/FT-S2 1			= 36.1
BUND RHO*VSQ LB/FT-S2 1	. 1		

TUBE NOZ	ZLE DATA	IN	OUT	WEIGHT	PER	SHELL,	LB		
VELOCITY	FT/S	.89	.88	DRY				=	150.
DENSITY	LB/FT3	61.291	61.699	WET				=	165.
PRESS. DRO	P %	8.5	5.4						

## *** SPECIAL MESSAGES AND WARNINGS ***

WARNING--TUBESIDE FLUID HAS PASSED THROUGH TRANSITION ZONE. CONSIDER RERUNNING WITH ITEM 132 IN EFFECT.

□□Washington University ChE433 heat exchanger experiment E0002 P 84

□□Washington Unive Young model F302DY		eat exchang	ger experim		9/23/ 3
4 10					CASE 42
SIZE 4- 18 TYPE BE	M, MULTI-PASS				
		HOT TU	JBE SIDE	COLD SI	HELL SIDE
		Tube		Shell	L
		SENSI	IBLE LIQ	SENS	IBLE LIQ
TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY	KLB/HR		.600		.300
		IN	OUT	IN	OUT
TEMPERATURE	DEGF	140.0	105.9*	40.0	108.0
DENSITY	LB/FT3	61.2913	61.8116	62.5352	61.7829
VISCOSITY	CP	.4726	.6505	1.4791	.6369
SPECIFIC HEAT	BTU/LB-F	.9973	.9983	1.0058	.9982
THERMAL COND.	BTU/HR-FT-F	.3723	.3647	.3466	.3652
MOLAR MASS			18.02		18.02
TEMP, AVG & SKIN	DEGF	1//.9	100.4	/4.0	99.5
VISCOSITY, AVG & S	KIN CP	.5505	.6885	.9310	.6953
PRESSURE, IN & DES	IGN PSIA	50.00			
PRESSURE DROP, TOT	& ALLOWED PS	I .07	10.00	.00	10.00
VELOCITY, CALC & M	AX ALLOWED FT	/S .59	10.00	.05	10.00
FOULING RESISTANCE	HR-FT2-F/	BTU .(	00010	. (	00010
FILM COEFFICIENT	BTU/HR-FT				60.80
TOTAL HEAT DUTY RE					.020412
EFF TEMP DIF, DEGF	(LMTD = 46.9,	F= .78, BYPA	ASS= .92, BA	FF=1.00)	33.8
OVERALL COEFF REQU					84.47
CLEAN & FOULED COE	FF BTU/HR-	FT2-F	86.4	0	84.79
SHELLS IN SERIES	1 PARALLEL 1	TOTAL EF	F AREA	FT2	7.1
PASSES, SHELL	1 TUBE 4	EFFECTIVE	E AREA	FT2/SHELL	7.1
SHELL DIAMETER IN.	3.820	TEMA SHEI	LL TYPE E	; REAR HI	EAD FXTS
BAFFLE TYPE H	ORZ SEGMENTL	CROSS PAS	SSES PER SH	ELL PASS	4
SPACING, CENTRAL	IN. 4.309	BAFFLE CU	JT, PCT SHE	LL I.D.	30.00
SPACING, INLET			ANCE FROM C		
SPACING, OUTLET				•	
BAFFLE THICKNESS	IN125	IMPINGEME	ENT BAFFLE	INCLUDED	NO
PAIRS OF SEALING D	EVICES 1	TUBESHEET	r blank are	A, %	.0

TUBE TYPE PLAIN	MATERIAL ELECTROLYTI	C CODDED
		36
TUBE LGTH, OVERALL FT 1.500	EST MAX TUBE COUNT	.3125
TUBE LGTH, EFF FT 1.436	TUBE OUTSIDE DIAM IN.	.250
TUBE LAYOUT DEG 60	TUBE INSIDE DIAM IN.	.214
PITCH RATIO 1.250	TUBE SURFACE RATIO, OUT/IN	1.184
SHL NOZZ ID, IN&OUT 1.0 1.0	TUBE NOZZ ID, IN&OUT IN.	.8 .8
* CALCULATED ITEMHEAT BALANCE	CODE = 8	
□□Washington University ChE433 hea	at exchanger experiment	E0002 P 85
Young model F302DY4P		9/23/ 3
-		CASE 42
SUPPLEMENTAP	R Y R E S U L T S	
HT PARAMETERS SHELL TUBE	SHELLSIDE PERFORMANCE	
WALL CORRECTION 1.042 .000	NOMINAL VEL Y-FLOW FT/S	0.4
PRANDTL NUMBER 6.3 3.6		0.8
RYNLD NO, AVG 121. 1718.	CDOCCELOW CORE DELL/UD_EET2	.00 _p 161 5
RYNLD NO, IN BUN 76. 2000.		
RYNLD NO, OUT BUN 177. 1453.	WINDOW COEF BIO/HR-F12	-F 102.3
		-
FOULNG LAYER IN0014 .0014	SHELLSIDE FLOW, % OF TOTA	
		81.30
THERMAL RESISTANCE, % OF TOTAL	TUBE TO BAFFLE LEAKAGE A	= 2.70
SHELL TUBE FOULING METAL	MAIN CROSSFLOW B	= 69.46
52.14 45.96 1.84 .06	BUNDLE TO SHELL BYPASS C	= 11.29
	BAFFLE TO SHELL LEAKAGE E	
TOT FOUL RESIST .000217	TUBE PASSLANE BYPASS F	= .00
DIFF RESIST .000045		
	SHELLSIDE HEAT TRANSFER F	ACTORS
DIAMETRAL CLEARANCES	TOTAL = (BETA) (GAMMA) (FIN)	= .600
BUNDLE TO SHELL IN5000	BETA (BAFF CUT FACTOR)	= .920
TUBE TO BAFFLE HOLE IN0284	GAMMA (TUBE ROW ENTRY EFCT)	= .652
BAFFLE TO SHELL IN1000		
	,	
SHELL NOZZLE DATA IN OUT	SHELL PRESSURE DROP, % OF	TOTAL
HT UNDR NOZ IN25		= 9.2
HT OPP NOZ IN25		= 5.8
	CROSS FLOW	= 4.7
DENSITY LB/FT3 62.535 61.783		= 42.2
NOZZ RHO*VSQ LB/FT-S2 3 3		= 38.1
	OUILEI NOZZLE	- 30.1
BUND RHO*VSQ LB/FT-S2 2 2		
THE VOICE DATA		
TUBE NOZZLE DATA IN OUT		150
VELOCITY FT/S .89 .88	DRY =	200.
DENSITY LB/FT3 61.291 61.812	WET =	165.
PRESS. DROP % 8.4 5.3		

^{***} SPECIAL MESSAGES AND WARNINGS ***

WARNING--TUBESIDE FLUID HAS PASSED THROUGH TRANSITION ZONE. CONSIDER RERUNNING WITH ITEM 132 IN EFFECT.

 $\square\square$ Washington University ChE433 heat exchanger experiment E0002 P 86 Young model F302DY4P 9/23/ 3

CASE 43

SIZE 4- 18 TYPE BEI		HOT TU Tube	JBE SIDE	COLD SI Sheli	HELL SIDE l
		SENSI	BLE LIQ	SENS	IBLE LIQ
TOTAL FLOW RATE	KLB/HR		.600 OUT		.400
		IN	OUT	IN	OUT
TEMPERATURE	DEGF	140.0	99.7*	40.0	100.2*
DENSITY	LB/FT3	61.2913	61.8949	62.5352	61.8894
VISCOSITY	CP	.4726	.6937	1.4791	.6906
SPECIFIC HEAT	BTU/LB-F	.9973	.9987	1.0058	.9987
THERMAL COND.	BTU/HR-FT-F	.3723	.3632	.3466	.3633
MOLAR MASS			18.02		18.02
TEMP, AVG & SKIN	DEGF	119.9	95.1	70.1	94.1
VISCOSITY, AVG & SI	KIN CP	.5667	.7293	.9773	.7375
PRESSURE, IN & DES	IGN PSIA	50.00	165.00	50.00	165.00
PRESSURE DROP, TOT	& ALLOWED PSI	.07	10.00	.00	10.00
VELOCITY, CALC & M	AX ALLOWED FT/	's .59	10.00	.06	10.00
FOULING RESISTANCE	HR-FT2-F/E	STU .C	00010	. (	00010
FILM COEFFICIENT	BTU/HR-FT2	2-F 21	.8.48	18	38.53
TOTAL HEAT DUTY RE	QUIRED MEGBTU/F	ΗR			.024098
EFF TEMP DIF, DEGF	(LMTD = 49.1, E	F = .80, BYPA	ASS= .93,BA	FF=1.00)	36.6
OVERALL COEFF REQU	IRED BTU/HR-E	FT2-F			92.27
CLEAN & FOULED COE	FF BTU/HR-E	FT2-F	93.8	2	91.85
SHELLS IN SERIES					
PASSES, SHELL					
SHELL DIAMETER IN.	3.820	TEMA SHEI	LL TYPE E	; REAR H	EAD FXTS
BAFFLE TYPE HO					
SPACING, CENTRAL					
SPACING, INLET			ANCE FROM C	ENTER, IN.	.764
SPACING, OUTLET	IN. 4.309				
BAFFLE THICKNESS	IN125	IMPINGEME	ENT BAFFLE	INCLUDED	NO
PAIRS OF SEALING D	EVICES 1	TUBESHEET	BLANK ARE	A, %	.0
TUBE TYPE	PLAIN				C COPPER
NO. OF TUBES/SHELL					36
TUBE LGTH, OVERALL	FT 1.500	TUBE PITO	CH	IN.	.3125
TUBE LGTH, EFF					
TUBE LAYOUT					
PITCH RATIO					
SHL NOZZ ID, IN&OU'	T 1.0 1.0	TUBE NOZZ	Z ID, IN&OU	T IN.	.8 .8

^{*} CALCULATED ITEM--HEAT BALANCE CODE = 8  $\square\square$ Washington University ChE433 heat exchanger experiment E0002 P 87 Young model F302DY4P

9/23/ 3

CASE 43

S U P P L E M E N T A R	Y RESULTS
	SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S .05  NOMINAL VEL, WINDOW FT/S .10  CROSSFLOW COEF BTU/HR-FT2-F 189.3  WINDOW COEF BTU/HR-FT2-F 190.4  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.42  TUBE TO BAFFLE LEAKAGE A = 2.93  MAIN CROSSFLOW B = 68.47  BUNDLE TO SHELL BYPASS C = 12.35  BAFFLE TO SHELL LEAKAGE E = 16.24  TUBE PASSLANE BYPASS F = .00
HT PARAMETERS SHELL TUBE	SHELLSIDE PERFORMANCE
WALL CORRECTION 1.040 .000	NOMINAL VEL, X-FLOW FT/S .US
PRAND'IL NUMBER 6./ 3./	NOMINAL VEL, WINDOW FT/S .10
RYNLD NO, AVG 154. 1668.	CROSSFLOW COEF BTU/HR-FT2-F 189.3
RYNLD NO, IN BUN 102. 2000.	WINDOW COEF BTU/HR-FTZ-F 190.4
EQUINC LAVED IN 0014 0014	CHELLCIDE ELOM & OF TOTAL
FOOLING LATER IN0014 .0014	SELLSIDE FLOW, 6 OF TOTAL  UPAT TRANSFER V_FION 91 42
THEDMAI DECICTANCE & OF TOTAL	TIDE TO DARRIE IEANACE A - 2 02
CHELL TUDE FOLLING METAL	MAIN COCCETON D - 69 47
AO 17 AO 77 1 OO 07	DINDLE TO CHELL DVDACC C = 12 25
40.17 49.77 1.99 .07	DARRIE DO CURIL LEAVACE E - 16 24
PCI OVER DESIGN40	BAFFLE TO SHELL LEANAGE E - 10.24
DIFF RESIST000050	TUBE PASSLANE BIPASS F00
	SHELLSIDE HEAT TRANSFER FACTORS  TOTAL = (BETA) (GAMMA) (FIN) = .617  BETA (BAFF CUT FACTOR) = .920  GAMMA (TUBE ROW ENTRY EFCT) = .671  END (HT LOSS IN END ZONE) = .994
DIAMETRAL CLEARANCES	TOTAL - (BETA) (GAMMA) (FIN)01/
BUNDLE TO SHELL IN5000	CAMMA (MUDE DOM ENERGY = .920
TUBE TO BAFFLE HOLE INU284	GAMMA (TUBE ROW ENTRY EFCT) = .0/1
BAFFLE TO SHELL IN1000	END (HT LOSS IN END ZONE) = .994
SHELL NOZZLE DATA IN OUT	SHELL PRESSURE DROP. % OF TOTAL
HT IINDR NOZ IN 25	WINDOW = 9 0
HT OPP NOZ IN25	SHELL PRESSURE DROP, % OF TOTAL WINDOW = 9.0 END ZONE = 5.2
VELOCITY FT/S 33 33	CROSS FLOW = 4 3
DENSITY I.B/FT3 62 535 61 889	INLET NOZZLE = 42 5
NOZZ RHO*VSO LB/FT-S2 6 6	OUTLET NOZZLE = $39.0$
BUND RHO*VSQ LB/FT-S2 4 4	WINDOW = 9.0 END ZONE = 5.2 CROSS FLOW = 4.3 INLET NOZZLE = 42.5 OUTLET NOZZLE = 39.0
TUBE NOZZLE DATA IN OUT	WEIGHT PER SHELL, LB
TUBE NOZZLE DATA IN OUT VELOCITY FT/S .89 .88	DRY = 150.
DENSITY LB/FT3 61.291 61.895	WET = 165.
PRESS. DROP % 8.3 5.3	DRY = 150. WET = 165.
*** SPECIAL MESSAGES AND WARNINGS *	**
WARNINGTUBESIDE FLUID HAS PASSED	
RERUNNING WITH ITEM 132 IN	
$\square\square$ Washington University ChE433 heat	
Young model F302DY4P	9/23/ 3
	CASE 44
SIZE 4- 18 TYPE BEM, MULTI-PASS FLO	
	HOT TUBE SIDE COLD SHELL SIDE
	Tube Shell
	SENSIBLE LIQ SENSIBLE LIQ
TOTAL FLOW RATE KLB/HR	.600 .500
	IN OUT IN OUT

TEMPERATURE DEGF 140.0 95.1* 40.0 93.7* DENSITY LB/FT3 61.2913 61.9561 62.5352 61.9733

IN OUT IN OUT 140.0 95.1* 40.0 93.7*

VISCOSITY CP SPECIFIC HEAT BTU/I THERMAL COND. BTU/F MOLAR MASS LB/LE	B-F R-FT-F	.9973 .3723	.7295 .9990	.3466	.9991
TEMP, AVG & SKIN I VISCOSITY, AVG & SKIN C PRESSURE, IN & DESIGN I	P	117.5 .5795	90.8 .7648	66.9 1.0181	89.7 .7744
PRESSURE DROP, TOT & ALI VELOCITY, CALC & MAX ALI	OWED PSI OWED FT/S	.07 .59	10.00	.01	10.00
FOULING RESISTANCE FILM COEFFICIENT F		F 218	.49	21	00010
TOTAL HEAT DUTY REQUIRED EFF TEMP DIF, DEGF (LMT OVERALL COEFF REQUIRED CLEAN & FOULED COEFF	MEGBTU/HR D= 50.5,F=	.82,BYPAS	S= .94,BA	FF=1.00)	.026906 38.6 97.48 97.45
SHELLS IN SERIES 1 PARA PASSES, SHELL 1 TUBE SHELL DIAMETER IN.	4	EFFECTIVE A	AREA	FT2/SHELL	7.1
BAFFLE TYPE HORZ S SPACING, CENTRAL IN. SPACING, INLET IN. SPACING, OUTLET IN. BAFFLE THICKNESS IN. PAIRS OF SEALING DEVICES	4.309 4.309 4.309 .125	BAFFLE CUT CUT DISTAN IMPINGEMEN'	, PCT SHE CE FROM C T BAFFLE	ENTER, IN.	30.00 .764 NO
TUBE TYPE  NO. OF TUBES/SHELL  TUBE LGTH, OVERALL FT  TUBE LGTH, EFF FT  TUBE LAYOUT DEG  PITCH RATIO  SHL NOZZ ID, IN&OUT 1.	76 1.500 1.436 60 1.250	EST MAX TU TUBE PITCH TUBE OUTSI TUBE INSID TUBE SURFA	BE COUNT  DE DIAM  E DIAM  CE RATIO,	IN. IN. IN. OUT/IN	36 .3125 .250 .214 1.184
* CALCULATED ITEMHEAD Substitution University Young model F302DY4P	ChE433 hea	t exchange	_		E0002 P 89 9/23/ 3 CASE 44
HT PARAMETERS SHELI WALL CORRECTION 1.039 PRANDTL NUMBER 7.0 RYNLD NO, AVG 185. RYNLD NO, IN BUN 127. RYNLD NO,OUT BUN 254. FOULNG LAYER IN0014	TUBE .000 3.8 1631. 2000. 1296.	SHELLS NOMINAL NOMINAL CROSSFLO WINDOW CO	IDE PERFO: VEL, X-FLOI VEL, WINDOI W COEF	RMANCE W FT/S W FT/S BTU/HR-FT2- BTU/HR-FT2- % OF TOTAL	·F 216.3

THERMAL RESISTANCE, % OF TOTAL	TUBE TO BAFFLE LEAKAGE A = 3.12
SHELL TUBE FOULING METAL	MAIN CROSSFLOW $B = 67.66$
45.01 52.81 2.11 .07	BUNDLE TO SHELL BYPASS $C = 13.21$
PCT OVER DESIGN03	BAFFLE TO SHELL LEAKAGE E = 16.01
TOT FOUL RESIST .000217	TUBE PASSLANE BYPASS $F = .00$
DIFF RESIST000003	
	SHELLSIDE HEAT TRANSFER FACTORS
DIAMETRAL CLEARANCES	TOTAL = (BETA) (GAMMA) (FIN) = .633  BETA (BAFF CUT FACTOR) = .920
BUNDLE TO SHELL IN500	D BETA (BAFF CUT FACTOR) = .920
TUBE TO BAFFLE HOLE IN028	4 GAMMA (TUBE ROW ENTRY EFCT) = .688
BAFFLE TO SHELL IN100	O END (HT LOSS IN END ZONE) = .994
	SHELL PRESSURE DROP, % OF TOTAL
HT UNDR NOZ IN25 HT OPP NOZ IN25	WINDOW = 8.9 END ZONE = 4.7
HT UNDR NOZ IN25 HT OPP NOZ IN25	WINDOW = 8.9 END ZONE = 4.7
HT UNDR NOZ IN25 HT OPP NOZ IN25 VELOCITY FT/S .41 .4 DENSITY LB/FT3 62.535 61.97	WINDOW = 8.9 END ZONE = 4.7 1 CROSS FLOW = 4.0 3 INLET NOZZLE = 42.7
HT UNDR NOZ IN25 HT OPP NOZ IN25 VELOCITY FT/S .41 .4 DENSITY LB/FT3 62.535 61.97 NOZZ RHO*VSQ LB/FT-S2 10 1	WINDOW = 8.9 END ZONE = 4.7 1 CROSS FLOW = 4.0 3 INLET NOZZLE = 42.7 0 OUTLET NOZZLE = 39.6
HT UNDR NOZ IN25 HT OPP NOZ IN25 VELOCITY FT/S .41 .4 DENSITY LB/FT3 62.535 61.97	WINDOW = 8.9 END ZONE = 4.7 1 CROSS FLOW = 4.0 3 INLET NOZZLE = 42.7 0 OUTLET NOZZLE = 39.6
HT UNDR NOZ IN25 HT OPP NOZ IN25 VELOCITY FT/S .41 .4 DENSITY LB/FT3 62.535 61.97 NOZZ RHO*VSQ LB/FT-S2 10 1 BUND RHO*VSQ LB/FT-S2 7	WINDOW = 8.9 END ZONE = 4.7 1 CROSS FLOW = 4.0 3 INLET NOZZLE = 42.7 0 OUTLET NOZZLE = 39.6
HT UNDR NOZ IN25 HT OPP NOZ IN25 VELOCITY FT/S .41 .4 DENSITY LB/FT3 62.535 61.97 NOZZ RHO*VSQ LB/FT-S2 10 1 BUND RHO*VSQ LB/FT-S2 7  TUBE NOZZLE DATA IN OU	WINDOW = 8.9 END ZONE = 4.7 1 CROSS FLOW = 4.0 3 INLET NOZZLE = 42.7 0 OUTLET NOZZLE = 39.6 7 WEIGHT PER SHELL, LB
HT UNDR NOZ IN25 HT OPP NOZ IN25 VELOCITY FT/S .41 .4 DENSITY LB/FT3 62.535 61.97 NOZZ RHO*VSQ LB/FT-S2 10 1 BUND RHO*VSQ LB/FT-S2 7  TUBE NOZZLE DATA IN OU VELOCITY FT/S .89 .8	WINDOW = 8.9 END ZONE = 4.7 1 CROSS FLOW = 4.0 3 INLET NOZZLE = 42.7 0 OUTLET NOZZLE = 39.6 7  WEIGHT PER SHELL, LB 8 DRY = 150.
HT UNDR NOZ IN25 HT OPP NOZ IN25 VELOCITY FT/S .41 .4 DENSITY LB/FT3 62.535 61.97 NOZZ RHO*VSQ LB/FT-S2 10 1 BUND RHO*VSQ LB/FT-S2 7  TUBE NOZZLE DATA IN OU	WINDOW = 8.9 END ZONE = 4.7 1 CROSS FLOW = 4.0 3 INLET NOZZLE = 39.6 7  WEIGHT PER SHELL, LB B DRY = 150. 6 WET = 165.

## *** SPECIAL MESSAGES AND WARNINGS ***

WARNING--TUBESIDE FLUID HAS PASSED THROUGH TRANSITION ZONE. CONSIDER RERUNNING WITH ITEM 132 IN EFFECT.

	SIZE	4 –	18	TYPE	BEM,	MULTI-PASS	FLOW,	SEGMENTAL	BAFFLES,	RATING
--	------	-----	----	------	------	------------	-------	-----------	----------	--------

			HOT TU	JBE SIDE	COLD SH	HELL SIDE
			Tube		Shell	L
			SENS	IBLE LIQ	SENSI	BLE LIQ
TOTAL FLOW RATE	KLB/HR			.600		.600
			IN	OUT	IN	OUT
TEMPERATURE	DEGF		140.0	91.2*	40.0	88.5*
DENSITY	LB/FT3		61.2913	62.0044	62.5352	62.0381
VISCOSITY	CP		.4726	.7607	1.4791	.7843
SPECIFIC HEAT	BTU/LB-F		.9973	.9993	1.0058	.9996
THERMAL COND.	BTU/HR-FT-	F	.3723	.3610	.3466	.3603
MOLAR MASS	LB/LBMOL			18.02		18.02
TEMP, AVG & SKIN	DEGF		115.6	87.2	64.3	86.0
VISCOSITY, AVG & :	SKIN CP		.5903	.7962	1.0527	.8070
PRESSURE, IN & DE	SIGN PSIA		50.00	165.00	50.00	165.00
PRESSURE DROP, TO	T & ALLOWED	PSI	.07	10.00	.01	10.00
VELOCITY, CALC & I	MAX ALLOWED	FT/S	.58	10.00	.09	10.00

FOULING RESISTANCE FILM COEFFICIENT	BTU/HR-FT2-F		.00010 238.33	
TOTAL HEAT DUTY REQUIRE EFF TEMP DIF, DEGF (LM OVERALL COEFF REQUIRED CLEAN & FOULED COEFF	TD= 51.4,F=			
SHELLS IN SERIES 1 PAR PASSES, SHELL 1 TUB SHELL DIAMETER IN.	E 4 E		FT2/SHELL 7.1	
BAFFLE TYPE HORZ SPACING, CENTRAL IN. SPACING, INLET IN. SPACING, OUTLET IN. BAFFLE THICKNESS IN.	4.309 E 4.309 C 4.309		L I.D. 30.00 NTER, IN764	
PAIRS OF SEALING DEVICE		UBESHEET BLANK AREA		
TUBE TYPE  NO. OF TUBES/SHELL  TUBE LGTH, OVERALL FT  TUBE LGTH, EFF FT  TUBE LAYOUT DEG  PITCH RATIO  SHL NOZZ ID, IN&OUT 1	1.500 T 1.436 T 60 T 1.250 T		36 IN3125 IN250 IN214 DUT/IN 1.184	
* CALCULATED ITEMHE UNAShington University Young model F302DY4P	ChE433 heat	exchanger experime	9/23/ 3 CASE 45	1
S U P P L E M E  HT PARAMETERS SHEL	L TUBE	SHELLSIDE PERFOR	MANCE	
WALL CORRECTION 1.03 PRANDTL NUMBER 7. RYNLD NO, AVG 215 RYNLD NO, IN BUN 153	2 3.9 1602.	NOMINAL VEL, WINDOW CROSSFLOW COEF B	FT/S .15 FU/HR-FT2-F 239.3	
RYNLD NO, OUT BUN 288 FOULNG LAYER IN001	. 1243. 4 .0014	SHELLSIDE FLOW, HEAT TRANSFER X-FL	% OF TOTAL DW 81.58	
THERMAL RESISTANCE, % C SHELL TUBE FOULING 42.37 55.35 2.21	METAL .07	MAIN CROSSFLOW BUNDLE TO SHELL BY	B = 66.96 PASS $C = 13.95$	
PCT OVER DESIGN TOT FOUL RESIST DIFF RESIST	.00 .000217 .000000			
DIAMETRAL CLEARANCES BUNDLE TO SHELL IN TUBE TO BAFFLE HOLE IN BAFFLE TO SHELL IN	0284	GAMMA (TUBE ROW EN	A)(FIN) = .649 CTOR) = .920 FRY EFCT) = .705	

SHELL NOZZLE DATA	IN	OUT	SHELL PRESSURE DROP,	% OF	TOTAL
HT UNDR NOZ IN.	.25		WINDOW		= 8.8
HT OPP NOZ IN.	.25		END ZONE		= 4.4
VELOCITY FT/S	.49	.49	CROSS FLOW		= 3.8
DENSITY LB/FT3	62.535	62.038	INLET NOZZLE		= 42.8
NOZZ RHO*VSQ LB/FT-S	14	15	OUTLET NOZZLE		= 40.1
BUND RHO*VSQ LB/FT-S	10	10			
TUBE NOZZLE DATA	IN	OUT	WEIGHT PER SHELL, LB		
VELOCITY FT/S	.89	.88	DRY	=	150.
DENSITY LB/FT3	61.291	62.004	WET	=	165.
PRESS. DROP %	8.2	5.2			

## *** SPECIAL MESSAGES AND WARNINGS ***

WARNING--TUBESIDE FLUID HAS PASSED THROUGH TRANSITION ZONE. CONSIDER RERUNNING WITH ITEM 132 IN EFFECT.

SIZE 4- 18 TYPE BEM, MULTI-PASS FLOW, SEGMENTAL BAFFLES, RATING

SIZE 4- 18 TYPE BEI	M, MULTI-PASS	FLOW, SEGME	INTAL BAFFLE	S, RATING	
		HOT TU	BE SIDE	COLD SH	ELL SIDE
		Tube		Shell	
		SENSI	BLE LIQ	SENSI	BLE LIQ
TOTAL FLOW RATE			.600		.700
		IN	OUT	IN	OUT
TEMPERATURE	DEGF	140.0	88.1*	40.0	84.2*
DENSITY	LB/FT3	61.2913	62.0429	62.5352	62.0902
VISCOSITY	CP	.4726	.7877	1.4791	.8238
SPECIFIC HEAT	BTU/LB-F	.9973	.9996	1.0058	1.0000
THERMAL COND.	BTU/HR-FT-F	.3723	.3602	.3466	.3592
MOLAR MASS	LB/LBMOL		18.02		18.02
TEMP, AVG & SKIN	DEGF	114.1	84.2	62.1	83.0
VISCOSITY, AVG & SI	KIN CP	.5993	.8243	1.0828	.8362
PRESSURE, IN & DES	IGN PSIA	50.00	165.00	50.00	165.00
PRESSURE DROP, TOT	& ALLOWED PS	SI .07	10.00	.01	10.00
VELOCITY, CALC & MA	AX ALLOWED FI	r/s .58	10.00	.11	10.00
FOULING RESISTANCE					
FILM COEFFICIENT	BTU/HR-FT	T2-F 21	.8.35	26	1.47
TOTAL HEAT DUTY REG					.031044
EFF TEMP DIF, DEGF			ASS= .94,BAF		
OVERALL COEFF REQU					106.19
CLEAN & FOULED COE	FF BTU/HR-	-FT2-F	108.91		106.07
SHELLS IN SERIES					
PASSES, SHELL	1 TUBE 4	EFFECTIVE	AREA	FT2/SHELL	7.1

	che433b(40).OUT
SHELL DIAMETER IN. 3.820	che433b(40).OUT TEMA SHELL TYPE E ; REAR HEAD FXTS
BAFFLE TYPE HORZ SEGMENTI.	CROSS PASSES PER SHELL PASS 4
SDACING CENTRAL IN / 309	CROSS PASSES PER SHELL PASS 4 BAFFLE CUT, PCT SHELL I.D. 30.00
SPACING, INLET IN. 4.309	CUT DISTANCE FROM CENTER, IN764
SPACING, OUTLET IN. 4.309	
BAFFLE THICKNESS IN125	IMPINGEMENT BAFFLE INCLUDED NO
PAIRS OF SEALING DEVICES 1	TUBESHEET BLANK AREA, % .0
TUBE TYPE PLAIN NO. OF TUBES/SHELL 76	MATERIAL ELECTROLYTIC COPPER
NO. OF TUBES/SHELL 76	EST MAX TUBE COUNT 36
TUBE LOTH, OVERALL FT 1 500	TUBE PITCH IN 3125
TIBE ICTH FFF FT 1 /36	TUBE OUTSIDE DIAM IN 250
TIDE LAVOID DEC 60	TUDE THOUSE DIAM IN
TUBE LATUUT DEG 00	TUBE PITCH IN3125 TUBE OUTSIDE DIAM IN250 TUBE INSIDE DIAM IN214 TUBE SURFACE RATIO, OUT/IN 1.184
PITCH RATIO 1.250	TUBE SURFACE RATIO, OUT/IN 1.184
SHL NOZZ ID, IN&OUT 1.0 1.0	TUBE NOZZ ID, IN&OUT IN8 .8
* CALCULATED ITEMHEAT BALANCE	CODE = 8
□□Washington University ChE433 hea	t exchanger experiment E0002 P 93
Young model F302DY4P	9/23/ 3
	CASE 46
SUPPLEMENTAR	
HT PARAMETERS SHELL TUBE	CHELL CIDE DEDECRMANCE
WALL CORRECTION 1.037 .000	SHELLSIDE PERFORMANCE
WALL CORRECTION 1.037 .000	NOMINAL VEL, X-FLOW FT/S .09 NOMINAL VEL, WINDOW FT/S .18
PRANDTL NUMBER 7.4 3.9	NOMINAL VEL, WINDOW FT/S .18
RYNLD NO, AVG 244. 1578.	CROSSFLOW COEF BTU/HR-FT2-F 262.5 WINDOW COEF BTU/HR-FT2-F 264.1
RYNLD NO, IN BUN 178. 2000.	WINDOW COEF BTU/HR-FT2-F 264.1
RYNLD NO, OUT BUN 320. 1200.	
FOULNG LAYER IN0014 .0014	SHELLSIDE FLOW, % OF TOTAL
	HEAT TRANSFER X-FLOW 81.57
THEDMAI DESISTANCE & OF TOTAL	TUBE TO BAFFLE LEAKAGE A = 3.43
SHELL TUBE FOULING METAL	MAIN CROSSFLOW B = 66.25
SHELL TUBE FOULING METAL	BUNDLE TO SHELL BYPASS C = 14.63
40.11 57.51 2.30 .08	BUNDLE TO SHELL BYPASS C = 14.63
PCT OVER DESIGN11	BONDLE TO SHELL BIPASS C = 14.65  BAFFLE TO SHELL LEAKAGE E = 15.69  TUBE PASSLANE BYPASS F = .00
TOT FOUL RESIST .000217	TUBE PASSLANE BYPASS $F = .00$
DIFF RESIST000010	
	SHELLSIDE HEAT TRANSFER FACTORS
DIAMETRAL CLEARANCES	TOTAL = (BETA) (GAMMA) (FIN) = .664 BETA (BAFF CUT FACTOR) = .920
BUNDLE TO SHELL IN5000	BETA (BAFF CUT FACTOR) = .920
TUBE TO BAFFLE HOLE IN 0284	GAMMA (THRE ROW ENTRY EFCT) = $722$
DARRIE TO CHRIT IN 1000	END (HT LOSS IN END ZONE) = .994
BAFFLE TO SHELL IN1000	END (HI LOSS IN END ZONE)994
SHELL NOZZLE DATA IN OUT	SHELL PRESSURE DROP. & OF TOTAL
HT UNDR NOZ IN25 HT OPP NOZ IN25	
	WINDOW = 8.8
HT OPP NOZ IN25	WINDOW = 8.8 END ZONE = 4.1
VELOCITY FT/S .57 .57	WINDOW = 8.8 END ZONE = 4.1 CROSS FLOW = 3.6
NT OPP NOZ IN25 VELOCITY FT/S .57 .57 DENSITY LB/FT3 62.535 62.090	WINDOW = 8.8 END ZONE = 4.1 CROSS FLOW = 3.6 INLET NOZZLE = 42.9
VELOCITY FT/S .57 .57 DENSITY LB/FT3 62.535 62.090 NOZZ RHO*VSO LB/FT-S2 20 20	WINDOW = 8.8 END ZONE = 4.1 CROSS FLOW = 3.6 INLET NOZZLE = 42.9
VELOCITY FT/S .57 .57 DENSITY LB/FT3 62.535 62.090 NOZZ RHO*VSO LB/FT-S2 20 20	WINDOW = 8.8 END ZONE = 4.1 CROSS FLOW = 3.6 INLET NOZZLE = 42.9
VELOCITY         FT/S         .57         .57           DENSITY         LB/FT3         62.535         62.090	WINDOW = 8.8 END ZONE = 4.1 CROSS FLOW = 3.6 INLET NOZZLE = 42.9
VELOCITY FT/S .57 .57  DENSITY LB/FT3 62.535 62.090  NOZZ RHO*VSQ LB/FT-S2 20 20  BUND RHO*VSQ LB/FT-S2 13 13	WINDOW = 8.8 END ZONE = 4.1 CROSS FLOW = 3.6 INLET NOZZLE = 42.9 OUTLET NOZZLE = 40.5
VELOCITY FT/S .57 .57 DENSITY LB/FT3 62.535 62.090 NOZZ RHO*VSO LB/FT-S2 20 20	WINDOW = 8.8  END ZONE = 4.1  CROSS FLOW = 3.6  INLET NOZZLE = 42.9  OUTLET NOZZLE = 40.5

= 165.

DENSITY LB/FT3 61.291 62.043 WET
PRESS. DROP % 8.2 5.1

### *** SPECIAL MESSAGES AND WARNINGS ***

WARNING--TUBESIDE FLUID HAS PASSED THROUGH TRANSITION ZONE. CONSIDER RERUNNING WITH ITEM 132 IN EFFECT.

F.0002 P 94 □□Washington University ChE433 heat exchanger experiment

□□Washington University Young model F302D	<del>-</del>	eat exchang	ger experim	ent	E0002 P 94 9/23/ 3
					CASE 47
SIZE 4- 18 TYPE B	EM, MULTI-PASS I	FLOW, SEGME	ENTAL BAFFL	ES, RATING	
	,		JBE SIDE		
					1
		SENSI	IBLE LIQ	SENS	IBLE LIQ
TOTAL FLOW RATE	KLB/HR		600		.800
		IN	OUT	IN	OUT
TEMPERATURE	DEGF	140.0	85.6*	40.0	80.6*
DENSITY	LB/FT3			62.5352	62.1328
VISCOSITY	CP	.4726	.8112	1.4791	.8594
SPECIFIC HEAT	BTU/LB-F	.9973	.9998		1.0003
THERMAL COND.	BTU/HR-FT-F	.3723	.3596	.3466	.3583
MOLAR MASS	LB/LBMOL		18.02		18.02
TEMP, AVG & SKIN	DEGF		81.6		
VISCOSITY, AVG & :	SKIN CP	.6069	.8496	1.1090	.8626
PRESSURE, IN & DE	SIGN PSIA	50.00	165.00	50.00	165.00
PRESSURE DROP, TO				.01	10.00
VELOCITY, CALC & I	MAX ALLOWED FT	/s .58	10.00	.12	10.00
FOULING RESISTANCE					00010
FILM COEFFICIENT	BTU/HR-FT2	2-F 21	18.28	2	84.03
TOTAL HEAT DUTY R					.032589
EFF TEMP DIF, DEG			ASS= .94,BA	FF=1.00)	41.6
OVERALL COEFF REQ					109.59
CLEAN & FOULED CO	EFF BTU/HR-I	FT2-F	112.6	1	109.54
SHELLS IN SERIES	1 PARALLEL 1	TOTAL EFF			
PASSES, SHELL	1 TUBE 4	EFFECTIVE	E AREA		
SHELL DIAMETER IN	. 3.820	TEMA SHEI	LL TYPE E	; REAR H	EAD FXTS
BAFFLE TYPE					
SPACING, CENTRAL	IN. 4.309	BAFFLE CU	JT, PCT SHE	LL I.D.	30.00
SPACING, INLET	IN. 4.309	CUT DISTA	ANCE FROM C	ENTER, IN.	.764
SPACING, OUTLET	IN. 4.309				
BAFFLE THICKNESS					NO
PAIRS OF SEALING	DEVICES 1	TUBESHEET	r blank are.	A, %	.0
TUBE TYPE	PLAIN	MATERIAL	E	LECTROLYTI	C COPPER
NO. OF TUBES/SHELT	L 76	EST MAX 7	TUBE COUNT		36

TUBE LGTH, OVERALL FT 1.500 T	UBE PITCH IN3125
TUBE LGTH, EFF FT 1.436 T	UBE OUTSIDE DIAM IN250
TUBE LAYOUT DEG 60 T	UBE INSIDE DIAM IN214
PITCH RATIO 1.250 T	UBE SURFACE RATIO, OUT/IN 1.184
SHL NOZZ ID, IN&OUT 1.0 1.0 T	UBE NOZZ ID, IN&OUT IN8 .8
* CALCULATED ITEMHEAT BALANCE C	ODE = 8
□□Washington University ChE433 heat	exchanger experiment E0002 P 95
Young model F302DY4P	9/23/ 3
Tourig model 15022111	CASE 47
S U P P L E M E N T A R	
	I RESULIS
D.D.WEEDO	averrane personavas
HT PARAMETERS SHELL TUBE	SHELLSIDE PERFORMANCE
	NOMINAL VEL, X-FLOW FT/S .10
PRANDTL NUMBER 7.6 4.0	NOMINAL VEL, WINDOW FT/S .20
RYNLD NO, AVG 272. 1558.	CROSSFLOW COEF BTU/HR-FT2-F 285.2
	WINDOW COEF BTU/HR-FT2-F 286.9
RYNLD NO, OUT BUN 351. 1166.	
FOULNG LAYER IN0014 .0014	SHELLSIDE FLOW, % OF TOTAL
	HEAT TRANSFER X-FLOW 81.58
THERMAL RESISTANCE, % OF TOTAL	TUBE TO BAFFLE LEAKAGE A = 3.57
SHELL TUBE FOULTING METAL	MAIN CROSSFLOW B = 65.64
38 13 59 41 2 38 08	BUNDLE TO SHELL BYPASS C = 15.22
DOT OVER DESIGN - OA	BAFFLE TO SHELL LEAKAGE E = 15.58
TOT OVER DESIGN .04	TUBE PASSLANE BYPASS F = .00
DIFF RESIST000004	TUBE PASSLANE BIPASS F00
DIFF RESIST000004	
DILVERDIT GLEDDINGEG	SHELLSIDE HEAT TRANSFER FACTORS TOTAL = (BETA) (GAMMA) (FIN) = .679
DIAMETRAL CLEARANCES	TOTAL = (BETA) (GAMMA) (FIN) = .6/9
	BETA (BAFF CUT FACTOR) = .920
	GAMMA (TUBE ROW ENTRY EFCT) = .738
BAFFLE TO SHELL IN1000	END (HT LOSS IN END ZONE) = .994
	SHELL PRESSURE DROP, % OF TOTAL
HT UNDR NOZ IN25	WINDOW = 8.8
HT OPP NOZ IN25	END ZONE = 3.9
VELOCITY FT/S .65 .66	WINDOW = 8.8 END ZONE = 3.9 CROSS FLOW = 3.4 INLET NOZZLE = 43.0
DENSITY LB/FT3 62.535 62.133	INLET NOZZLE = 43.0
NOZZ RHO*VSQ LB/FT-S2 26 26	OUTLET NOZZLE = 40.8
BUND RHO*VSQ LB/FT-S2 18 18	
10	
TUBE NOZZLE DATA IN OUT	WEIGHT PER SHELL, LB
VELOCITY FT/S .89 .88	DRY = $150.$
DENSITY LB/FT3 61.291 62.074	WET = 165.
	— 103.
PRESS. DROP % 8.1 5.1	

## *** SPECIAL MESSAGES AND WARNINGS ***

WARNING--TUBESIDE FLUID HAS PASSED THROUGH TRANSITION ZONE. CONSIDER RERUNNING WITH ITEM 132 IN EFFECT.

					CASE 48
SIZE 4- 18 TYPE BEM	M, MULTI-PASS E	LOW, SEGME	NTAL BAFFLE	ES, RATING	
		HOT TU	JBE SIDE	COLD SI	HELL SIDE
				Shell	
			BLE LIQ		
TOTAL ELOW DATE	עו ס / טס	DHIDI	600	SHIVS.	מטט
TOTAL FLOW RATE	VTD/ UK	T. 7. 7. 7. 7. 7. 7. 7. 7. 7. 7. 7. 7. 7.	.000	T.1.1	. 900
		IN	OUT	IN	00.1
TEMPERATURE	DEGF'	140.0	83.3*	40.0	//.6*
	LB/FT3				
	CP		.8326	1.4791	.8910
SPECIFIC HEAT	BTU/LB-F	.9973	1.0001	1.0058	1.0006
THERMAL COND. MOLAR MASS	BTU/HR-FT-F	.3723	.3590	.3466	.3574
MOLAR MASS	LB/LBMOL	.3723	18.02		18.02
TEMP, AVG & SKIN	DEGF	111.7	79.3	58.8	78.0
VISCOSITY, AVG & SK			.8727		
PRESSURE, IN & DESI	ICM PSTA	50 00	165.00		
INESSONE, IN & DESI	IGN ISIA	30.00	103.00	30.00	103.00
PRESSURE DROP, TOT	c Allowed Del	. 07	10 00	0.2	10 00
VELOCITY, CALC & MA					
VELOCITY, CALC & MA	AX ALLOWED F.I.\	5 .58	10.00	. 14	10.00
	- 1	_			
FOULING RESISTANCE					
FILM COEFFICIENT					06.55
-					
TOTAL HEAT DUTY REQ					.033937
EFF TEMP DIF, DEGF			ASS= .95,BAI	FF=1.00)	42.1
OVERALL COEFF REQUI	IRED BTU/HR-E	T2-F			112.89
CLEAN & FOULED COEF	FF BTU/HR-F	T2-F	115.96	5	112.66
SHELLS IN SERIES 1	l parallel 1	TOTAL EFF	` AREA	FT2	7.1
PASSES, SHELL 1	L TUBE 4	EFFECTIVE	AREA	FT2/SHELL	7.1
SHELL DIAMETER IN.					
				•	
BAFFLE TYPE HO	ORZ SEGMENTL	CROSS PAS	SES PER SHE	ELL PASS	4
SPACING, CENTRAL I	rn 4 309	BAFFLE CI	IT. PCT SHEI	T. T. D.	30 00
SPACING, INLET I	IN 1.309	CIIT DISTA	NCE EDOM CE	NTED TH	764
SPACING, OUTLET I	IN. 4.303	COI DISTE	MCD INON CI	литшк <b>,</b> ти.	. 704
		TMDTNCEME	NIM DADETH	MOT HEE	NO
BAFFLE THICKNESS I					
PAIRS OF SEALING DE	EVICES I	TUBESHEET	BLANK AREA	A, 8	. 0
TUBE TYPE			EI	TECLKOTALI.	
NO. OF TUBES/SHELL	76	EST MAX T	UBE COUNT		36
TUBE LGTH, OVERALL	FT 1.500	TUBE PITC	H	IN.	
TUBE LGTH, EFF	FT 1.436	TUBE OUTS	SIDE DIAM	IN.	.250
TUBE LAYOUT	DEG 60	TUBE INSI	DE DIAM	IN.	.214
PITCH RATIO	1.250	TUBE SURF	ACE RATIO,	OUT/IN	1.184
PITCH RATIO SHL NOZZ ID, IN&OUT	Γ 1.0 1.0	TUBE NOZZ	ID, IN&OUT	r IN.	.8 .8
,			,		
* CALCULATED ITEM	MHEAT BALANCE	CODE = 8			
□□Washington Univer			er experime	ent.	E0002 P 97
Young model F302DY4	_		,	0	9/23/ 3
roung moder roughly	11				CASE 48
SUPPLEM	1 E N T A	R Y R	- F C II	L T S	CADL 40

HT PARAMETERS SHELL TUBE	
WALL CORRECTION 1.035 .000	NOMINAL VEL, X-FLOW FT/S .12
PRANDTL NUMBER 7.8 4.0	
	CROSSFLOW COEF BTU/HR-FT2-F 307.8
RYNLD NO, IN BUN 229. 2000.	WINDOW COEF BTU/HR-FT2-F 309.6
RYNLD NO, OUT BUN 381. 1136.	
FOOLING LAILE INUU14 .UU14	SUPPRESTOR LTOM, & OL TOTAL
	HEAT TRANSFER X-FLOW 81.56
	TUBE TO BAFFLE LEAKAGE A = 3.69
	MAIN CROSSFLOW $B = 65.38$
	BUNDLE TO SHELL BYPASS C = 15.43
PCT OVER DESIGN20	BAFFLE TO SHELL LEAKAGE E = 15.50 TUBE PASSLANE BYPASS F = .00
TOT FOUL RESIST .000217	TUBE PASSLANE BYPASS $F = .00$
DIFF RESIST000018	
	SHELLSIDE HEAT TRANSFER FACTORS
DIAMETRAL CLEARANCES	TOTAL = (BETA) (GAMMA) (FIN) = $.695$
BUNDLE TO SHELL IN5000	BETA (BAFF CUT FACTOR) = .920
TUBE TO BAFFLE HOLE IN0284	GAMMA (TUBE ROW ENTRY EFCT) = .756
BAFFLE TO SHELL IN1000	END (HT LOSS IN END ZONE) = .994
SHELL NOZZLE DATA IN OUT	SHELL PRESSURE DROP, % OF TOTAL
HT UNDR NOZ IN25	WINDOW = 8.8
HT OPP NOZ IN25	END ZONE = 3.7
VELOCITY FT/S .73 .74	CROSS FLOW = 3.3
DENSITY LB/FT3 62.535 62.168	INLET NOZZLE = 43.1
NOZZ RHO*VSQ LB/FT-S2 33 33	WINDOW = 8.8 END ZONE = 3.7 CROSS FLOW = 3.3 INLET NOZZLE = 43.1 OUTLET NOZZLE = 41.1
BUND RHO*VSQ LB/FT-S2 22 23	
TUBE NOZZLE DATA IN OUT	WEIGHT PER SHELL, LB
VELOCITY FT/S .89 .87	
DENSITY LB/FT3 61.291 62.101	
PRESS. DROP % 8.1 5.1	

# *** SPECIAL MESSAGES AND WARNINGS ***

WARNING--TUBESIDE FLUID HAS PASSED THROUGH TRANSITION ZONE. CONSIDER RERUNNING WITH ITEM 132 IN EFFECT.

□□Washington University ChE433 heat exchanger experiment E0002 P 98
Young model F302DY4P 9/23/3
CASE 49

SIZE 4- 18 TYPE BEM, MULTI-PASS FLOW, SEGMENTAL BAFFLES, RATING

		HOT TO	JBE SIDE	COLD SI	COLD SHELL SIDE		
		Tube	Tube		L		
		SENS	IBLE LIQ	SENS	IBLE LIQ		
TOTAL FLOW RATE	KLB/HR		.700		.200		
		IN	OUT	IN	OUT		
TEMPERATURE	DEGF	140.0	117.0*	40.0	120.3*		
DENSITY	LB/FT3	61.2913	61.6533	62.5352	61.6045		
VISCOSITY	CP	.4726	.5825	1.4791	.5645		
SPECIFIC HEAT	BTU/LB-F	.9973	.9977	1.0058	.9976		

THERMAL COND. BTU MOLAR MASS LB/		che433b(40		.3466	.3681
MOLAR MASS LB/	LBMOL		18.02		18.02
TEMP, AVG & SKIN VISCOSITY, AVG & SKIN	DEGF	128.5	109.1	80.1	108.2
VISCOSITY, AVG & SKIN PRESSURE, IN & DESIGN	CP	.5230	.6298	.8643	.6353
PRESSURE, IN & DESIGN	PSIA	50.00	165.00	50.00	165.00
PRESSURE DROP, TOT & A	LLOWED PSI	.09	10.00	.00	10.00
PRESSURE DROP, TOT & AVELOCITY, CALC & MAX A	ALLOWED FT/S	.68	10.00	.03	10.00
FOULING RESISTANCE	HR-FT2-F/BT	U .00	010	. (	00010
FILM COEFFICIENT	BTU/HR-FT2-	F 234	. 24	1:	35.35
TOTAL HEAT DUTY REQUIF					.016061
EFF TEMP DIF, DEGF (I	MTD= 42.1,F=	.76,BYPAS	S= .88,BAF		28.3
OVERALL COEFF REQUIRED	BTU/HR-FT	2-F			79.54
CLEAN & FOULED COEFF	BTU/HR-FT	2-F	80.76		79.47
SHELLS IN SERIES 1 PAPASSES, SHELL 1 TU	RALLEL 1	TOTAL EFF	AREA	FT2	7.1
PASSES, SHELL 1 TU	JBE 4	EFFECTIVE	AREA	FT2/SHELL	7.1
SHELL DIAMETER IN.	3.820	TEMA SHELL	TYPE E	; REAR HI	EAD FXTS
BAFFLE TYPE HORZ	SEGMENTL	CROSS PASS	ES PER SHE	LL PASS	4
SPACING, CENTRAL IN.	4.309	BAFFLE CUT	, PCT SHEL	L I.D.	30.00
SPACING, CENTRAL IN. SPACING, INLET IN. SPACING, OUTLET IN. BAFFLE THICKNESS IN. PAIRS OF SEALING DEVICE	4.309	CUT DISTAN	ICE FROM CE	NTER, IN.	.764
SPACING, OUTLET IN.	4.309	TMDTNCEMEN		NCILIDED	NO
PAIRS OF STAILING DEVICE	.145 ES 1	TMPINGEMEN	BI'VNK VBE'V	% % %	NO O
TUBE TYPE NO. OF TUBES/SHELL TUBE LGTH, OVERALL FT	PLAIN I	MATERIAL	EL:	ECTROLYTI	C COPPER
NO. OF TUBES/SHELL	/6	EST MAX TU	BE COUNT	T.N.T	36
TUBE LOTH, OVERALL FI	1.500	TUBE PITCH	DE DIAM	IN.	.3123
TIBE LAYOUT DE	1.430	TUBE UUISI Tiire tnetp	DE DIAM	IN.	214
PITCH RATIO	1 250	TUBE INSID	CE RATIO. (	OUT/TN	1 184
TUBE LGTH, OVERALL FT TUBE LGTH, EFF FT TUBE LAYOUT DE PITCH RATIO SHL NOZZ ID, IN&OUT	1.0 1.0	TUBE NOZZ	ID, IN&OUT	IN.	.8 .8
			•		
* CALCULATED ITEMH			er experime	nt.	E0002 P 99
Young model F302DY4P	.,				9/23/ 3
3					CASE 49
S U P P L E M E	N T A R	Y R	E S U	L T S	
HT PARAMETERS SHE			IDE PERFORI	MANCE	
WALL CORRECTION 1.0	.969	NOMINAL	VEL, X-FLOW	FT/S	.03
PRANDTL NUMBER 5	3.4	NOMINAL	VEL, WINDOW		.05
RYNLD NO, AVG	2109.		W COEF B		
RYNLD NO, IN BUN 5	2334.	WINDOW C	OEF B	TU/HR-FT2	-F 134.2
RYNLD NO, OUT BUN 13	1894.			o ====	_
FOULNG LAYER IN00	.0014		IDE FLOW, NSFER X-FL		L 80.18
THERMAL RESISTANCE, %	OF TOTAT.		NSFER X-FL BAFFLE LEA		
SHELL TUBE FOULING		MAIN CRO			= 68.71

		BUNDLE TO SHELL BYPASS C BAFFLE TO SHELL LEAKAGE E TUBE PASSLANE BYPASS F		
DIFF RESIST				
		SHELLSIDE HEAT TRANSFER F		
DIAMETRAL CLEARANCES		TOTAL = (BETA) (GAMMA) (FIN)	=	.598
BUNDLE TO SHELL IN.	.5000	BETA (BAFF CUT FACTOR)	=	.920
TUBE TO BAFFLE HOLE IN.	.0284	GAMMA (TUBE ROW ENTRY EFCT)	=	.650
BAFFLE TO SHELL IN.	.1000	END (HT LOSS IN END ZONE)	=	.998
SHELL NOZZLE DATA IN	OUT	SHELL PRESSURE DROP, % OF	TO	ΓAL
HT UNDR NOZ IN25			=	9.7
		END ZONE	=	7.4
VELOCITY FT/S .16	.17	CROSS FLOW	=	5.7
DENSITY LB/FT3 62.535	61.604	CROSS FLOW INLET NOZZLE	=	41.1
NOZZ RHO*VSQ LB/FT-S2 1	1	OUTLET NOZZLE	=	36.2
BUND RHO*VSQ LB/FT-S2 1	1			
TUBE NOZZLE DATA IN	OUT	WEIGHT PER SHELL, LB		
VELOCITY FT/S 1.03				150.
DENSITY LB/FT3 61.291	61.653	DRY = WET =		165.
PRESS. DROP % 8.7	5.5			

## *** SPECIAL MESSAGES AND WARNINGS ***

WARNING--TUBESIDE FLUID HAS PASSED THROUGH TRANSITION ZONE. CONSIDER RERUNNING WITH ITEM 132 IN EFFECT.

HEAT TRANSFER COEFF. AT RE = 2000 IS 220.45 BTU/HR-FT2-F HEAT TRANSFER COEFF. AT RE = 10000 IS 1233.15 BTU/HR-FT2-F

SIZE	4 –	18	TYPE	BEM,	MULTI-PASS	FLOW,	SEGMENTAL	BAFFLES,	RATING
------	-----	----	------	------	------------	-------	-----------	----------	--------

		HOT T	UBE SIDE	COLD SH	HELL SIDE
		Tube		Shell	L
		SENS	IBLE LIQ	SENSI	BLE LIQ
TOTAL FLOW RATE	KLB/HR		.700		.300
		IN	OUT	IN	OUT
TEMPERATURE	DEGF	140.0	109.7*	40.0	110.5*
DENSITY	LB/FT3	61.2913	61.7589	62.5352	61.7471
VISCOSITY	CP	.4726	.6260	1.4791	.6208
SPECIFIC HEAT	BTU/LB-F	.9973	.9981	1.0058	.9980
THERMAL COND.	BTU/HR-FT-F	.3723	.3656	.3466	.3658
MOLAR MASS	LB/LBMOL		18.02		18.02
TEMP, AVG & SKIN	DEGF	124.8	102.4	75.3	101.5
VISCOSITY, AVG & S	KIN CP	.5409	.6742	.9166	.6810
PRESSURE, IN & DES	IGN PSIA	50.00	165.00	50.00	165.00
PRESSURE DROP, TOT	& ALLOWED PSI	.09	10.00	.00	10.00
VELOCITY, CALC & M	AX ALLOWED FT/	s .68	10.00	.05	10.00

FOULING RESISTANCE FILM COEFFICIENT	BTU/HR-FT2-		.00010 161.71
	MTD= 46.7,F=	.80,BYPASS= .92,BAFF=1.00	
PASSES, SHELL 1 TUI	BE 4 1	FT2  EFFECTIVE AREA FT2/SI  FEMA SHELL TYPE E ; REA	HELL 7.1
BAFFLE TYPE HORZ SPACING, CENTRAL IN. SPACING, INLET IN. SPACING, OUTLET IN. BAFFLE THICKNESS IN. PAIRS OF SEALING DEVICE	4.309 4.309 4.309 .125	CROSS PASSES PER SHELL PASSAFFLE CUT, PCT SHELL I.D. CUT DISTANCE FROM CENTER, IMPINGEMENT BAFFLE INCLUDE TUBESHEET BLANK AREA, %	. 30.00 IN764 ED NO
TUBE TYPE NO. OF TUBES/SHELL TUBE LGTH, OVERALL FT TUBE LGTH, EFF FT	PLAIN 1 76 1 1 1 1 5 0 0 1 1 1 4 3 6 1 1	MATERIAL ELECTRONEST MAX TUBE COUNT TUBE PITCH IN. TUBE OUTSIDE DIAM IN.	LYTIC COPPER 36 .3125 .250
	1.250	TUBE INSIDE DIAM IN. TUBE SURFACE RATIO, OUT/IN TUBE NOZZ ID, IN&OUT IN.	N 1.184
* CALCULATED ITEMHI		CODE = 8 t exchanger experiment	9/23/ 3
□□Washington University Young model F302DY4P	y ChE433 hea		9/23/ 3 CASE 50
University Young model F302DY4P  S U P P L E M E  HT PARAMETERS SHEE WALL CORRECTION 1.04 PRANDTL NUMBER 6 RYNLD NO, AVG 123 RYNLD NO, IN BUN 76	N T A R LL TUBE 42 .964 .2 3.5 3. 2039. 6. 2334.	t exchanger experiment  Y R E S U L T  SHELLSIDE PERFORMANCE NOMINAL VEL,X-FLOW FT/S	9/23/3 CASE 50 S .04 S .08 -FT2-F 162.4
□□Washington University Young model F302DY4P  S U P P L E M E  HT PARAMETERS SHEE WALL CORRECTION 1.04 PRANDTL NUMBER 6 RYNLD NO, AVG 123 RYNLD NO, IN BUN 76 RYNLD NO, OUT BUN 183 FOULNG LAYER IN003	N T A R  LL TUBE 42 .964 .2 3.5 3. 2039 .6. 2334 .2. 1762 .14 .0014	Y R E S U L T  SHELLSIDE PERFORMANCE NOMINAL VEL, X-FLOW FT/S NOMINAL VEL, WINDOW FT/S CROSSFLOW COEF BTU/HR- WINDOW COEF BTU/HR- SHELLSIDE FLOW, % OF S HEAT TRANSFER X-FLOW	9/23/3 CASE 50 S  S  .04 S .08 -FT2-F 162.4 -FT2-F 163.2  TOTAL 81.33
Washington University Young model F302DY4P  S U P P L E M E  HT PARAMETERS SHEEL WALL CORRECTION 1.04 PRANDTL NUMBER 6 RYNLD NO, AVG 123 RYNLD NO, IN BUN 76 RYNLD NO,OUT BUN 183 FOULNG LAYER IN003  THERMAL RESISTANCE, % G SHELL TUBE FOULING 52.89 45.17 1.88	N T A R LL TUBE 42 .964 .2 3.5 3. 2039. 6. 2334. 2. 1762. 14 .0014 DF TOTAL METAL .06	Y R E S U L T  SHELLSIDE PERFORMANCE NOMINAL VEL,X-FLOW FT/S NOMINAL VEL,WINDOW FT/S CROSSFLOW COEF BTU/HR- WINDOW COEF BTU/HR- SHELLSIDE FLOW, % OF S HEAT TRANSFER X-FLOW TUBE TO BAFFLE LEAKAGE MAIN CROSSFLOW BUNDLE TO SHELL BYPASS	9/23/3 CASE 50 S  S  .04 S .08 -FT2-F 162.4 -FT2-F 163.2  TOTAL  81.33 A = 2.72 B = 69.43 C = 11.35
University Young model F302DY4P  S U P P L E M E  HT PARAMETERS SHEE WALL CORRECTION 1.04 PRANDTL NUMBER 6 RYNLD NO, AVG 123 RYNLD NO, IN BUN 76 RYNLD NO, OUT BUN 183 FOULNG LAYER IN003  THERMAL RESISTANCE, % 0 SHELL TUBE FOULING 52.89 45.17 1.88 PCT OVER DESIGN TOT FOUL RESIST DIFF RESIST	N T A R  LL TUBE 42 .964 .2 3.5 3. 2039. 6. 2334. 2. 1762. 14 .0014  DF TOTAL METAL .06 .03 .000217000004	Y R E S U L T  SHELLSIDE PERFORMANCE NOMINAL VEL,X-FLOW FT/S NOMINAL VEL,WINDOW FT/S CROSSFLOW COEF BTU/HR- WINDOW COEF BTU/HR- WINDOW COEF BTU/HR- SHELLSIDE FLOW, % OF S HEAT TRANSFER X-FLOW TUBE TO BAFFLE LEAKAGE MAIN CROSSFLOW BUNDLE TO SHELL BYPASS BAFFLE TO SHELL LEAKAGE TUBE PASSLANE BYPASS	9/23/3 CASE 50 S  S .04 S .08 -FT2-F 162.4 -FT2-F 163.2  TOTAL  81.33 A = 2.72 B = 69.43 C = 11.35 E = 16.51 F = .00
DOWNSHINGTON University Young model F302DY4P  S U P P L E M E  HT PARAMETERS SHEE WALL CORRECTION 1.04 PRANDTL NUMBER 6 RYNLD NO, AVG 123 RYNLD NO, IN BUN 76 RYNLD NO, OUT BUN 183 FOULNG LAYER IN003  THERMAL RESISTANCE, % 6 SHELL TUBE FOULING 52.89 45.17 1.88 PCT OVER DESIGN TOT FOUL RESIST DIFF RESIST  DIAMETRAL CLEARANCES BUNDLE TO SHELL IN TUBE TO BAFFLE HOLE IN	N T A R  LL TUBE 42 .964 .2 3.5 3. 2039. 6. 2334. 2. 1762. 14 .0014  DF TOTAL METAL .06 .03 .000217000004  N5000 N0284	Y R E S U L T  SHELLSIDE PERFORMANCE NOMINAL VEL, X-FLOW FT/S NOMINAL VEL, WINDOW FT/S CROSSFLOW COEF BTU/HR- WINDOW COEF BTU/HR- WINDOW COEF BTU/HR- TRANSFER X-FLOW TUBE TO BAFFLE LEAKAGE MAIN CROSSFLOW BUNDLE TO SHELL BYPASS BAFFLE TO SHELL LEAKAGE TUBE PASSLANE BYPASS	9/23/3 CASE 50 S  S  .04 S .08 -FT2-F 162.4 -FT2-F 163.2  TOTAL  81.33 A = 2.72 B = 69.43 C = 11.35 E = 16.51 F = .00  ER FACTORS N) = .601 = .920 FCT) = .653

SHELL NOZZLE DATA I	N OUT	SHELL PRESSURE DROP, %	oF.	TOTAL
HT UNDR NOZ IN2	5	WINDOW		= 9.2
HT OPP NOZ IN2	5	END ZONE		= 5.7
VELOCITY FT/S .2	.25	CROSS FLOW		= 4.7
DENSITY LB/FT3 62.53	5 61.747	INLET NOZZLE		= 42.3
NOZZ RHO*VSQ LB/FT-S2	3 3	OUTLET NOZZLE		= 38.1
BUND RHO*VSQ LB/FT-S2	2 2			
TUBE NOZZLE DATA	N OUT	WEIGHT PER SHELL, LB		
VELOCITY FT/S 1.0	3 1.03	DRY	=	150.
DENSITY LB/FT3 61.29	1 61.759	WET	=	165.
PRESS. DROP % 8.	6 5.4			

### *** SPECIAL MESSAGES AND WARNINGS ***

WARNING--TUBESIDE FLUID HAS PASSED THROUGH TRANSITION ZONE. CONSIDER RERUNNING WITH ITEM 132 IN EFFECT.

HEAT TRANSFER COEFF. AT RE = 2000 IS 221.66 BTU/HR-FT2-F HEAT TRANSFER COEFF. AT RE = 10000 IS 1241.91 BTU/HR-FT2-F

SIZE 4- 18 TYPE BEM, MULTI-PASS FLOW, SEGMENTAL BAFFLES, RATING

SIZE 4- 18 TYPE BE	M, MULTI-PASS F	LOW, SEGME	INTAL BAFFLE	S, RATING		
		HOT TU	JBE SIDE	COLD SE	HELL SIDE	
		Tube		Shell	L	
		SENSI	BLE LIQ	SENSI	IBLE LIQ	
TOTAL FLOW RATE			.700		.400	
		IN	OUT	IN	OUT	
TEMPERATURE	DEGF					
DENSITY	LB/FT3	61.2913	61.8356	62.5352	61.8580	
VISCOSITY	CP	.4726	.6623	1.4791	.6738	
SPECIFIC HEAT	BTU/LB-F	.9973	.9984	1.0058	.9985	
THERMAL COND.	BTU/HR-FT-F	.3723	.3643	.3466	.3639	
MOLAR MASS			18.02			
TEMP, AVG & SKIN	DEGF	122.1	96.9	71.3	95.9	
VISCOSITY, AVG & S	KIN CP	.5550	.7148	.9631	.7230	
PRESSURE, IN & DES					165.00	
PRESSURE DROP, TOT	& ALLOWED PSI	.09	10.00	.00	10.00	
VELOCITY, CALC & M					10.00	
FOULING RESISTANCE	HR-FT2-F/B	STU .C	00010	. (	00010	
FILM COEFFICIENT	BTU/HR-FT2	-F 22	22.46	18	39.60	
TOTAL HEAT DUTY RE	QUIRED MEGBTU/H	IR			.025034	
EFF TEMP DIF, DEGF	(LMTD= 49.6,F	'= .82,BYPA	ASS= .93,BAF	F=1.00)	37.8	
OVERALL COEFF REQU					92.61	
CLEAN & FOULED COE			94.94		92.93	

		che433b(40).OUT	
SHELLS IN SERIES 1 PARALL	EL 1	TOTAL EFF AREA FT2	7.1
PASSES, SHELL 1 TUBE		EFFECTIVE AREA FT2/SHELL	7 1
SHELL DIAMETER IN.		TEMA SHELL TYPE E ; REAR HE	
SHELL DIAMETER IN.	3.020	IEMA SHELL IIPE E , KEAR HI	TAD FAIS
BAFFLE TYPE HORZ SEG		CROSS PASSES PER SHELL PASS	
SPACING, CENTRAL IN.	4.309	BAFFLE CUT, PCT SHELL I.D.	30.00
SPACING, INLET IN.	4.309	CUT DISTANCE FROM CENTER, IN.	.764
SPACING, OUTLET IN.	4.309		
BAFFLE THICKNESS IN.		IMPINGEMENT BAFFLE INCLUDED	NO
PAIRS OF SEALING DEVICES		TUBESHEET BLANK AREA, %	
TAINS OF SEADING DEVICES		TODESHEET BLANK AKEA, *	• 0
	D	W1 == 0 = 1 = 0 = 1 = 1	
		MATERIAL ELECTROLYTIC	
NO. OF TUBES/SHELL		EST MAX TUBE COUNT	
TUBE LGTH, OVERALL FT	1.500	TUBE PITCH IN.	.3125
TUBE LGTH, EFF FT	1.436	TUBE OUTSIDE DIAM IN.	.250
TUBE LAYOUT DEG	60	TUBE INSIDE DIAM IN.	.214
		TUBE SURFACE RATIO, OUT/IN	
SHL NOZZ ID, IN&OUT 1.0			.8 .8
3111 NOZZ 1D, 1N&OO1 1.0	1.0	TOBE NOZZ ID, INGOOT IN.	.0
		2077	
* CALCULATED ITEMHEAT			
-	E433 hea	t exchanger experiment	E0002 P103
Young model F302DY4P			9/23/ 3
			CASE 51
SUPPLEMEN	T A R	Y RESULTS	
HT PARAMETERS SHELL	THE	SHELLSIDE PERFORMANCE	
WALL CORRECTION 1.041			0.5
	3.6		
RYNLD NO, AVG 156.			
RYNLD NO, IN BUN 102.	2334.	WINDOW COEF BTU/HR-FT2-	-F 191.5
RYNLD NO, OUT BUN 223.	1665.		
FOULNG LAYER IN0014	.0014	SHELLSIDE FLOW, % OF TOTAL	J
		HEAT TRANSFER X-FLOW	
THERMAL RESISTANCE, % OF T	$\cap$ T $\Lambda$ T		
SHELL TUBE FOULING ME			
		BUNDLE TO SHELL BYPASS C	
PCT OVER DESIGN		BAFFLE TO SHELL LEAKAGE E	
		TUBE PASSLANE BYPASS F	= .00
DIFF RESIST .	000037		
		SHELLSIDE HEAT TRANSFER FA	ACTORS
DIAMETRAL CLEARANCES		TOTAL = (BETA) (GAMMA) (FIN)	= .618
		BETA (BAFF CUT FACTOR)	
		GAMMA (TUBE ROW ENTRY EFCT)	
BAFFLE TO SHELL IN.	.1000	END (HT LOSS IN END ZONE)	= .994
		SHELL PRESSURE DROP, % OF	TOTAL
HT UNDR NOZ IN25		WINDOW	= 9.0
HT OPP NOZ IN25			= 5.1
VELOCITY FT/S .33			= 4.3
DENSITY LB/FT3 62.535			= 42.6
NOZZ RHO*VSQ LB/FT-S2 6			= 39.0
BUND RHO*VSQ LB/FT-S2 4	4		

TUBE NOZZLE DA	TA IN	OUT	WEIGHT	PER	SHELL,	LB		
VELOCITY FT/	s 1.03	1.02	DRY				=	150.
DENSITY LB/FT	3 61.291	61.836	WET				=	165.
PRESS. DROP %	8.5	5.4						

### *** SPECIAL MESSAGES AND WARNINGS ***

WARNING--TUBESIDE FLUID HAS PASSED THROUGH TRANSITION ZONE. CONSIDER RERUNNING WITH ITEM 132 IN EFFECT.

□□Washington University ChE433 heat exchanger experiment E0002 P104

□□Washington Unive Young model F302DY		eat exchang	ger experim		9/23/ 3
SIZE 4- 18 TYPE BE	M MIII.TT-PASS	FIOW SEGME	ZNTAT. RAFFT.		CASE 52
	11, 110111 11100				
		Tube	JBE SIDE	Shell	l SIDE
	MID/ND	SENS	700	SENS.	200 200
TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY	VTD/ UK	TNI	. / 0 0	TN	. 300
	DECE	140 0	001	10 0	06.3
DENGINA	DEGE	C1 2012	99.7	40.0	90.3
DENSITY	LB/FT3	01.2913	61.8960	02.3332	61.9407
VISCOSITY	CP	.4/26	.6943	1.4/91	. /201
SPECIFIC HEAT	B.L.O.\ TB-F.	.99/3	.9987	1.0058	.9989
THERMAL COND.		.3723	.3632	.3466	.3623
MOLAR MASS	LB/LBMOL		18.02		18.02
TEMP, AVG & SKIN	DEGF	119 8	92.7	68.I	91.5
VISCOSITY, AVG & S	KIN CP	.5669	.7488	1.0018	.7583
PRESSURE, IN & DES	IGN PSIA	50.00			
PRESSURE DROP, TOI	' & ALLOWED PS	T .09	10.00	. 01	10.00
VELOCITY, CALC & M	ALLOWED FT	1/S .68	10.00	.08	10.00
FOULING RESISTANCE	HR-FT2-F/	BTU .(	00010	. (	00010
FILM COEFFICIENT	BTU/HR-FT	'2-F 22	22.50	2.3	15.49
TOTAL HEAT DUTY RE	OUITED MEGRIU				.028174
EFF TEMP DIF, DEGF			199 94 B1	FF=1 00)	40.0
OVERALL COEFF REQU			100 J 1 , DA	11-1.00)	98.58
CLEAN & FOULED COE			101 0	2	98.68
CLEAN & FOOLED COE	FF BIU/HK-	·F 1 Z - F	101.0	3	90.00
SHELLS IN SERIES	1 PARALLEL 1	TOTAL EF	F AREA	FT2	7.1
PASSES, SHELL	1 TUBE 4	EFFECTIVE	E AREA	FT2/SHELL	
SHELL DIAMETER IN.	3.820	TEMA SHEI	LL TYPE E	; REAR HI	EAD FXTS
BAFFLE TYPE H	ORZ SEGMENTI	CROSS PAS	SSES PER SH	ELL PASS	4
SPACING, CENTRAL					
SPACING, INLET			ANCE FROM C		
SPACING OUTTET	IN 1.300				
SPACING, OUTLET BAFFLE THICKNESS	TN 125	TMDTNCEME	יאים פא פידי	TNCTIDED	NO
PAIRS OF SEALING D	INIZJ	THI THGEN	ממע ממעום יי	V 8	.0
THIRD OF SEALING L	T ATCED T	TOPPOUFF	DUANN AKE	n, o	. 0

TUBE TYPE	PLAIN N	MATERIAL ELECTROLYTI	IC COPPER
NO. OF TUBES/SHELL	76 I	EST MAX TUBE COUNT	36
TUBE LGTH, OVERALL FT	1.500	TUBE PITCH IN.	.3125
TUBE LGTH, EFF FT	1.436	TUBE OUTSIDE DIAM IN.	.250
		TUBE INSIDE DIAM IN.	
		TUBE SURFACE RATIO, OUT/IN	
		TUBE NOZZ ID, IN&OUT IN.	
,		,	
* CALCULATED ITEMHEAT	BALANCE (	CODE = 8	
□□Washington University Cl	hE433 heat	t exchanger experiment	E0002 P105
Young model F302DY4P			9/23/ 3
			CASE 52
S U P P L E M E N	T A R	Y RESULTS	
		SHELLSIDE PERFORMANCE	
		NOMINAL VEL, X-FLOW FT/S	
PRANDTL NUMBER 6.8		· ·	
		CROSSFLOW COEF BTU/HR-FT2	
RYNLD NO, IN BUN 127.	2334.	WINDOW COEF BTU/HR-FT2	2-F 217.7
RYNLD NO, OUT BUN 262.			
FOULNG LAYER IN0014	.0014	SHELLSIDE FLOW, % OF TOTA	ΑL
		HEAT TRANSFER X-FLOW	81.52
THERMAL RESISTANCE, % OF '	TOTAL	TUBE TO BAFFLE LEAKAGE	A = 3.14
SHELL TUBE FOULING M	ETAL	MAIN CROSSFLOW	3 = 67.61
45.28 52.51 2.14	.07	BUNDLE TO SHELL BYPASS (	c = 13.27
PCT OVER DESIGN	.10	BAFFLE TO SHELL LEAKAGE	E = 15.98
TOT FOUL RESIST	.000217	BAFFLE TO SHELL LEAKAGE TUBE PASSLANE BYPASS	.00
DIFF RESIST	.000011		
		SHELLSIDE HEAT TRANSFER H	FACTORS
DIAMETRAL CLEARANCES		SHELLSIDE HEAT TRANSFER F TOTAL = (BETA) (GAMMA) (FIN)	= .635
BUNDLE TO SHELL IN.	.5000	BETA (BAFF CUT FACTOR)	= .920
TUBE TO BAFFLE HOLE IN.	.0284	GAMMA (TUBE ROW ENTRY EFCT)	= .690
BAFFLE TO SHELL IN.	.1000	END (HT LOSS IN END ZONE)	= .994
		SHELL PRESSURE DROP, % OF	
HT UNDR NOZ IN25			= 8.9
HT OPP NOZ IN25	5	END ZONE	= 4.7
VELOCITY FT/S .43	1 .41	CROSS FLOW	= 4.0
DENSITY LB/FT3 62.53	5 61.941	INLET NOZZLE	= 42.8
NOZZ RHO*VSQ LB/FT-S2 10		OUTLET NOZZLE	= 39.6
BUND RHO*VSQ LB/FT-S2	7 7		
		WEIGHT PER SHELL, LB	
VELOCITY FT/S 1.03		DRY =	200.
DENSITY LB/FT3 61.293		WET =	165.
PRESS. DROP % 8.4	4 5.3		

^{***} SPECIAL MESSAGES AND WARNINGS ***

WARNING--TUBESIDE FLUID HAS PASSED THROUGH TRANSITION ZONE. CONSIDER RERUNNING WITH ITEM 132 IN EFFECT.

 $\square\square$ Washington University ChE433 heat exchanger experiment E0002 P106 Young model F302DY4P 9/23/3

CASE 53

SIZE 4- 18 TYPE BEM, MULTI-PASS FLOW, SEGMENTAL BAFFLES, RATING

0120 4 10 1110 00	M, MULTI-PASS	FLOW, SEGME	ENTAL BAFFLE	S, RATING	
		HOT TU	JBE SIDE	COLD SH	HELL SIDE
		Tube		Shell	
		SENSI	BLE LIQ	SENSI	BLE LIQ
TOTAL FLOW RATE TEMPERATURE DENSITY	KLB/HR		.700		.600
		IN	OUT	IN	OUT
TEMPERATURE	DEGF	140.0	95.9*	40.0	91.2*
DENSITY	LB/FT3	61.2913	61.9446	62.5352	62.0054
VISCOSITY	CP	.4726	.7225	1.4791	.7614
SPECIFIC HEAT	BTU/LB-F	.9973	.9990	1.0058	.9993
THERMAL COND.	BTU/HR-FT-F	.3723	.3622	.3466	.3610
MOLAR MASS	LB/LBMOL		18.02		18.02
TEMP, AVG & SKIN	DEGF		89.1 .7790		
VISCOSITY, AVG & S	KIN CP	.5770	.7790	1.0349	.7898
PRESSURE, IN & DES		50.00	165.00	50.00	165.00
PRESSURE DROP, TOT VELOCITY, CALC & M	& ALLOWED PS:	I .09	10.00	.01	10.00
VELOCITY, CALC & M	AX ALLOWED FT	/S .68	10.00	.09	10.00
FOULING RESISTANCE FILM COEFFICIENT	HR-FT2-F/I BTU/HR-FT:	2-F 22	22.44		00010
TOTAL HEAT DUTY RE	OTITOED MECOMIT/	IID			020766
	COTUED WEGDIO\	HK			.030766
EFF TEMP DIF, DEGF	(LMTD= 52.3,	нк F= .84,ВҮРА	ASS= .94,BAF	F=1.00)	41.5
EFF TEMP DIF, DEGF	(LMTD= 52.3,	F= .84,BYPA	ASS= .94,BAF	F=1.00)	
EFF TEMP DIF, DEGF OVERALL COEFF REQU CLEAN & FOULED COE	(LMTD= 52.3,1 IRED BTU/HR-1	F= .84,BYPA FT2-F		F=1.00)	41.5
EFF TEMP DIF, DEGF OVERALL COEFF REQU CLEAN & FOULED COE	(LMTD= 52.3,1 IRED BTU/HR-1 FF BTU/HR-1	F= .84,BYP# FT2-F FT2-F	106.10	F=1.00)	41.5 103.84 103.46
EFF TEMP DIF, DEGF OVERALL COEFF REQU CLEAN & FOULED COE SHELLS IN SERIES	(LMTD= 52.3,1 IRED BTU/HR-1 FF BTU/HR-1	F= .84,BYP# FT2-F FT2-F TOTAL EFF	106.10 F AREA	FT2	41.5 103.84 103.46
EFF TEMP DIF, DEGF OVERALL COEFF REQU CLEAN & FOULED COE SHELLS IN SERIES PASSES, SHELL	(LMTD= 52.3,1 IRED BTU/HR-1 FF BTU/HR-1 1 PARALLEL 1 1 TUBE 4	F= .84,BYPF FT2-F FT2-F TOTAL EFF EFFECTIVE	106.10 F AREA E AREA	FT2 FT2/SHELL	41.5 103.84 103.46 7.1 7.1
EFF TEMP DIF, DEGF OVERALL COEFF REQU CLEAN & FOULED COE SHELLS IN SERIES	(LMTD= 52.3,1 IRED BTU/HR-1 FF BTU/HR-1 1 PARALLEL 1 1 TUBE 4	F= .84,BYPF FT2-F FT2-F TOTAL EFF EFFECTIVE	106.10 F AREA E AREA	FT2 FT2/SHELL	41.5 103.84 103.46 7.1 7.1
EFF TEMP DIF, DEGF OVERALL COEFF REQU CLEAN & FOULED COE SHELLS IN SERIES PASSES, SHELL SHELL DIAMETER IN.	(LMTD= 52.3,1 IRED BTU/HR-1 FF BTU/HR-1 1 PARALLEL 1 1 TUBE 4 3.820	F= .84,BYPF FT2-F FT2-F TOTAL EFF EFFECTIVE TEMA SHEI	106.10 F AREA E AREA LL TYPE E	FT2 FT2/SHELL ; REAR HE	41.5 103.84 103.46 7.1 7.1 EAD FXTS
EFF TEMP DIF, DEGF OVERALL COEFF REQU CLEAN & FOULED COE  SHELLS IN SERIES PASSES, SHELL SHELL DIAMETER IN.  BAFFLE TYPE H	(LMTD= 52.3,1) IRED BTU/HR-1 FF BTU/HR-1 1 PARALLEL 1 1 TUBE 4 3.820  ORZ SEGMENTL	F= .84,BYPA FT2-F FT2-F TOTAL EFF EFFECTIVE TEMA SHEI CROSS PAS	106.10 F AREA E AREA LL TYPE E SSES PER SHE	FT2 FT2/SHELL ; REAR HE	41.5 103.84 103.46 7.1 7.1 EAD FXTS
EFF TEMP DIF, DEGF OVERALL COEFF REQU CLEAN & FOULED COE  SHELLS IN SERIES PASSES, SHELL SHELL DIAMETER IN.  BAFFLE TYPE H SPACING, CENTRAL	(LMTD= 52.3,1 IRED BTU/HR-1 FF BTU/HR-1 1 PARALLEL 1 1 TUBE 4 3.820  ORZ SEGMENTL IN. 4.309	F= .84,BYPA FT2-F FT2-F TOTAL EFF EFFECTIVE TEMA SHEI CROSS PAS BAFFLE CU	106.10  F AREA  E AREA  LL TYPE E  SSES PER SHE  JT, PCT SHEL	FT2 FT2/SHELL ; REAR HE	41.5 103.84 103.46 7.1 7.1 EAD FXTS
EFF TEMP DIF, DEGF OVERALL COEFF REQU CLEAN & FOULED COE  SHELLS IN SERIES PASSES, SHELL SHELL DIAMETER IN.  BAFFLE TYPE H SPACING, CENTRAL SPACING, INLET	(LMTD= 52.3,1 IRED BTU/HR-1 FF BTU/HR-1 1 PARALLEL 1 1 TUBE 4 3.820  ORZ SEGMENTL IN. 4.309 IN. 4.309	F= .84,BYPA FT2-F FT2-F TOTAL EFF EFFECTIVE TEMA SHEI CROSS PAS BAFFLE CU	106.10  F AREA  E AREA  LL TYPE E  SSES PER SHE  JT, PCT SHEL	FT2 FT2/SHELL ; REAR HE	41.5 103.84 103.46 7.1 7.1 EAD FXTS
EFF TEMP DIF, DEGF OVERALL COEFF REQU CLEAN & FOULED COE  SHELLS IN SERIES PASSES, SHELL SHELL DIAMETER IN.  BAFFLE TYPE H SPACING, CENTRAL SPACING, INLET SPACING, OUTLET	(LMTD= 52.3,1) IRED BTU/HR-1 FF BTU/HR-1 1 PARALLEL 1 1 TUBE 4 3.820  ORZ SEGMENTL IN. 4.309 IN. 4.309 IN. 4.309	F= .84,BYPA FT2-F FT2-F TOTAL EFF EFFECTIVE TEMA SHEI CROSS PAS BAFFLE CU	106.10 F AREA E AREA LL TYPE E SSES PER SHE JT, PCT SHEI ANCE FROM CE	FT2 FT2/SHELL ; REAR HE GLL PASS L I.D. ENTER, IN.	41.5 103.84 103.46 7.1 7.1 EAD FXTS 4 30.00 .764
EFF TEMP DIF, DEGF OVERALL COEFF REQU CLEAN & FOULED COE  SHELLS IN SERIES PASSES, SHELL SHELL DIAMETER IN.  BAFFLE TYPE H SPACING, CENTRAL SPACING, INLET	(LMTD= 52.3,1) IRED BTU/HR-1 FF BTU/HR-1 1 PARALLEL 1 1 TUBE 4 3.820  ORZ SEGMENTL IN. 4.309 IN. 4.309 IN. 4.309 IN. 125	F= .84,BYPF FT2-F FT2-F  TOTAL EFF EFFECTIVE TEMA SHEI  CROSS PAS BAFFLE CU CUT DISTF	106.10 F AREA E AREA LL TYPE E SSES PER SHE JT, PCT SHEL ANCE FROM CE	FT2 FT2/SHELL ; REAR HE GLL PASS LL I.D. GNTER, IN.	41.5 103.84 103.46 7.1 7.1 EAD FXTS 4 30.00 .764
EFF TEMP DIF, DEGF OVERALL COEFF REQU CLEAN & FOULED COE  SHELLS IN SERIES PASSES, SHELL SHELL DIAMETER IN.  BAFFLE TYPE H SPACING, CENTRAL SPACING, INLET SPACING, OUTLET BAFFLE THICKNESS	(LMTD= 52.3,1) IRED BTU/HR-1 FF BTU/HR-1 1 PARALLEL 1 1 TUBE 4 3.820  ORZ SEGMENTL IN. 4.309 IN. 4.309 IN. 4.309 IN. 125	F= .84,BYPF FT2-F FT2-F  TOTAL EFF EFFECTIVE TEMA SHEI  CROSS PAS BAFFLE CU CUT DISTF	106.10 F AREA E AREA LL TYPE E SSES PER SHE JT, PCT SHEL ANCE FROM CE	FT2 FT2/SHELL ; REAR HE GLL PASS LL I.D. GNTER, IN.	41.5 103.84 103.46 7.1 7.1 EAD FXTS 4 30.00 .764
EFF TEMP DIF, DEGF OVERALL COEFF REQU CLEAN & FOULED COE  SHELLS IN SERIES PASSES, SHELL SHELL DIAMETER IN.  BAFFLE TYPE H SPACING, CENTRAL SPACING, INLET SPACING, OUTLET BAFFLE THICKNESS PAIRS OF SEALING D	(LMTD= 52.3,1 IRED BTU/HR-1 FF BTU/HR-1 1 PARALLEL 1 1 TUBE 4 3.820  ORZ SEGMENTL IN. 4.309 IN. 4.309 IN. 4.309 IN. 125 EVICES 1	F= .84,BYPA FT2-F FT2-F  TOTAL EFF EFFECTIVE TEMA SHEI  CROSS PAS BAFFLE CU CUT DISTA  IMPINGEME TUBESHEET	106.10  F AREA  E AREA  LL TYPE E  SSES PER SHE  ANCE FROM CE  ENT BAFFLE I  B BLANK AREA  EL	FT2 FT2/SHELL ; REAR HE GLL PASS JL I.D. GNTER, IN.	41.5 103.84 103.46 7.1 7.1 EAD FXTS 4 30.00 .764 NO .0
EFF TEMP DIF, DEGF OVERALL COEFF REQU CLEAN & FOULED COE  SHELLS IN SERIES PASSES, SHELL SHELL DIAMETER IN.  BAFFLE TYPE H SPACING, CENTRAL SPACING, INLET SPACING, OUTLET BAFFLE THICKNESS PAIRS OF SEALING D  TUBE TYPE NO. OF TUBES/SHELL	(LMTD= 52.3,1) IRED BTU/HR-1 FF BTU/HR-1 1 PARALLEL 1 1 TUBE 4 3.820  ORZ SEGMENTL IN. 4.309 IN. 4.309 IN. 4.309 IN. 125 EVICES 1  PLAIN 76	F= .84,BYPA FT2-F FT2-F  TOTAL EFF EFFECTIVE TEMA SHEI  CROSS PAS BAFFLE CU CUT DISTA  IMPINGEME TUBESHEET  MATERIAL EST MAX I	106.10  F AREA  E AREA  LL TYPE E  SSES PER SHE  ANCE FROM CE  ENT BAFFLE I  BLANK AREA  EL  CUBE COUNT	FT2 FT2/SHELL ; REAR HE GLL PASS GL I.D. GNTER, IN. GNCLUDED A, % GECTROLYTIC	41.5 103.84 103.46 7.1 7.1 EAD FXTS 4 30.00 .764 NO .0
EFF TEMP DIF, DEGF OVERALL COEFF REQU CLEAN & FOULED COE  SHELLS IN SERIES PASSES, SHELL SHELL DIAMETER IN.  BAFFLE TYPE H SPACING, CENTRAL SPACING, INLET SPACING, OUTLET BAFFLE THICKNESS PAIRS OF SEALING D  TUBE TYPE NO. OF TUBES/SHELL TUBE LGTH, OVERALL	(LMTD= 52.3,1 IRED BTU/HR-1 FF BTU/HR-1 1 PARALLEL 1 1 TUBE 4 3.820  ORZ SEGMENTL IN. 4.309 IN. 4.309 IN. 4.309 IN. 125 EVICES 1  PLAIN 76 FT 1.500	F= .84,BYPA FT2-F FT2-F  TOTAL EFF EFFECTIVE TEMA SHEI  CROSS PAS BAFFLE CU CUT DISTA  IMPINGEME TUBESHEET  MATERIAL EST MAX T TUBE PITC	106.10 F AREA E AREA LL TYPE E SSES PER SHE JT, PCT SHEL ANCE FROM CE ENT BAFFLE I BLANK AREA EL TUBE COUNT	FT2 FT2/SHELL ; REAR HE GLL PASS LL I.D. ENTER, IN. ENCLUDED A, % JECTROLYTIC IN.	41.5 103.84 103.46 7.1 7.1 EAD FXTS 4 30.00 .764 NO .0
EFF TEMP DIF, DEGF OVERALL COEFF REQU CLEAN & FOULED COE  SHELLS IN SERIES PASSES, SHELL SHELL DIAMETER IN.  BAFFLE TYPE H SPACING, CENTRAL SPACING, INLET SPACING, OUTLET BAFFLE THICKNESS PAIRS OF SEALING D  TUBE TYPE NO. OF TUBES/SHELL TUBE LGTH, OVERALL TUBE LGTH, EFF	(LMTD= 52.3,1) IRED BTU/HR-1 FF BTU/HR-1 1 PARALLEL 1 1 TUBE 4 3.820  ORZ SEGMENTL IN. 4.309 IN. 4.309 IN. 4.309 IN. 125 EVICES 1  PLAIN 76 FT 1.500 FT 1.436	F= .84,BYPA FT2-F FT2-F TOTAL EFF EFFECTIVE TEMA SHEI  CROSS PAS BAFFLE CU CUT DISTA  IMPINGEME TUBESHEET  MATERIAL EST MAX I TUBE PITC TUBE OUTS	106.10  F AREA  E AREA  LL TYPE E  SSES PER SHE  ANCE FROM CE  ENT BAFFLE I  BLANK AREA  EL  CUBE COUNT  CH  SIDE DIAM	FT2 FT2/SHELL ; REAR HE CLL PASS LL I.D. CNTER, IN. CNCLUDED A, % ECTROLYTIC IN. IN.	41.5 103.84 103.46 7.1 7.1 7.1 EAD FXTS 4 30.00 .764 NO .0
EFF TEMP DIF, DEGF OVERALL COEFF REQU CLEAN & FOULED COE  SHELLS IN SERIES PASSES, SHELL SHELL DIAMETER IN.  BAFFLE TYPE H SPACING, CENTRAL SPACING, INLET SPACING, OUTLET BAFFLE THICKNESS PAIRS OF SEALING D  TUBE TYPE NO. OF TUBES/SHELL TUBE LGTH, OVERALL TUBE LGTH, EFF TUBE LAYOUT	(LMTD= 52.3,1) IRED BTU/HR-1 FF BTU/HR-1 1 PARALLEL 1 1 TUBE 4 3.820  ORZ SEGMENTL IN. 4.309 IN. 4.309 IN. 4.309 IN. 125 EVICES 1  PLAIN 76 FT 1.500 FT 1.436 DEG 60	F= .84,BYPA FT2-F FT2-F TOTAL EFF EFFECTIVE TEMA SHEI  CROSS PAS BAFFLE CU CUT DISTA  IMPINGEME TUBESHEET  MATERIAL EST MAX T TUBE PITC TUBE OUTS TUBE INSI	106.10  F AREA E AREA LL TYPE E  SSES PER SHE ANCE FROM CE  ENT BAFFLE I F BLANK AREA  EL  CUBE COUNT CH SIDE DIAM EDE DIAM	FT2 FT2/SHELL ; REAR HE  GLL PASS GL I.D.  GNTER, IN.  GNCLUDED  A, %  JECTROLYTIC  IN.  IN.  IN.	41.5 103.84 103.46 7.1 7.1 EAD FXTS 4 30.00 .764 NO .0 C COPPER 36 .3125 .250 .214
EFF TEMP DIF, DEGF OVERALL COEFF REQU CLEAN & FOULED COE  SHELLS IN SERIES PASSES, SHELL SHELL DIAMETER IN.  BAFFLE TYPE H SPACING, CENTRAL SPACING, INLET SPACING, OUTLET BAFFLE THICKNESS PAIRS OF SEALING D  TUBE TYPE NO. OF TUBES/SHELL TUBE LGTH, OVERALL TUBE LGTH, EFF TUBE LAYOUT PITCH RATIO	(LMTD= 52.3,1 IRED BTU/HR-1 FF BTU/HR-1  1 PARALLEL 1 1 TUBE 4 3.820  ORZ SEGMENTL IN. 4.309 IN. 4.309 IN. 4.309 IN. 125 EVICES 1  PLAIN 76 FT 1.500 FT 1.436 DEG 60 1.250	F= .84,BYPA FT2-F FT2-F TOTAL EFF EFFECTIVE TEMA SHEI  CROSS PAS BAFFLE CU CUT DISTA  IMPINGEME TUBESHEET  MATERIAL EST MAX T TUBE PITC TUBE OUTS TUBE INSI TUBE SURE	106.10  F AREA E AREA LL TYPE E  SSES PER SHE ANCE FROM CE  ENT BAFFLE I F BLANK AREA  EL TUBE COUNT CH SIDE DIAM FACE RATIO,	FT2 FT2/SHELL ; REAR HE GLL PASS JL I.D. GNTER, IN. GNCLUDED A, % JECTROLYTIC IN. IN. OUT/IN	41.5 103.84 103.46 7.1 7.1 EAD FXTS 4 30.00 .764 NO .0 C COPPER 36 .3125 .250 .214 1.184
EFF TEMP DIF, DEGF OVERALL COEFF REQU CLEAN & FOULED COE  SHELLS IN SERIES PASSES, SHELL SHELL DIAMETER IN.  BAFFLE TYPE H SPACING, CENTRAL SPACING, INLET SPACING, OUTLET BAFFLE THICKNESS PAIRS OF SEALING D  TUBE TYPE NO. OF TUBES/SHELL TUBE LGTH, OVERALL TUBE LGTH, EFF TUBE LAYOUT	(LMTD= 52.3,1 IRED BTU/HR-1 FF BTU/HR-1  1 PARALLEL 1 1 TUBE 4 3.820  ORZ SEGMENTL IN. 4.309 IN. 4.309 IN. 4.309 IN. 125 EVICES 1  PLAIN 76 FT 1.500 FT 1.436 DEG 60 1.250	F= .84,BYPA FT2-F FT2-F TOTAL EFF EFFECTIVE TEMA SHEI  CROSS PAS BAFFLE CU CUT DISTA  IMPINGEME TUBESHEET  MATERIAL EST MAX T TUBE PITC TUBE OUTS TUBE INSI TUBE SURE	106.10  F AREA E AREA LL TYPE E  SSES PER SHE ANCE FROM CE  ENT BAFFLE I F BLANK AREA  EL TUBE COUNT CH SIDE DIAM FACE RATIO,	FT2 FT2/SHELL ; REAR HE GLL PASS JL I.D. GNTER, IN. GNCLUDED A, % JECTROLYTIC IN. IN. OUT/IN	41.5 103.84 103.46 7.1 7.1 EAD FXTS 4 30.00 .764 NO .0 C COPPER 36 .3125 .250 .214 1.184

^{*} CALCULATED ITEM--HEAT BALANCE CODE = 8

□ Washington University ChE433 heat exchanger experiment E0002 P107 Young model F302DY4P 9/23/3

	CASE 53
S U P P L E M E N T A R	Y RESULTS
HT PARAMETERS SHELL TUBE	SHELLSIDE PERFORMANCE
WALL CORRECTION 1.039 .000	NOMINAL VEL, X-FLOW FT/S .08
	NOMINAL VEL, WINDOW FT/S .15
	CROSSFLOW COEF BTU/HR-FT2-F 241.0
	WINDOW COEF BTU/HR-FT2-F 242.5
RYNLD NO, OUT BUN 297. 1527.	
FOULNG LAYER IN0014 .0014	SHELLSIDE FLOM & OF TOTAL
	HEAT TRANSFER X-FLOW 81.58
	TUBE TO BAFFLE LEAKAGE A = 3.30
	MAIN CROSSFLOW $B = 66.89$
	BUNDLE TO SHELL BYPASS C = 14.02
	BAFFLE TO SHELL LEAKAGE E = 15.78
TOT FOUL RESIST .000217	TUBE PASSLANE BYPASS $F = .00$
DIFF RESIST000036	
	SHELLSIDE HEAT TRANSFER FACTORS
DIAMETRAL CLEARANCES	TOTAL = (BETA) (GAMMA) (FIN) = .651
BUNDLE TO SHELL IN5000	BETA (BAFF CUT FACTOR) = .920
	GAMMA (TUBE ROW ENTRY EFCT) = .708
BAFFLE TO SHELL IN1000	
Difficult to difficult title 11000	in Edge In Englisher, .331
CUPIT NO77IP DATA IN OUT	SHELL PRESSURE DROP, % OF TOTAL
HT UNDR NOZ IN25	
HT OPP NOZ IN25	
VELOCITY FT/S .49 .49	CROSS FLOW = 3.8
DENSITY LB/FT3 62.535 62.005	
	OUTLET NOZZLE = 40.1
BUND RHO*VSQ LB/FT-S2 10 10	
TUBE NOZZLE DATA IN OUT	
VELOCITY FT/S 1.03 1.02	DRY = 150.
DENSITY LB/FT3 61.291 61.945	WET $=$ 165.
PRESS. DROP % 8.4 5.3	
*** SPECIAL MESSAGES AND WARNINGS *	**
WARNINGTUBESIDE FLUID HAS PASSED	THROUGH TRANSITION ZONE. CONSIDER
RERUNNING WITH ITEM 132 IN	
□□Washington University ChE433 heat	
Young model F302DY4P	9/23/ 3
Toung model F302D14F	
OTER 4 10 MADE DEM MILET DAGO DIO	CASE 54
SIZE 4- 18 TYPE BEM, MULTI-PASS FLO	
	HOT TUBE SIDE COLD SHELL SIDE
	Tube Shell
	SENSIBLE LIQ SENSIBLE LIQ
TOTAL FLOW RATE KLB/HR	.700 .700
	T11 011 T11 011 T11
TEMPERATURE DEGF	IN OUT IN OUT
IEMPERATURE DEGE	1N OUT 1N OUT 140.0 92.9* 40.0 86.9*

VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS	CP BTU/LB-F BTU/HR-FT-F	.9973 .	7469 1.4791 9992 1.0058 3615 .3466	.9997
TEMP, AVG & SKIN VISCOSITY, AVG & S PRESSURE, IN & DES	KIN CP	.5855 .	86.1 63.4 8063 1.0642	84.8 .8183
PRESSURE DROP, TOT VELOCITY, CALC & M				
FOULING RESISTANCE FILM COEFFICIENT		-F 222.38	2	.00010 263.46
TOTAL HEAT DUTY RE EFF TEMP DIF, DEGF OVERALL COEFF REQU CLEAN & FOULED COE	QUIRED MEGBTU/H (LMTD= 53.0,F IRED BTU/HR-F	R = .85,BYPASS= T2-F	.94,BAFF=1.00)	.032889 42.6 108.00 107.52
SHELLS IN SERIES PASSES, SHELL SHELL DIAMETER IN.	1 TUBE 4	EFFECTIVE ARE	A FT2/SHELI	7.1
BAFFLE TYPE H SPACING, CENTRAL SPACING, INLET SPACING, OUTLET BAFFLE THICKNESS PAIRS OF SEALING D	IN. 4.309 IN. 4.309 IN. 4.309 IN125	BAFFLE CUT, P CUT DISTANCE IMPINGEMENT B	CT SHELL I.D. FROM CENTER, IN.	30.00 .764 NO
TUBE TYPE NO. OF TUBES/SHELL TUBE LGTH, OVERALL TUBE LGTH, EFF TUBE LAYOUT PITCH RATIO SHL NOZZ ID, IN&OU	76 FT 1.500 FT 1.436 DEG 60 1.250	EST MAX TUBE TUBE PITCH TUBE OUTSIDE TUBE INSIDE D TUBE SURFACE	IN. DIAM IN. IAM IN. RATIO, OUT/IN	36 .3125 .250 .214 1.184
* CALCULATED ITE UNIVERSE TO THE Washington Universe Young model F302DY	rsity ChE433 he		xperiment	E0002 P109 9/23/ 3 CASE 54
S U P P L E	M E N T A	R Y R E	S U L T S	071011 0 1
HT PARAMETERS WALL CORRECTION PRANDTL NUMBER RYNLD NO, AVG RYNLD NO, IN BUN RYNLD NO,OUT BUN FOULNG LAYER IN.	1.037 .000 7.3 3.9 248. 1884. 178. 2334. 330. 1477.	NOMINAL VEL NOMINAL VEL CROSSFLOW C WINDOW COEF	PERFORMANCE ,X-FLOW FT/S ,WINDOW FT/S OEF BTU/HR-FT2 BTU/HR-FT2 FLOW, % OF TOTA	2-F 264.5 2-F 266.1
	• • • • • • • • • • • • • • • • • • • •	HEAT TRANSF		81.58

THERMAL RESISTANCE, % OF	TOTAL	TUBE TO BAFFLE LEAKAGE	4 =	3.45
SHELL TUBE FOULING M	ETAL	MAIN CROSSFLOW	3 =	66.18
40.35 57.24 2.33	.08	BUNDLE TO SHELL BYPASS (	=	14.70
PCT OVER DESIGN	45	BAFFLE TO SHELL LEAKAGE	=	15.67
TOT FOUL RESIST	.000217	TUBE PASSLANE BYPASS	· =	.00
DIFF RESIST -	.000041			
		SHELLSIDE HEAT TRANSFER H		
DIAMETRAL CLEARANCES		TOTAL = (BETA) (GAMMA) (FIN) BETA (BAFF CUT FACTOR)	=	.667
BUNDLE TO SHELL IN.	.5000	BETA (BAFF CUT FACTOR)	=	.920
TUBE TO BAFFLE HOLE IN.	.0284	GAMMA (TUBE ROW ENTRY EFCT)	=	.725
BAFFLE TO SHELL IN.	.1000	END (HT LOSS IN END ZONE)	=	.994
SHELL NOZZLE DATA I	N OUT	SHELL PRESSURE DROP, % OF	TO	TAL
HT UNDR NOZ IN2	5	WINDOW END ZONE	=	8.8
HT OPP NOZ IN2	5	END ZONE	=	4.1
VELOCITY FT/S .5	7.57	CROSS FLOW INLET NOZZLE	=	3.6
DENSITY LB/FT3 62.53	5 62.058	INLET NOZZLE	=	43.0
		OUTLET NOZZLE	=	40.5
BUND RHO*VSQ LB/FT-S2 1	3 13			
		WEIGHT PER SHELL, LB		
VELOCITY FT/S 1.0				150.
DENSITY LB/FT3 61.29		WET =		165.
PRESS. DROP % 8.				

## *** SPECIAL MESSAGES AND WARNINGS ***

WARNING--TUBESIDE FLUID HAS PASSED THROUGH TRANSITION ZONE. CONSIDER RERUNNING WITH ITEM 132 IN EFFECT.

SIZE 4- 18 TYPE BEM, MULTI-PASS FLOW, SEGMENTAL BAFFLES, RATING

		HOT TO	JBE SIDE	COLD SH	HELL SIDE
		Tube		Shell	L
		SENS	IBLE LIQ	SENSI	BLE LIQ
TOTAL FLOW RATE	KLB/HR		.700		.800
		IN	OUT	IN	OUT
TEMPERATURE	DEGF	140.0	90.4*	40.0	83.2*
DENSITY	LB/FT3	61.2913	62.0146	62.5352	62.1030
VISCOSITY	CP	.4726	.7677	1.4791	.8341
SPECIFIC HEAT	BTU/LB-F	.9973	.9994	1.0058	1.0001
THERMAL COND.	BTU/HR-FT-F	.3723	.3608	.3466	.3589
MOLAR MASS	LB/LBMOL		18.02		18.02
TEMP, AVG & SKIN	DEGF	115.2	83.5	61.6	82.2
VISCOSITY, AVG & SI	KIN CP	.5926	.8311	1.0905	.8442
PRESSURE, IN & DES	IGN PSIA	50.00	165.00	50.00	165.00
PRESSURE DROP, TOT	& ALLOWED PSI	.09	10.00	.01	10.00
VELOCITY, CALC & MA	AX ALLOWED FT/S	s .68	10.00	.12	10.00

FOULING RESISTANCE HREFILM COEFFICIENT BTO	J/HR-FT2-F		.00010 286.30
	= 53.6,F=	.86,BYPASS= .95,BAFF=1.00) -F -F 114.23	
PASSES, SHELL 1 TUBE	4 E	DTAL EFF AREA FT2 FFECTIVE AREA FT2/SHEL EMA SHELL TYPE E ; REAR	L 7.1
BAFFLE TYPE HORZ SEC SPACING, CENTRAL IN. SPACING, INLET IN. SPACING, OUTLET IN. BAFFLE THICKNESS IN. PAIRS OF SEALING DEVICES	4.309 Bi 4.309 CI 4.309 .125 II	ROSS PASSES PER SHELL PASS AFFLE CUT, PCT SHELL I.D. JT DISTANCE FROM CENTER, IN MPINGEMENT BAFFLE INCLUDED JBESHEET BLANK AREA, %	30.00 .764
TUBE LGTH, EFF FT TUBE LAYOUT DEG PITCH RATIO	1.500 TO 1.436 TO 60 TO 1.250 TO	ATERIAL ELECTROLYT ST MAX TUBE COUNT JBE PITCH IN. JBE OUTSIDE DIAM IN. JBE INSIDE DIAM IN. JBE SURFACE RATIO, OUT/IN JBE NOZZ ID, IN&OUT IN.	36 .3125 .250 .214 1.184
* CALCULATED ITEMHEAT	BALANCE CO		
Young model F302DY4P		exchanger experiment  Y R E S U L T S	E0002 P111 9/23/ 3 CASE 55
Young model F302DY4P  S U P P L E M E N  HT PARAMETERS SHELL WALL CORRECTION 1.036 PRANDTL NUMBER 7.5 RYNLD NO, AVG 277. RYNLD NO, IN BUN 204. RYNLD NO,OUT BUN 361.	T A R  TUBE .000 3.9 1861. 2334. 1437.	Y R E S U L T S  SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S  NOMINAL VEL, WINDOW FT/S  CROSSFLOW COEF BTU/HR-FT  WINDOW COEF BTU/HR-FT	9/23/3 CASE 55 .10 .20 2-F 287.5 2-F 289.1
Young model F302DY4P  S U P P L E M E N  HT PARAMETERS SHELL WALL CORRECTION 1.036 PRANDTL NUMBER 7.5 RYNLD NO, AVG 277. RYNLD NO, IN BUN 204. RYNLD NO,OUT BUN 361. FOULNG LAYER IN0014  THERMAL RESISTANCE, % OF SHELL TUBE FOULING MI 38.36 59.15 2.41	T A R  TUBE .000 3.9 1861. 2334. 14370014  FOTAL ETAL .0818 .000217	Y R E S U L T S  SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S  NOMINAL VEL, WINDOW FT/S  CROSSFLOW COEF BTU/HR-FT	9/23/3 CASE 55 .10 .20 2-F 287.5 2-F 289.1 AL 81.58 A = 3.59 B = 65.62 C = 15.24 E = 15.56 F = .00

SHELL NOZZLE DATA	IN	OUT	SHELL PRESSURE DROP,	% OF	TOTA	AL
HT UNDR NOZ IN.	.25		WINDOW		=	8.8
HT OPP NOZ IN.	.25		END ZONE		=	3.9
VELOCITY FT/S	.65	.66	CROSS FLOW		=	3.4
DENSITY LB/FT3	62.535	62.103	INLET NOZZLE		=	43.1
NOZZ RHO*VSQ LB/FT-	S2 26	26	OUTLET NOZZLE		=	40.8
BUND RHO*VSQ LB/FT-	S2 18	18				
TUBE NOZZLE DATA	IN	OUT	WEIGHT PER SHELL, LB			
VELOCITY FT/S	1.03	1.02	DRY	=		150.
DENSITY LB/FT3	61.291	62.015	WET	=		165.
PRESS. DROP %	8.3	5.2				

## *** SPECIAL MESSAGES AND WARNINGS ***

WARNING--TUBESIDE FLUID HAS PASSED THROUGH TRANSITION ZONE. CONSIDER RERUNNING WITH ITEM 132 IN EFFECT.

SIZE 4- 18 TYPE BEM, MULTI-PASS FLOW, SEGMENTAL BAFFLES, RATING

5120 4 10 1110 00.	M, MODII IASS I				
			JBE SIDE		
		Tube		Shell	
		CENCI	DIE IIO	CENCT	DIE IIO
TOTAL FLOW RATE	KLB/HR		.700		.900
TOTAL FLOW RATE		IN	OUT	IN	OUT
TEMPERATURE	DEGF	140.0	88.3*	40.0	80.0*
DENSITY					
VISCOSITY	CP	.4726	.7866	1.4791	.8654
SPECIFIC HEAT					
THERMAL COND.	BTU/HR-FT-F	.3723	.3603	.3466	.3581
MOLAR MASS			18.02		18.02
TEMP, AVG & SKIN	DEGF	114.1	81.2	60.0	79.8
VISCOSITY, AVG & S	KIN CP	.5989	.8538	1.1134	.8680
PRESSURE, IN & DES	IGN PSIA	50.00	165.00	50.00	165.00
PRESSURE DROP, TOT	& ALLOWED PSI	.09	10.00	.02	10.00
VELOCITY, CALC & M					
FOULING RESISTANCE	HR-FT2-F/B	TU .(	00010	.0	0010
FILM COEFFICIENT	BTU/HR-FT2	-F 22	22.26	30	9.08
TOTAL HEAT DUTY RE	 OUIRED MEGBTU/H				.036135
EFF TEMP DIF, DEGF	_		ASS= 95.BAI	FF=1 ()()	
OVERALL COEFF REQU					114.45
CLEAN & FOULED COE					
OLLIN & LOOLLD COL	II DIO/III( I	10 1	±± / • 0 ·	<u> </u>	111.27
SHELLS IN SERIES	1 PARALLEL 1	TOTAL EFF	F AREA	FT2	7.1
PASSES, SHELL					

(	che433b(40).OUT
SHELL DIAMETER IN. 3.820 T	che433b(40).OUT CEMA SHELL TYPE E ; REAR HEAD FXTS
BAFFLE TYPE HORZ SEGMENTI. C	ROSS PASSES PER SHELL PASS 4
SPACING, CENTRAL IN. 4.309 B	CROSS PASSES PER SHELL PASS 4 SAFFLE CUT, PCT SHELL I.D. 30.00
SPACING, INLET IN. 4.309 C	CUT DISTANCE FROM CENTER, IN764
SPACING, OUTLET IN. 4.309	voi promine river emiliar, river
SPACING, OUTLET IN. 4.309  SPACING, OUTLET IN. 4.309  BAFFLE THICKNESS IN125	MPINGEMENT BAFFLE INCLUDED NO
PAIRS OF SEALING DEVICES 1 T	UBESHEET BLANK AREA, % .0
	• • • • • • • • • • • • • • • • • • • •
TUBE TYPE PLAIN M. NO. OF TUBES/SHELL 76 E	MATERIAL ELECTROLYTIC COPPER
NO. OF TUBES/SHELL 76 E	ST MAX TUBE COUNT 36
TUBE LGTH, OVERALL FT 1.500 T	UBE PITCH IN3125
TUBE LGTH, EFF FT 1.436 T	UBE OUTSIDE DIAM IN250
TUBE LAYOUT DEG 60 T	UBE INSIDE DIAM IN214
PITCH RATIO 1.250 T	CUBE PITCH IN3125 CUBE OUTSIDE DIAM IN250 CUBE INSIDE DIAM IN214 CUBE SURFACE RATIO, OUT/IN 1.184
SHL NOZZ ID, IN&OUT 1.0 1.0 T	UBE NOZZ ID, IN&OUT IN8 .8
* CALCULATED ITEMHEAT BALANCE C	CODE = 8
□□Washington University ChE433 heat	exchanger experiment E0002 P113
Young model F302DY4P	9/23/ 3
	CASE 56
S U P P L E M E N T A R	Y RESULTS
HT PARAMETERS SHELL TUBE	SHELLSIDE PERFORMANCE
WALL CORRECTION 1 035 000	NOMINAL VELLX-FLOW FT/S 12
PRANDTL NUMBER 7.7 3.9	NOMINAL VEL, X-FLOW FT/S .12 NOMINAL VEL, WINDOW FT/S .23
RYNID NO. AVG 305. 1842.	CROSSFLOW COEF BTU/HR-FT2-F 310.4
RYNID NO. TN BIIN 229 2334	CROSSFLOW COEF BTU/HR-FT2-F 310.4 WINDOW COEF BTU/HR-FT2-F 312.1
RYNLD NO.OUT BUN 392. 1402.	WINDOW GOLD BIO, MY 112 1 GIZ.1
FOULNG LAYER IN0014 .0014	SHELLSIDE FLOW, % OF TOTAL
	HEAT TRANSFER X-FLOW 81.56
THERMAL RESISTANCE, % OF TOTAL	MIDE MO DARRIE IRAKACE A - 2 71
SHELL TUBE FOULING METAL	MAIN CROSSFLOW B = 65.36  BUNDLE TO SHELL BYPASS C = 15.45  BAFFLE TO SHELL LEAKAGE E = 15.48
36.56 60.88 2.48 .08	BUNDLE TO SHELL BYPASS C = 15.45
PCT OVER DESIGN14	BAFFLE TO SHELL LEAKAGE E = 15.48
TOT FOUL RESIST .000217	TUBE PASSLANE BYPASS F = .00
DIFF RESIST000012	
	SHELLSIDE HEAT TRANSFER FACTORS
DIAMETRAL CLEARANCES	TOTAL = (BETA) (GAMMA) (FIN) = .698 BETA (BAFF CUT FACTOR) = .920
BUNDLE TO SHELL IN5000	BETA (BAFF CUT FACTOR) = .920
TUBE TO BAFFLE HOLE IN0284	GAMMA (TUBE ROW ENTRY EFCT) = .759
BAFFLE TO SHELL IN1000	END (HT LOSS IN END ZONE) = .994
SHELL NOZZIE DATA IN OUT	SHELL PRESSURE DROP, % OF TOTAL
HT UNDR NOZ IN25	WINDOW = 8.8
HT OPP NOZ IN25	END ZONE = 3.7
VELOCITY FT/S .73 .74	CDOGG ETOM - 3 3
DENSITY LB/FT3 62.535 62.140	INLET NOZZLE = 43.1 OUTLET NOZZLE = 41.1
NOZZ RHO*VSQ LB/FT-S2 33 33	OUTLET NOZZLE = 41 1
BUND RHO*VSQ LB/FT-S2 22 23	11.1
TUBE NOZZLE DATA IN OUT	WEIGHT PER SHELL, LB
TUBE NOZZLE DATA IN OUT VELOCITY FT/S 1.03 1.02	DRY = 150.
, = = = = = = = = = = = = = = = = = = =	

DENSITY LB/FT3 61.291 62.041 WET = 165. PRESS. DROP % 8.3 5.2

### *** SPECIAL MESSAGES AND WARNINGS ***

WARNING--TUBESIDE FLUID HAS PASSED THROUGH TRANSITION ZONE. CONSIDER RERUNNING WITH ITEM 132 IN EFFECT.

□□Washington University ChE433 heat exchanger experiment E0002 P114

Young model F302D	versity ChE433 h 0Y4P	neat exchang	ger experime		9/23/ 3 CASE 57
SIZE 4- 18 TYPE E	REM MIIT.TT-DASS	FI.OW SECME	ZNTAT. BAFFT.F		
5120 4 10 1110 1	HOLII IASS		JBE SIDE		
		SENSI	IBLE LIQ	SENS	IBLE LIO
TOTAL FLOW RATE	KLB/HR				
TOTAL FLOW RATE		IN	OUT	IN	OUT
	DEGF				
DENSITY	LB/FT3	61.2913	61.6182	62.5352	61.5735
VISCOSITY			.5694		.5537
SPECIFIC HEAT			.9976		.9975
THERMAL COND.		.3723	.3679		
MOLAR MASS	LB/LBMOL				18.02
TEMP, AVG & SKIN	DEGE		112 N		
VISCOSITY, AVG &					
PRESSURE, IN & DE			165.00		
PRESSURE DROP, TO	T & ALLOWED PS	.12	10.00	.00	10.00
VELOCITY, CALC &	MAX ALLOWED FT	:/S .78	10.00	.03	10.00
FOULING RESISTANC	'E. HR-FT2-F/	'RTII (	00010		00010
FILM COEFFICIENT					35.82
TOTAL HEAT DUTY F					.016469
TOTAL HEAT DUTY F	REQUIRED MEGBTU/	'HR		FF=1.00)	
EFF TEMP DIF, DEG OVERALL COEFF REQ	REQUIRED MEGBTU/ GF (LMTD= 41.1, QUIRED BTU/HR-	HR F= .76,BYP? -FT2-F	ASS= .87,BAI		27.2 84.71
EFF TEMP DIF, DEG	REQUIRED MEGBTU/ GF (LMTD= 41.1, QUIRED BTU/HR-	HR F= .76,BYP? -FT2-F	ASS= .87,BAI		27.2
EFF TEMP DIF, DEG OVERALL COEFF REÇ CLEAN & FOULED CO	REQUIRED MEGBTU/ F (LMTD= 41.1, QUIRED BTU/HR- DEFF BTU/HR-	HR F= .76,BYPA FT2-F FT2-F	ASS= .87,BAI	2	27.2 84.71 84.63
EFF TEMP DIF, DEG OVERALL COEFF REQ CLEAN & FOULED CO SHELLS IN SERIES	REQUIRED MEGBTU/ F (LMTD= 41.1, QUIRED BTU/HR- DEFF BTU/HR-	HR F= .76,BYPF FT2-F FT2-F TOTAL EFF	ASS= .87,BAI 86.02 F AREA	2 FT2	27.2 84.71 84.63
EFF TEMP DIF, DEG OVERALL COEFF REQ CLEAN & FOULED CO SHELLS IN SERIES PASSES, SHELL	REQUIRED MEGBTU/ F (LMTD= 41.1, QUIRED BTU/HR- DEFF BTU/HR- 1 PARALLEL 1 1 TUBE 4	HR F= .76,BYPF FT2-F FT2-F TOTAL EFF EFFECTIVE	ASS= .87,BAB 86.02 F AREA E AREA	PT2 FT2/SHELL	27.2 84.71 84.63 7.1 7.1
EFF TEMP DIF, DEG OVERALL COEFF REQ CLEAN & FOULED CO SHELLS IN SERIES	REQUIRED MEGBTU/ F (LMTD= 41.1, QUIRED BTU/HR- DEFF BTU/HR- 1 PARALLEL 1 1 TUBE 4	HR F= .76,BYPF FT2-F FT2-F TOTAL EFF EFFECTIVE	ASS= .87,BAI 86.02 F AREA	PT2 FT2/SHELL	27.2 84.71 84.63 7.1 7.1
EFF TEMP DIF, DEGOVERALL COEFF REQUIED COEFF REQUIED COEFF REQUIED COEFF REQUIED COEFF REQUIED SHELLS IN SERIES PASSES, SHELL SHELL DIAMETER IN BAFFLE TYPE	REQUIRED MEGBTU/ FF (LMTD= 41.1, DUIRED BTU/HR- DEFF BTU/HR-  1 PARALLEL 1 1 TUBE 4 I. 3.820  HORZ SEGMENTL	HR F= .76,BYPF FT2-F FT2-F TOTAL EFF EFFECTIVE TEMA SHEI	ASS= .87,BAI 86.02 F AREA E AREA LL TYPE E	FT2 FT2/SHELL ; REAR H	27.2 84.71 84.63 7.1 7.1 EAD FXTS
EFF TEMP DIF, DEG OVERALL COEFF REQ CLEAN & FOULED CO SHELLS IN SERIES PASSES, SHELL SHELL DIAMETER IN BAFFLE TYPE SPACING, CENTRAL	REQUIRED MEGBTU/ F (LMTD= 41.1, DUIRED BTU/HR- DEFF BTU/HR-  1 PARALLEL 1 1 TUBE 4 I. 3.820  HORZ SEGMENTL IN. 4.309	HR F= .76,BYPF FT2-F TOTAL EFF EFFECTIVE TEMA SHEIL CROSS PASS BAFFLE CU	ASS= .87,BAI 86.02 F AREA E AREA LL TYPE E SSES PER SHE JT, PCT SHEI	FT2 FT2/SHELL ; REAR H ELL PASS LL I.D.	27.2 84.71 84.63 7.1 7.1 EAD FXTS
EFF TEMP DIF, DEG OVERALL COEFF REQ CLEAN & FOULED CO SHELLS IN SERIES PASSES, SHELL SHELL DIAMETER IN BAFFLE TYPE SPACING, CENTRAL SPACING, INLET	REQUIRED MEGBTU/ FF (LMTD= 41.1, QUIRED BTU/HR- DEFF BTU/HR-  1 PARALLEL 1 1 TUBE 4 I. 3.820  HORZ SEGMENTL IN. 4.309 IN. 4.309 IN. 4.309	HR F= .76,BYPF FT2-F TOTAL EFF EFFECTIVE TEMA SHEIL CROSS PASS BAFFLE CU	ASS= .87,BAI 86.02 F AREA E AREA LL TYPE E	FT2 FT2/SHELL ; REAR H ELL PASS LL I.D.	27.2 84.71 84.63 7.1 7.1 EAD FXTS
EFF TEMP DIF, DEGOVERALL COEFF REQUESTION OF THE PROPERTY OF TEMPS OF THE PROPERTY OF THE PROP	REQUIRED MEGBTU/ FF (LMTD= 41.1, PUIRED BTU/HR- DEFF BTU/HR-  1 PARALLEL 1 1 TUBE 4 I. 3.820  HORZ SEGMENTL IN. 4.309 IN. 4.309 IN. 4.309 IN. 4.309	HR F= .76,BYPF FT2-F FT2-F TOTAL EFF EFFECTIVE TEMA SHEI CROSS PAS BAFFLE CU CUT DISTE	ASS= .87,BAB 86.02 F AREA E AREA LL TYPE E SSES PER SHE JT, PCT SHEI ANCE FROM CE	FT2 FT2/SHELL ; REAR HI ELL PASS LL I.D. ENTER, IN.	27.2 84.71 84.63 7.1 7.1 EAD FXTS 4 30.00 .764
EFF TEMP DIF, DEGOVERALL COEFF REQUESTION OF THE PROPERTY OF T	REQUIRED MEGBTU/ FF (LMTD= 41.1, QUIRED BTU/HR- DEFF BTU/HR-  1 PARALLEL 1 1 TUBE 4 I. 3.820  HORZ SEGMENTL IN. 4.309 IN. 4.309 IN. 4.309 IN. 125	HR F= .76,BYPF FT2-F FT2-F TOTAL EFF EFFECTIVE TEMA SHEI CROSS PAS BAFFLE CU CUT DISTE	ASS= .87,BAH  86.02  F AREA  E AREA  LL TYPE E  SSES PER SHE  JT, PCT SHEI  ANCE FROM CH	FT2 FT2/SHELL ; REAR HI ELL PASS LL I.D. ENTER, IN.	27.2 84.71 84.63 7.1 7.1 EAD FXTS 4 30.00 .764 NO
EFF TEMP DIF, DEGOVERALL COEFF REQUESTION OF THE PROPERTY OF TEMPS OF THE PROPERTY OF THE PROP	REQUIRED MEGBTU/ FF (LMTD= 41.1, QUIRED BTU/HR- DEFF BTU/HR-  1 PARALLEL 1 1 TUBE 4 I. 3.820  HORZ SEGMENTL IN. 4.309 IN. 4.309 IN. 4.309 IN. 125	HR F= .76,BYPF FT2-F FT2-F TOTAL EFF EFFECTIVE TEMA SHEI CROSS PAS BAFFLE CU CUT DISTE	ASS= .87,BAB 86.02 F AREA E AREA LL TYPE E SSES PER SHE JT, PCT SHEI ANCE FROM CE	FT2 FT2/SHELL ; REAR HI ELL PASS LL I.D. ENTER, IN.	27.2 84.71 84.63 7.1 7.1 EAD FXTS 4 30.00 .764
EFF TEMP DIF, DEGOVERALL COEFF REQUESTION OF SEALING	REQUIRED MEGBTU/ FF (LMTD= 41.1, DUIRED BTU/HR- DEFF BTU/HR-  1 PARALLEL 1 1 TUBE 4 I. 3.820  HORZ SEGMENTL IN. 4.309 IN. 4.309 IN. 4.309 IN. 125 DEVICES 1	HR F= .76,BYPF FT2-F TOTAL EFF EFFECTIVE TEMA SHEI  CROSS PAS BAFFLE CU CUT DISTA  IMPINGEME TUBESHEET	ASS= .87,BAH  86.02  F AREA  E AREA  LL TYPE E  SSES PER SHEI  ANCE FROM CHEMICE FROM CHEMICE  ENT BAFFLE IN BLANK AREA	FT2 FT2/SHELL ; REAR HI ELL PASS LL I.D. ENTER, IN. INCLUDED A, %	27.2 84.71 84.63 7.1 7.1 EAD FXTS 4 30.00 .764 NO .0
EFF TEMP DIF, DEGOVERALL COEFF REQUESTION OF THE PROPERTY OF T	REQUIRED MEGBTU/ FF (LMTD= 41.1, DUIRED BTU/HR- DEFF BTU/HR-  1 PARALLEL 1 1 TUBE 4 I. 3.820  HORZ SEGMENTL IN. 4.309 IN. 4.309 IN. 4.309 IN. 125 DEVICES 1	HR F= .76,BYPF FT2-F TOTAL EFF EFFECTIVE TEMA SHEI  CROSS PAS BAFFLE CU CUT DISTA  IMPINGEME TUBESHEET	ASS= .87,BAH  86.02  F AREA  E AREA  LL TYPE E  SSES PER SHEI  ANCE FROM CHE  ENT BAFFLE II  BLANK AREA  EI	FT2 FT2/SHELL ; REAR HI ELL PASS LL I.D. ENTER, IN. INCLUDED A, %	27.2 84.71 84.63 7.1 7.1 EAD FXTS 4 30.00 .764 NO .0

TUBE LGTH, OVERALL FT 1.500 T	UBE PITCH IN.	.3125
TUBE LGTH, EFF FT 1.436 T		
TUBE LAYOUT DEG 60 T		
PITCH RATIO 1.250 T		
SHL NOZZ ID, IN&OUT 1.0 1.0 T		
	·	
* CALCULATED ITEMHEAT BALANCE C	ODE = 8	
□□Washington University ChE433 heat	exchanger experiment	E0002 P115
Young model F302DY4P	-	9/23/ 3
		CASE 57
S U P P L E M E N T A R	Y RESULTS	
HT PARAMETERS SHELL TUBE	SHELLSIDE PERFORMANCE	
WALL CORRECTION 1.046 .972	NOMINAL VEL, X-FLOW FT/S	.03
PRANDTL NUMBER 5.8 3.4		
RYNLD NO, AVG 87. 2436.	CROSSFLOW COEF BTU/HR-FT2	-F 137.0
RYNLD NO, IN BUN 50. 2667.	WINDOW COEF BTU/HR-FT2	-F 134.8
RYNLD NO, OUT BUN 134. 2214.		
FOULNG LAYER IN0014 .0014	SHELLSIDE FLOW, % OF TOTA	L
	HEAT TRANSFER X-FLOW	80.26
THERMAL RESISTANCE, % OF TOTAL	TUBE TO BAFFLE LEAKAGE A	= 2.59
SHELL TUBE FOULING METAL	MAIN CROSSFLOW B	= 68.82
61.61 36.49 1.83 .06	BUNDLE TO SHELL BYPASS C	= 10.92
PCT OVER DESIGN09	BAFFLE TO SHELL LEAKAGE E	= 17.68
TOT FOUL RESIST .000217	TUBE PASSLANE BYPASS F	= .00
DIFF RESIST000011		
	SHELLSIDE HEAT TRANSFER FX	ACTORS
DIAMETRAL CLEARANCES		
BUNDLE TO SHELL IN5000		
TUBE TO BAFFLE HOLE IN0284		
BAFFLE TO SHELL IN1000	END (HT LOSS IN END ZONE)	= .998
SHELL NOZZLE DATA IN OUT	SHELL PRESSURE DROP, % OF	TOTAL
HT UNDR NOZ IN25	WINDOW	= 9.7
HT OPP NOZ IN25	END ZONE	= 7.3
VELOCITY FT/S .16 .17	CROSS FLOW	= 5.6
HT UNDR NOZ IN25 HT OPP NOZ IN25 VELOCITY FT/S .16 .17 DENSITY LB/FT3 62.535 61.573	INLET NOZZLE	= 41.2
NOZZ RHO*VSQ LB/FT-SZ I I	OUTLET NOZZLE	= 36.2
BUND RHO*VSQ LB/FT-S2 1 1		
	WEIGHT PER SHELL, LB	150
VELOCITY FT/S 1.18 1.18	DRY =	
DENSITY LB/FT3 61.291 61.618	WET =	165.
PRESS. DROP % 8.8 5.6		

## *** SPECIAL MESSAGES AND WARNINGS ***

WARNING--TUBESIDE FLUID HAS PASSED THROUGH TRANSITION ZONE. CONSIDER RERUNNING WITH ITEM 132 IN EFFECT.

HEAT TRANSFER COEFF. AT RE = 2000 IS 219.34 BTU/HR-FT2-F HEAT TRANSFER COEFF. AT RE = 10000 IS 1231.85 BTU/HR-FT2-F

□□Washington University ChE433 heat exchanger experiment E0002 P116 Young model F302DY4P 9/23/ 3

CASE 58

SIZE 4- 18 TYPE BEM, MU	JLTI-PASS FLOW,	SEGMENTAL	BAFFLES,	RATING
-------------------------	-----------------	-----------	----------	--------

SIZE 4- 18 TYPE BE	M, MULTI-PASS H	FLOW, SEGME	ENTAL BAFFL	ES, RATING	
		HOT TU	JBE SIDE	COLD SH	HELL SIDE
		Tube		Shell	-
		SENSI	TRIF LTO	SENSI	BLE LIO
TOTAL FLOW RATE	KLB/HR		.800		.300
		IN	OUT	IN	OUT
TEMPERATURE	DEGF	140.0	112.4*	40.0	113.4*
DENSITY	LB/FT3	61.2913	61.7206	62.5352	61.7052
VISCOSITY	CP		.6094		
SPECIFIC HEAT	BTU/LB-F		.9979		.9979
THERMAL COND.	BTU/HR-FT-F			.3466	
MOLAR MASS	LB/LBMOL		18.02		18.02
	, -		18.02  105.7		
TEMP, AVG & SKIN	DEGF	126.2	105.7	76.7	104.7
VISCOSITY, AVG & S			.6517		
PRESSURE, IN & DES				50.00	
,,					
PRESSURE DROP, TOT	& ALLOWED PS	г .12	10.00	- 00	10.00
VELOCITY, CALC & M					
veedolli, died a ii	1111 1111101111111111111111111111111111	• • • • • • • • • • • • • • • • • • • •	10.00	• • • •	10.00
FOULING RESISTANCE	HR-FT2-F/F	3TU . (	00010	.0	00010
FILM COEFFICIENT					52.98
					,2.50
TOTAL HEAT DUTY RE	OUTRED MEGRTU/	HR.			.022048
EFF TEMP DIF, DEGF			199= 92 B1	FF=1 00)	
OVERALL COEFF REQU			100 . JZ <b>,</b> BII	11.00)	92.76
CLEAN & FOULED COE			95 0	1	93.18
CHEAN & LOOPED COL	II DIO/III I	12 1	<b>33.</b> 0	<u> </u>	93.10
SHELLS IN SERIES	1 DADATTET 1	יי∩ייאו בבו		<u></u> ምግን	7 1
PASSES, SHELL					
SHELL DIAMETER IN.					
SHELL DIAMETER IN.	3.020	IEMA SHEI	THE E	, KEAK HE	IAD FXIS
BAFFLE TYPE H	OD7 CECMENTI	CDOCC DAG	cere pro eu	ETT DACC	1
SPACING, CENTRAL					
SPACING, CENTRAL SPACING, INLET					
SPACING, OUTLET			ANCE FROM C.	ENIER, IN.	. 704
BAFFLE THICKNESS			NU DARRIE	TNCTUDED	NO
PAIRS OF SEALING D	EVICES I	TUBESHEE.	r blank are	A, 6	. 0
	D.T. 7. T.N.I	MAMDDIAI			CODDED
TUBE TYPE NO. OF TUBES/SHELL	PLAIN				
TUBE LGTH, OVERALL	/ b	EST MAX	TUBE COUNT	T.).	36
TUBE LGTH, OVERALL	FT 1.500	TORE PIT	THE DIM	IN.	
TUBE LGTH, EFF	FT 1.436	TUBE OUTS	PIDE DIII	IN.	.250
TUBE LAYOUT PITCH RATIO	DEG 60	TUBE INSI	IDE DIAM	IN.	.214
PITCH RATIO	1.250	TUBE SURI	FACE RATIO,	OUT/IN	1.184
SHL NOZZ ID, IN&OU	T 1.0 1.0	TUBE NOZ2	Z ID, IN&OU'	T. TN.	.8 .8

^{*} CALCULATED ITEM--HEAT BALANCE CODE = 8

 $\square\square$ Washington University ChE433 heat exchanger experiment E0002 P117 Young model F302DY4P 9/23/ 3

CASE 58

S U P P L E M E N	T A R	Y RESULTS	CASE 58
HT PARAMETERS SHELL	TUBE	SHELLSIDE PERFORMANCE	
WALL CORRECTION 1.045	.967	SHELLSIDE PERFORMANCE NOMINAL VEL,X-FLOW FT/S NOMINAL VEL,WINDOW FT/S	.04
PRANDTL NUMBER 6.1	3.5	NOMINAL VEL, WINDOW FT/S	.08
RYNLD NO. AVG 125.	2360.	CROSSFLOW COEF BTU/HR-FT2-1	163.7
RYNLD NO, IN BUN 76.	2667.	WINDOW COEF BTU/HR-FT2-1	164.5
RYNLD NO, OUT BUN 187.	2068.		
FOULNG LAYER IN0014	.0014	SHELLSIDE FLOW, % OF TOTAL	
		SHELLSIDE FLOW, $\%$ OF TOTAL HEAT TRANSFER X-FLOW	81.36
THERMAL RESISTANCE, % OF TO	TAL	TUBE TO BAFFLE LEAKAGE A =	= 2.73
SHELL TUBE FOULING MET	'AL	MAIN CROSSFLOW B =	= 69.42
56.53 41.38 2.02 .	07	BUNDLE TO SHELL BYPASS C =	= 11.39
PCT OVER DESIGN	.46	BAFFLE TO SHELL LEAKAGE E =	= 16.46
TOT FOUL RESIST .0	000217	TUBE PASSLANE BYPASS F =	00
DIFF RESIST .0	000049	BUNDLE TO SHELL BYPASS C = BAFFLE TO SHELL LEAKAGE E = TUBE PASSLANE BYPASS F =	
		SHELLSIDE HEAT TRANSFER FAC	TORS
DIAMETRAL CLEARANCES		TOTAL = (BETA) (GAMMA) (FIN)	602
BUNDLE TO SHELL IN.	.5000	TOTAL = (BETA) (GAMMA) (FIN) = BETA (BAFF CUT FACTOR) =	920
TUBE TO BAFFLE HOLE IN.	.0284	GAMMA (TUBE ROW ENTRY EFCT) =	655
BAFFLE TO SHELL IN.	.1000	END (HT LOSS IN END ZONE) =	994
SHELL NOZZLE DATA IN	OUT	SHELL PRESSURE DROP, % OF	TOTAL
HT UNDR NOZ IN25		WINDOW =	= 9.2
HT OPP NOZ IN25		END ZONE =	= 5.7
VELOCITY FT/S .24	.25	CROSS FLOW =	= 4.6
DENSITY LB/FT3 62.535	61.705	INLET NOZZLE =	= 42.4
NOZZ RHO*VSQ LB/FT-S2 3	3	OUTLET NOZZLE =	= 38.1
BUND RHO*VSQ LB/FT-S2 2	2	WINDOW = CROSS FLOW INLET NOZZLE = OUTLET NOZZLE = E	
		WEIGHT PER SHELL, LB	
VELOCITY FT/S 1.18		DRY =	150.
DENSITY LB/FT3 61.291			165.
PRESS. DROP % 8.8			
*** SPECIAL MESSAGES AND WA	RNINGS **	* *	

WARNING--TUBESIDE FLUID HAS PASSED THROUGH TRANSITION ZONE. CONSIDER RERUNNING WITH ITEM 132 IN EFFECT.

HEAT TRANSFER COEFF. AT RE = 2000 IS 220.70 BTU/HR-FT2-F

HEAT TRANSFER COEFF. AT RE = 10000 IS 1240.46 BTU/HR-FT2-F

□□Washington University ChE433 heat exchanger experiment E0002 P118 Young model F302DY4P 9/23/3 CASE 59

SIZE 4- 18 TYPE BEM, MULTI-PASS FLOW, SEGMENTAL BAFFLES, RATING

HOT TUBE SIDE COLD SHELL SIDE

Tube Shell

SENSIBLE LIQ

TOTAL FLOW RATE KLB/HR

.800 .400

IN OUT IN OUT

		che433b(	40).OUT		
TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS	DEGF	140.0	106.9*	40.0	106.0*
DENSITY	LB/FT3	61.2913	61.7981	62.5352	61.8100
VISCOSITY	CP	.4726	.6441	1.4791	.6497
SPECIFIC HEAT	BTII/I.B-F	9973	9982	1 0058	9983
THERMAL COND	BTU/HR-FT-F	3723	3649	3466	3647
MOLAR MASS	I.B / I.BMOI.	. 3723	18 02	.5400	18 02
	,				
TEMP, AVG & SKIN	DEGF	123.4	100.4	73.0	99.2
VISCOSITY, AVG & S	SKIN CP	.5480	.6892	.9423	.6975
VISCOSITY, AVG & S PRESSURE, IN & DES	SIGN PSIA	50.00	165.00	50.00	165.00
PRESSURE DROP, TO	r & Allowed Ps	.12	10.00	.00	10.00
VELOCITY, CALC & N	MAX ALLOWED FI	'/S .78	10.00	.06	10.00
FOULING RESISTANCE	E HR-FT2-F/	BTU .(	00010 60.25	. (	00010
FILM COEFFICIENT					91.40
TOTAL HEAT DUTY RI	OULDED MECDALL				.026437
EFF TEMP DIF, DEG			, cc	EE-1 00)	36.6
OVERALL COEFF REQU			ASS93, BA	FF-1.00)	101.04
CLEAN & FOULED CO	DIKED BTU/HK-	FTZ-F	100 0	7	101.04
CLEAN & FOOLED CO	EFF BIU/HK-	F12-F	102.0	/	100.61
SHELLS IN SERIES	1 PARALLEL 1	TOTAL EF	F AREA	FT2	7.1
SHELLS IN SERIES PASSES, SHELL	1 TUBE 4	EFFECTIVE	E AREA	FT2/SHELL	7.1
SHELL DIAMETER IN	3.820	TEMA SHE	LL TYPE E	; REAR HE	EAD FXTS
				,	
BAFFLE TYPE	HORZ SEGMENTL	CROSS PAS	SSES PER SH	ELL PASS	4
SPACING, CENTRAL	IN. 4.309	BAFFLE CU	JT, PCT SHE	LL I.D.	30.00
SPACING, INLET	IN. 4.309	CUT DISTA	ANCE FROM C	ENTER, IN.	.764
SPACING, OUTLET	IN. 4.309				
BAFFLE THICKNESS	IN125	IMPINGEM	ENT BAFFLE	INCLUDED	NO
PAIRS OF SEALING I	DEVICES 1	TUBESHEET	r blank are.	A, %	.0
	DI 2 TN	M3	E		COPPED
TUBE TYPE NO. OF TUBES/SHELD	PLAIN 76	MATERIAL FOR MAY	E. COUNT	LECTROLITIC	36
TUBE LGTH, OVERALI	. Trm 1 EOO	ESI MAX .	IOBE COONI	TNI	2125
			SIDE DIAM	IN.	.3125
TUBE LAYOUM	FT 1.436 DEG 60			IN.	.214
TUBE LAYOUT PITCH RATIO			IDE DIAM FACE RATIO,		1.184
SHL NOZZ ID, IN&OU					
SHE NOZZ ID, INWO	71 1.0 1.0	TOBE NOZZ	E ID, INAOO	I IN.	.0 .0
* CALCULATED ITE	EMHEAT BALANC	E CODE = 8			
□□Washington Unive			ger experim	ent	E0002 P119
Young model F302D	-		5 1 -		9/23/ 3
3					CASE 59
S U P P L E	M E N T A	R Y I	R E S U	L T S	
HT PARAMETERS	SHELL TUBE		LSIDE PERFO		
WALL CORRECTION	1.043 .962		L VEL, X-FLO	W FT/S	.05
PRANDTL NUMBER	6.4 3.6		L VEL, WINDO		.10
RYNLD NO, AVG	160. 2301.	CROSSF1	LOW COEF	BTU/HR-FT2-	-F 192.2
RYNLD NO, IN BUN		WINDOW	COEF	BTU/HR-FT2-	-F 193.3
RYNLD NO, OUT BUN	232. 1957.				

	che433b(40).OUT		
FOULNG LAYER IN0014 .0014		JATC	
	HEAT TRANSFER X-FLOW		81.46
THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL	TUBE TO BAFFLE LEAKAGE	A =	2.97
SHELL TUBE FOULING METAL	MAIN CROSSFLOW	B =	68.40
51.98 45.77 2.18 .07	BUNDLE TO SHELL BYPASS	C =	12.46
PCT OVER DESIGN42	BAFFLE TO SHELL LEAKAGE	E =	16.17
TOT FOUL RESIST .000217	TUBE PASSLANE BYPASS	F =	.00
DIFF RESIST000042			
	SHELLSIDE HEAT TRANSFER	R FACT	ORS
DIAMETRAL CLEARANCES	TOTAL = (BETA) (GAMMA) (FIN)	) =	.620
BUNDLE TO SHELL IN5000	BETA (BAFF CUT FACTOR)	=	.920
TUBE TO BAFFLE HOLE IN0284 BAFFLE TO SHELL IN1000	GAMMA (TUBE ROW ENTRY EFO	CT) =	.674
BAFFLE TO SHELL IN1000	END (HT LOSS IN END ZO	NE) =	.994
SHELL NOZZLE DATA IN OUT	SHELL PRESSURE DROP, %	OF TO	TAL
HT UNDR NOZ IN25 HT OPP NOZ IN25 VELOCITY FT/S .33 .33 DENSITY LB/FT3 62.535 61.810 NOZZ RHO*VSQ LB/FT-S2 6 6 BUND RHO*VSQ LB/FT-S2 4 4	WINDOW	=	9.0
HT OPP NOZ IN25	END ZONE	=	5.1
VELOCITY FT/S .33 .33	CROSS FLOW	=	4.2
DENSITY LB/FT3 62.535 61.810	INLET NOZZLE	=	42.7
NOZZ RHO*VSQ LB/FT-S2 6 6	OUTLET NOZZLE	=	39.0
BUND RHO*VSQ LB/FT-S2 4 4			
TUBE NOZZLE DATA IN OUT			
VELOCITY FT/S 1.18 1.17		=	150.
DENSITY LB/FT3 61.291 61.798	WET	=	165.
PRESS. DROP % 8.7 5.5			
*** SPECIAL MESSAGES AND WARNINGS	* * *		
WARNINGTUBESIDE FLUID HAS PASSED	THROUGH TRANSITION ZONE.	CONSI	DER
RERUNNING WITH ITEM 132 I	N EFFECT.		
HEAT TRANSFER COEFF. AT R	RE = 2000  IS 221.76  BTU/HB	R-FT2-	F
	RE = 10000 IS 1246.28 BTU/HB		
$\square\square$ Washington University ChE433 hea	t exchanger experiment	ΕO	002 P120
Young model F302DY4P		9	/23/ 3
			ASE 60
SIZE 4- 18 TYPE BEM, MULTI-PASS FL	OW, SEGMENTAL BAFFLES, RAT	ING	
	HOT TUBE SIDE COLI	O SHEL	L SIDE
	Tube Si		

DIZE I TO TITE DE	111/ 110111 11100	I HOW, DHOIM		10, 10111110		
		HOT TU	JBE SIDE	COLD SH	HELL SIDE	
		Tube		Shell	L	
		SENS	IBLE LIQ	SENSI	IBLE LIQ	
TOTAL FLOW RATE	KLB/HR		.800		.500	
		IN	OUT	IN	OUT	
TEMPERATURE	DEGF	140.0	102.6*	40.0	99.6*	
DENSITY	LB/FT3	61.2913	61.8563	62.5352	61.8971	
VISCOSITY	CP	.4726	.6730	1.4791	.6949	
SPECIFIC HEAT	BTU/LB-F	.9973	.9985	1.0058	.9987	
THERMAL COND.	BTU/HR-FT-F	.3723	.3639	.3466	.3631	
MOLAR MASS	LB/LBMOL		18.02		18.02	
TEMP, AVG & SKIN	DEGF	121.3	95.9	69.8	94.7	
VISCOSITY, AVG & S	SKIN CP	.5590	.7228	.9809	.7325	

PRESSURE, IN & DESIGN P	SIA	50.00			0 165.00
PRESSURE DROP, TOT & ALL VELOCITY, CALC & MAX ALL					1 10.00 8 10.00
FOULING RESISTANCE H FILM COEFFICIENT B	R-FT2-F/B7	ru .0	0010		.00010
					217.09
TOTAL HEAT DUTY REQUIRED	MEGBTU/HF	3			.029831
EFF TEMP DIF, DEGF (LMT	D= 50.7,F=	= .83,BYPA	SS= .93,BA	AFF=1.00)	39.4
OVERALL COEFF REQUIRED					106.08
CLEAN & FOULED COEFF	BTU/HR-F7	Γ2-F	108.9	95	106.32
SHELLS IN SERIES 1 PARA	LLEL 1	TOTAL EFF	AREA	FT2	7.1
PASSES, SHELL 1 TUBE					
SHELL DIAMETER IN.					
BAFFLE TYPE HORZ S	CMENITI	CDOCC DAC	CTC DTD CL	ובוו האפכ	4
SPACING, CENTRAL IN.					30.00
SPACING, INLET IN.					N764
SPACING, OUTLET IN.		001 210111	1.02 11.011 0	,,	• • • • • • • • • • • • • • • • • • • •
BAFFLE THICKNESS IN.		IMPINGEME:	NT BAFFLE	INCLUDED	NO
PAIRS OF SEALING DEVICES	1		BLANK ARE		
TUBE TYPE	DIATM	MATERIAI	т.	T ECEDAT V	TIC COPPER
NO. OF TUBES/SHELL	PLAIN 76		UBE COUNT		
TUBE LGTH, OVERALL FT					.3125
TUBE LGTH, EFF FT					.250
TUBE LAYOUT DEG					.214
PITCH RATIO					1.184
SHL NOZZ ID, IN&OUT 1.					.8 .8
* ONI CHI NEED TEEM HEN		CODE - 0			
* CALCULATED ITEMHEA			er evnerim	nan+	F0002 P121
Young model F302DY4P	CHE433 Hea	at excitating	er experim	lenc.	9/23/ 3
104119 110401 10022111					CASE 60
SUPPLEME	N T A F	R Y R	E S U	L T S	
HT PARAMETERS SHELL					0.7
WALL CORRECTION 1.042					.07
PRANDTL NUMBER 6.7 RYNLD NO, AVG 192.					
RYNLD NO, IN BUN 127.					
RYNLD NO, OUT BUN 271.			COLI	DIO/IIIC I	12 1 219.0
FOULNG LAYER IN0014			SIDE FLOW,	% OF TO	ΓAL
					81.55
THERMAL RESISTANCE, % OF					
SHELL TUBE FOULING					
48.32 49.30 2.31					
PCT OVER DESIGN TOT FOUL RESIST	.23	BAFFLE	TO SHELL I	LEAKAGE	E = 15.93
			SSLANE BYE	PASS	F = .00
DIFF RESIST	.000021		OIDE HERE	mp	
		SHELL	SIDE HEAT	TRANSFER	FACTORS

DIAMETRAL CLEARANCES		TOTAL = (BETA) (GAMMA) (FIN)	= .637
BUNDLE TO SHELL IN.	.5000	BETA (BAFF CUT FACTOR)	= .920
TUBE TO BAFFLE HOLE IN.	.0284	GAMMA (TUBE ROW ENTRY EFCT)	= .692
BAFFLE TO SHELL IN.	.1000	END (HT LOSS IN END ZONE)	= .994
SHELL NOZZLE DATA IN	OUT	SHELL PRESSURE DROP, % OF	TOTAL
HT UNDR NOZ IN25			= 8.9
HT OPP NOZ IN25		END ZONE	= 4.6
VELOCITY FT/S .41	.41	CROSS FLOW INLET NOZZLE	= 3.9
DENSITY LB/FT3 62.535	61.897	INLET NOZZLE	= 42.9
NOZZ RHO*VSQ LB/FT-S2 10	10	OUTLET NOZZLE	= 39.6
BUND RHO*VSQ LB/FT-S2 7	7		
TUBE NOZZLE DATA IN	OUT	WEIGHT PER SHELL, LB	
VELOCITY FT/S 1.18	1.17	DRY =	150.
DENSITY LB/FT3 61.291	61.856	WET =	165.
PRESS. DROP % 8.6	5.4		

### *** SPECIAL MESSAGES AND WARNINGS ***

WARNING--TUBESIDE FLUID HAS PASSED THROUGH TRANSITION ZONE. CONSIDER RERUNNING WITH ITEM 132 IN EFFECT.

HEAT TRANSFER COEFF. AT RE = 2000 IS 222.54 BTU/HR-FT2-F HEAT TRANSFER COEFF. AT RE = 10000 IS 1250.05 BTU/HR-FT2-F

SIZE	4 –	18	TYPE	BEM,	MULTI-PASS	FLOW,	SEGMENTAL	BAFFLES,	RATING
------	-----	----	------	------	------------	-------	-----------	----------	--------

		HOT TUBE SIDE			ELL SIDE
		Tube		Shell	
		SENSI	BLE LIQ	SENSI	BLE LIQ
TOTAL FLOW RATE	KLB/HR		.800		.600
		IN	OUT	IN	OUT
TEMPERATURE	DEGF	140.0	99.1*	40.0	94.3*
DENSITY	LB/FT3	61.2913	61.9033	62.5352	61.9658
VISCOSITY	CP	.4726	.6984	1.4791	.7356
SPECIFIC HEAT	BTU/LB-F	.9973	.9987	1.0058	.9991
THERMAL COND.	BTU/HR-FT-F	.3723	.3630	.3466	.3618
MOLAR MASS	LB/LBMOL		18.02		18.02
TEMP, AVG & SKIN	DEGF	119.6	92.2	67.1	90.9
VISCOSITY, AVG & S	KIN CP	.5684	.7531	1.0143	.7641
PRESSURE, IN & DES	IGN PSIA	50.00	165.00	50.00	165.00
PRESSURE DROP, TOT	& ALLOWED PSI	.12	10.00	.01	10.00
VELOCITY, CALC & M	AX ALLOWED FT/S	.78	10.00	.09	10.00
FOULING RESISTANCE	HR-FT2-F/BT	. C	00010	.0	0010
FILM COEFFICIENT	BTU/HR-FT2-1	F 25	51.13	24	2.36

TOTAL HEAT DUTY REQUIRED MEGBTU/HR

.032638

EFF TEMP DIF, DEGF (LMTD= 52.1,F)	= .84,BYPASS= .94,BAFF=1.00) 41.3
OVERALL COEFF REQUIRED BTU/HR-F	
CLEAN & FOULED COEFF BTU/HR-F	T2-F 113.83 110.89
SHELLS IN SERIES 1 PARALLEL 1	TOTAL EFF AREA FT2 7.1
PASSES, SHELL 1 TUBE 4	
SHELL DIAMETER IN. 3.820	
Sille Dimille III. 5.020	TEMM SHEET TITE E , NEAR HEAD TAIS
BAFFLE TYPE HORZ SEGMENTL	CROSS PASSES PER SHELL PASS 4
SPACING, CENTRAL IN. 4.309	BAFFLE CUT, PCT SHELL I.D. 30.00
SPACING, INLET IN. 4.309	CUT DISTANCE FROM CENTER, IN764
SPACING, OUTLET IN. 4.309	
BAFFLE THICKNESS IN125	IMPINGEMENT BAFFLE INCLUDED NO
PAIRS OF SEALING DEVICES 1	TUBESHEET BLANK AREA, % .0
TUBE TYPE PLAIN	MATERIAL ELECTROLYTIC COPPER
NO. OF TUBES/SHELL 76	EST MAX TUBE COUNT 36
TUBE LGTH, OVERALL FT 1.500	TUBE PITCH IN3125
TUBE LGTH, EFF FT 1.436	TUBE OUTSIDE DIAM IN250
TUBE LAYOUT DEG 60	TUBE INSIDE DIAM IN214
PITCH RATIO 1.250	TUBE SURFACE RATIO, OUT/IN 1.184
SHL NOZZ ID, IN&OUT 1.0 1.0	TUBE NOZZ ID, IN&OUT IN8 .8
5111 NOZZ 1D, 1N&OO1 1.0 1.0	10DE NOZZ 1D, 1N&001 1N0 .0
* CALCULATED ITEMHEAT BALANCE	CODE - 0
□□Washington University ChE433 he	
Young model F302DY4P	9/23/ 3
	CASE 61
SUPPLEMENTA	R Y R E S U L T S
HT PARAMETERS SHELL TUBE	SHELLSIDE PERFORMANCE
WALL CORRECTION 1.040 .954	NOMINAL VEL, X-FLOW FT/S .08
PRANDTL NUMBER 6.9 3.7	NOMINAL VEL, WINDOW FT/S .15
RYNLD NO, AVG 223. 2218.	CROSSFLOW COEF BTU/HR-FT2-F 243.3
	ONOBOLIEON COLL BIO/ MN LIE I 210.0
RYNLD NO, IN BUN 153. 2667.	WINDOW COEF BTU/HR-FT2-F 244.8
RYNLD NO, IN BUN 153. 2667. RYNLD NO, OUT BUN 308. 1805.	WINDOW COEF BTU/HR-FT2-F 244.8
RYNLD NO, IN BUN 153. 2667.	WINDOW COEF BTU/HR-FT2-F 244.8  SHELLSIDE FLOW, % OF TOTAL
RYNLD NO, IN BUN 153. 2667. RYNLD NO, OUT BUN 308. 1805. FOULNG LAYER IN0014 .0014	WINDOW COEF BTU/HR-FT2-F 244.8  SHELLSIDE FLOW, % OF TOTAL HEAT TRANSFER X-FLOW 81.60
RYNLD NO, IN BUN 153. 2667. RYNLD NO, OUT BUN 308. 1805. FOULNG LAYER IN0014 .0014 THERMAL RESISTANCE, % OF TOTAL	WINDOW COEF BTU/HR-FT2-F 244.8  SHELLSIDE FLOW, % OF TOTAL HEAT TRANSFER X-FLOW 81.60 TUBE TO BAFFLE LEAKAGE A = 3.33
RYNLD NO, IN BUN 153. 2667. RYNLD NO, OUT BUN 308. 1805. FOULNG LAYER IN0014 .0014  THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL	WINDOW COEF BTU/HR-FT2-F 244.8  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.60  TUBE TO BAFFLE LEAKAGE A = 3.33  MAIN CROSSFLOW B = 66.84
RYNLD NO, IN BUN 153. 2667. RYNLD NO, OUT BUN 308. 1805. FOULNG LAYER IN0014 .0014  THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL 45.24 52.28 2.40 .08	WINDOW COEF BTU/HR-FT2-F 244.8  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.60  TUBE TO BAFFLE LEAKAGE A = 3.33  MAIN CROSSFLOW B = 66.84  BUNDLE TO SHELL BYPASS C = 14.09
RYNLD NO, IN BUN 153. 2667. RYNLD NO, OUT BUN 308. 1805. FOULNG LAYER IN0014 .0014  THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL 45.24 52.28 2.40 .08	WINDOW COEF BTU/HR-FT2-F 244.8  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.60  TUBE TO BAFFLE LEAKAGE A = 3.33  MAIN CROSSFLOW B = 66.84  BUNDLE TO SHELL BYPASS C = 14.09
RYNLD NO, IN BUN 153. 2667. RYNLD NO, OUT BUN 308. 1805. FOULNG LAYER IN0014 .0014  THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL 45.24 52.28 2.40 .08 PCT OVER DESIGN .16 TOT FOUL RESIST .000217	WINDOW COEF BTU/HR-FT2-F 244.8  SHELLSIDE FLOW, % OF TOTAL HEAT TRANSFER X-FLOW 81.60 TUBE TO BAFFLE LEAKAGE A = 3.33 MAIN CROSSFLOW B = 66.84 BUNDLE TO SHELL BYPASS C = 14.09 BAFFLE TO SHELL LEAKAGE E = 15.75 TUBE PASSLANE BYPASS F = .00
RYNLD NO, IN BUN 153. 2667. RYNLD NO, OUT BUN 308. 1805. FOULNG LAYER IN0014 .0014  THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL 45.24 52.28 2.40 .08	WINDOW COEF BTU/HR-FT2-F 244.8  SHELLSIDE FLOW, % OF TOTAL HEAT TRANSFER X-FLOW 81.60 TUBE TO BAFFLE LEAKAGE A = 3.33 MAIN CROSSFLOW B = 66.84 BUNDLE TO SHELL BYPASS C = 14.09 BAFFLE TO SHELL LEAKAGE E = 15.75 TUBE PASSLANE BYPASS F = .00
RYNLD NO, IN BUN 153. 2667. RYNLD NO, OUT BUN 308. 1805. FOULNG LAYER IN0014 .0014  THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL 45.24 52.28 2.40 .08 PCT OVER DESIGN .16 TOT FOUL RESIST .000217 DIFF RESIST .000015	WINDOW COEF BTU/HR-FT2-F 244.8  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.60  TUBE TO BAFFLE LEAKAGE A = 3.33  MAIN CROSSFLOW B = 66.84  BUNDLE TO SHELL BYPASS C = 14.09  BAFFLE TO SHELL LEAKAGE E = 15.75  TUBE PASSLANE BYPASS F = .00
RYNLD NO, IN BUN 153. 2667. RYNLD NO, OUT BUN 308. 1805. FOULNG LAYER IN0014 .0014  THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL 45.24 52.28 2.40 .08 PCT OVER DESIGN .16 TOT FOUL RESIST .000217 DIFF RESIST .000015	WINDOW COEF BTU/HR-FT2-F 244.8  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.60  TUBE TO BAFFLE LEAKAGE A = 3.33  MAIN CROSSFLOW B = 66.84  BUNDLE TO SHELL BYPASS C = 14.09  BAFFLE TO SHELL LEAKAGE E = 15.75  TUBE PASSLANE BYPASS F = .00
RYNLD NO, IN BUN 153. 2667. RYNLD NO, OUT BUN 308. 1805. FOULNG LAYER IN0014 .0014  THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL 45.24 52.28 2.40 .08 PCT OVER DESIGN .16 TOT FOUL RESIST .000217 DIFF RESIST .000015	WINDOW COEF BTU/HR-FT2-F 244.8  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.60  TUBE TO BAFFLE LEAKAGE A = 3.33  MAIN CROSSFLOW B = 66.84  BUNDLE TO SHELL BYPASS C = 14.09  BAFFLE TO SHELL LEAKAGE E = 15.75  TUBE PASSLANE BYPASS F = .00
RYNLD NO, IN BUN 153. 2667. RYNLD NO, OUT BUN 308. 1805. FOULNG LAYER IN0014 .0014  THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL 45.24 52.28 2.40 .08 PCT OVER DESIGN .16 TOT FOUL RESIST .000217 DIFF RESIST .000015  DIAMETRAL CLEARANCES BUNDLE TO SHELL IN5000	WINDOW COEF BTU/HR-FT2-F 244.8  SHELLSIDE FLOW, % OF TOTAL HEAT TRANSFER X-FLOW 81.60 TUBE TO BAFFLE LEAKAGE A = 3.33 MAIN CROSSFLOW B = 66.84 BUNDLE TO SHELL BYPASS C = 14.09 BAFFLE TO SHELL LEAKAGE E = 15.75 TUBE PASSLANE BYPASS F = .00
RYNLD NO, IN BUN 153. 2667. RYNLD NO, OUT BUN 308. 1805. FOULNG LAYER IN0014 .0014  THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL 45.24 52.28 2.40 .08 PCT OVER DESIGN .16 TOT FOUL RESIST .000217 DIFF RESIST .000015  DIAMETRAL CLEARANCES BUNDLE TO SHELL IN5000 TUBE TO BAFFLE HOLE IN0284	WINDOW COEF BTU/HR-FT2-F 244.8  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.60  TUBE TO BAFFLE LEAKAGE A = 3.33  MAIN CROSSFLOW B = 66.84  BUNDLE TO SHELL BYPASS C = 14.09  BAFFLE TO SHELL LEAKAGE E = 15.75  TUBE PASSLANE BYPASS F = .00  SHELLSIDE HEAT TRANSFER FACTORS  TOTAL = (BETA) (GAMMA) (FIN) = .653  BETA (BAFF CUT FACTOR) = .920  GAMMA (TUBE ROW ENTRY EFCT) = .710
RYNLD NO, IN BUN 153. 2667. RYNLD NO, OUT BUN 308. 1805. FOULNG LAYER IN0014 .0014  THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL 45.24 52.28 2.40 .08 PCT OVER DESIGN .16 TOT FOUL RESIST .000217 DIFF RESIST .000015  DIAMETRAL CLEARANCES BUNDLE TO SHELL IN5000 TUBE TO BAFFLE HOLE IN0284	WINDOW COEF BTU/HR-FT2-F 244.8  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.60  TUBE TO BAFFLE LEAKAGE A = 3.33  MAIN CROSSFLOW B = 66.84  BUNDLE TO SHELL BYPASS C = 14.09  BAFFLE TO SHELL LEAKAGE E = 15.75  TUBE PASSLANE BYPASS F = .00  SHELLSIDE HEAT TRANSFER FACTORS  TOTAL = (BETA) (GAMMA) (FIN) = .653  BETA (BAFF CUT FACTOR) = .920
RYNLD NO, IN BUN 153. 2667. RYNLD NO, OUT BUN 308. 1805. FOULNG LAYER IN0014 .0014  THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL 45.24 52.28 2.40 .08 PCT OVER DESIGN .16 TOT FOUL RESIST .000217 DIFF RESIST .000015  DIAMETRAL CLEARANCES BUNDLE TO SHELL IN5000 TUBE TO BAFFLE HOLE IN0284 BAFFLE TO SHELL IN1000	WINDOW COEF BTU/HR-FT2-F 244.8  SHELLSIDE FLOW, % OF TOTAL HEAT TRANSFER X-FLOW 81.60 TUBE TO BAFFLE LEAKAGE A = 3.33 MAIN CROSSFLOW B = 66.84 BUNDLE TO SHELL BYPASS C = 14.09 BAFFLE TO SHELL LEAKAGE E = 15.75 TUBE PASSLANE BYPASS F = .00  SHELLSIDE HEAT TRANSFER FACTORS TOTAL = (BETA) (GAMMA) (FIN) = .653 BETA (BAFF CUT FACTOR) = .920 GAMMA (TUBE ROW ENTRY EFCT) = .710 END (HT LOSS IN END ZONE) = .994
RYNLD NO, IN BUN 153. 2667. RYNLD NO, OUT BUN 308. 1805. FOULNG LAYER IN0014 .0014  THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL 45.24 52.28 2.40 .08 PCT OVER DESIGN .16 TOT FOUL RESIST .000217 DIFF RESIST .000015  DIAMETRAL CLEARANCES BUNDLE TO SHELL IN5000 TUBE TO BAFFLE HOLE IN0284 BAFFLE TO SHELL IN1000  SHELL NOZZLE DATA IN OUT	WINDOW COEF BTU/HR-FT2-F 244.8  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.60  TUBE TO BAFFLE LEAKAGE A = 3.33  MAIN CROSSFLOW B = 66.84  BUNDLE TO SHELL BYPASS C = 14.09  BAFFLE TO SHELL LEAKAGE E = 15.75  TUBE PASSLANE BYPASS F = .00  SHELLSIDE HEAT TRANSFER FACTORS  TOTAL = (BETA) (GAMMA) (FIN) = .653  BETA (BAFF CUT FACTOR) = .920  GAMMA (TUBE ROW ENTRY EFCT) = .710  END (HT LOSS IN END ZONE) = .994  SHELL PRESSURE DROP, % OF TOTAL
RYNLD NO, IN BUN 153. 2667. RYNLD NO, OUT BUN 308. 1805. FOULNG LAYER IN0014 .0014  THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL 45.24 52.28 2.40 .08 PCT OVER DESIGN .16 TOT FOUL RESIST .000217 DIFF RESIST .000015  DIAMETRAL CLEARANCES BUNDLE TO SHELL IN5000 TUBE TO BAFFLE HOLE IN0284 BAFFLE TO SHELL IN1000  SHELL NOZZLE DATA IN OUT HT UNDR NOZ IN25	WINDOW COEF BTU/HR-FT2-F 244.8  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.60  TUBE TO BAFFLE LEAKAGE A = 3.33  MAIN CROSSFLOW B = 66.84  BUNDLE TO SHELL BYPASS C = 14.09  BAFFLE TO SHELL LEAKAGE E = 15.75  TUBE PASSLANE BYPASS F = .00  SHELLSIDE HEAT TRANSFER FACTORS  TOTAL = (BETA) (GAMMA) (FIN) = .653  BETA (BAFF CUT FACTOR) = .920  GAMMA (TUBE ROW ENTRY EFCT) = .710  END (HT LOSS IN END ZONE) = .994  SHELL PRESSURE DROP, % OF TOTAL  WINDOW = 8.8
RYNLD NO, IN BUN 153. 2667. RYNLD NO, OUT BUN 308. 1805. FOULNG LAYER IN0014 .0014  THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL 45.24 52.28 2.40 .08 PCT OVER DESIGN .16 TOT FOUL RESIST .000217 DIFF RESIST .000015  DIAMETRAL CLEARANCES BUNDLE TO SHELL IN5000 TUBE TO BAFFLE HOLE IN0284 BAFFLE TO SHELL IN1000  SHELL NOZZLE DATA IN OUT HT UNDR NOZ IN25 HT OPP NOZ IN25	WINDOW COEF BTU/HR-FT2-F 244.8  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.60  TUBE TO BAFFLE LEAKAGE A = 3.33  MAIN CROSSFLOW B = 66.84  BUNDLE TO SHELL BYPASS C = 14.09  BAFFLE TO SHELL LEAKAGE E = 15.75  TUBE PASSLANE BYPASS F = .00  SHELLSIDE HEAT TRANSFER FACTORS  TOTAL = (BETA) (GAMMA) (FIN) = .653  BETA (BAFF CUT FACTOR) = .920  GAMMA (TUBE ROW ENTRY EFCT) = .710  END (HT LOSS IN END ZONE) = .994  SHELL PRESSURE DROP, % OF TOTAL  WINDOW = 8.8  END ZONE = 4.3
RYNLD NO, IN BUN 153. 2667. RYNLD NO, OUT BUN 308. 1805. FOULNG LAYER IN0014 .0014  THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL 45.24 52.28 2.40 .08 PCT OVER DESIGN .16 TOT FOUL RESIST .000217 DIFF RESIST .000015  DIAMETRAL CLEARANCES BUNDLE TO SHELL IN5000 TUBE TO BAFFLE HOLE IN0284 BAFFLE TO SHELL IN1000  SHELL NOZZLE DATA IN OUT HT UNDR NOZ IN25	WINDOW COEF BTU/HR-FT2-F 244.8  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.60  TUBE TO BAFFLE LEAKAGE A = 3.33  MAIN CROSSFLOW B = 66.84  BUNDLE TO SHELL BYPASS C = 14.09  BAFFLE TO SHELL LEAKAGE E = 15.75  TUBE PASSLANE BYPASS F = .00  SHELLSIDE HEAT TRANSFER FACTORS  TOTAL = (BETA) (GAMMA) (FIN) = .653  BETA (BAFF CUT FACTOR) = .920  GAMMA (TUBE ROW ENTRY EFCT) = .710  END (HT LOSS IN END ZONE) = .994  SHELL PRESSURE DROP, % OF TOTAL  WINDOW = 8.8  END ZONE = 4.3

DENSITY	LB/FT3	62.535	61.966	INLET NOZZLE	=	43.0
NOZZ RHO*	VSQ LB/FT-	·S2 14	15	OUTLET NOZZLE	=	40.1
BUND RHO*	VSQ LB/FT-	·S2 10	10			
TUBE NO	ZZLE DATA	IN	OUT	WEIGHT PER SHELL, LB		
VELOCITY	FT/S	1.18	1.17	DRY	=	150.
DENSITY	LB/FT3	61.291	61.903	WET	=	165.
PRESS. DRO	OP %	8.6	5.4			

### *** SPECIAL MESSAGES AND WARNINGS ***

WARNING--TUBESIDE FLUID HAS PASSED THROUGH TRANSITION ZONE. CONSIDER RERUNNING WITH ITEM 132 IN EFFECT.

> HEAT TRANSFER COEFF. AT RE = 2000 IS 223.08 BTU/HR-FT2-F HEAT TRANSFER COEFF. AT RE = 10000 IS 1252.94 BTU/HR-FT2-F

□□Washington Univeryoung model F302DY		eat exchanç	ger experim		9/23/ 3
					CASE 62
SIZE 4- 18 TYPE BEI	M, MULTI-PASS H	FLOW, SEGME	ENTAL BAFFL	ES, RATING	
		HOT TU	JBE SIDE	COLD SI	HELL SIDE
		Tube		Shell	1
		SENSI	BLE LIQ	SENS	IBLE LIQ
TOTAL FLOW RATE	KLB/HR		.800		.700
		IN	.800 OUT	IN	OUT
TEMPERATURE	DECE	1 4 0 0	0 0 0 +	400	00 0+
DENSITY	LB/FT3	61.2913	61.9410	62.5352	62.0224
VISCOSITY	CP	.4726	.7203	1.4791	.7731
DENSITY VISCOSITY SPECIFIC HEAT	BTU/LB-F	.9973	.9989	1.0058	.9995
THERMAL COND.	BTU/HR-FT-F	.3723	.3623	.3466	.3607
MOLAR MASS	LB/LBMOL		18.02		18.02
	,				
TEMP, AVG & SKIN	DEGF				87.6
VISCOSITY, AVG & SI					
PRESSURE, IN & DES					
TREESCORE, IN a BES		00.00	100.00	00.00	100.00
PRESSURE DROP, TOT	& ALLOWED PSI	т 12	10 00	0.1	10 00
VELOCITY, CALC & MA					
VEHOCITI, CALC & PA	AK ADDOWED 11/	. 70	10.00	• 1 1	10.00
FOILT THE DESIGNANCE	UD_FT?_F/I	ס דו די ר	00010	(	00010
FOULING RESISTANCE FILM COEFFICIENT	חתו לוס בהתי	2-5 2/	17 68	2.0	66.01
	DIU/ NR-F12				00.01
TOTAL HEAT DUTY RE					.034938
EFF TEMP DIF, DEGF			ACC- 04 DA		
OVERALL COEFF REQUI			ASS94,BA		
			117 0		114.28
CLEAN & FOULED COE	F.F. B.I.O / HK-1	3T. S → F.	11/.8	8	114.66
	1	momat ===		770	7 4
SHELLS IN SERIES					
PASSES, SHELL					
SHELL DIAMETER IN.	3.820	TEMA SHEI	LL TYPE E	; REAR HI	EAD FXTS
					_
BAFFLE TYPE HO	ORZ SEGMENTL	CROSS PAS	SSES PER SH	ELL PASS	4

	che433b(40).OUT
SPACING, CENTRAL IN. 4.309	BAFFLE CUT, PCT SHELL I.D. 30.00
SPACING, INLET IN. 4.309	CUT DISTANCE FROM CENTER, IN764
	cor biblimon inon chivility in.
SPACING, OUTLET IN. 4.309	TURTUGENENE RAFELE TUGINDER
BAFFLE THICKNESS IN125	
PAIRS OF SEALING DEVICES 1	TUBESHEET BLANK AREA, % .0
TUBE TYPE PLAIN	MATERIAL ELECTROLYTIC COPPER
NO. OF TUBES/SHELL 76	EST MAX TUBE COUNT 36
TUBE LGTH, OVERALL FT 1.500	TUBE PITCH IN3125
TUBE LGTH, EFF FT 1.436	
TUBE LAYOUT DEG 60	TUBE INSIDE DIAM IN214
	TUBE SURFACE RATIO, OUT/IN 1.184
SHL NOZZ ID, IN&OUT 1.0 1.0	TUBE NOZZ ID, IN&OUT IN8 .8
* CALCULATED ITEMHEAT BALANCE	CODE = 8
□□Washington University ChE433 he	at exchanger experiment E0002 P125
Young model F302DY4P	9/23/ 3
J	CASE 62
SUPPLEMENTA	
	K I K E S O E I S
UE DADAMEEDO CUELL EUDE	CHELL CIDE DEDECDMANCE
HT PARAMETERS SHELL TUBE	
WALL CORRECTION 1.039 .951	
PRANDTL NUMBER 7.2 3.8	
RYNLD NO, AVG 253. 2188.	CROSSFLOW COEF BTU/HR-FT2-F 267.1
RYNLD NO, IN BUN 178. 2667.	WINDOW COEF BTU/HR-FT2-F 268.7
RYNLD NO, OUT BUN 341. 1750.	
FOULNG LAYER IN0014 .0014	
	HEAT TRANSFER X-FLOW 81.59
THERMAL RESISTANCE, % OF TOTAL	
SHELL TUBE FOULING METAL	
42.62 54.81 2.49 .08	
PCT OVER DESIGN .33	
TOT FOUL RESIST .000217	TUBE PASSLANE BYPASS $F = .00$
DIFF RESIST .000029	
	SHELLSIDE HEAT TRANSFER FACTORS
DIAMETRAL CLEARANCES	TOTAL = (BETA) (GAMMA) (FIN) = .669
BUNDLE TO SHELL IN5000	
TUBE TO BAFFLE HOLE IN0284	GAMMA (TUBE ROW ENTRY EFCT) = .727
	END (HT LOSS IN END ZONE) = .994
CUPIT NOTTE DATA IN OUT	SHELL PRESSURE DROP, % OF TOTAL
HT UNDR NOZ IN25	
HT OPP NOZ IN25	
VELOCITY FT/S .57 .57	
DENSITY LB/FT3 62.535 62.022	
NOZZ RHO*VSQ LB/FT-S2 20 20	OUTLET NOZZLE = 40.5
BUND RHO*VSQ LB/FT-S2 13 13	
TUBE NOZZLE DATA IN OUT	WEIGHT PER SHELL, LB
VELOCITY FT/S 1.18 1.17	
DENSITY LB/FT3 61.291 61.941	
PRESS. DROP % 8.5 5.4	

#### *** SPECIAL MESSAGES AND WARNINGS ***

WARNING--TUBESIDE FLUID HAS PASSED THROUGH TRANSITION ZONE. CONSIDER RERUNNING WITH ITEM 132 IN EFFECT.

> HEAT TRANSFER COEFF. AT RE = 2000 IS 223.49 BTU/HR-FT2-F HEAT TRANSFER COEFF. AT RE = 10000 IS 1254.93 BTU/HR-FT2-F

□□Washington University ChE433 heat exchanger experiment E0002 P126

Young model F302DY	_	eat exchang	ger experim		E0002 P12 9/23/ 3 CASE 63
SIZE 4- 18 TYPE BE	M. MULTI-PASS	FLOW, SEGME	ENTAL BAFFL		
			JBE SIDE		
		SENSI	IBLE LIQ	SENS	IBLE LIQ
TOTAL FLOW RATE	KLB/HR		.800		.800
TOTAL FLOW RATE		IN	OUT	IN	OUT
TEMPERATURE					
DENSITY	LB/FT3	61.2913	61.9735	62.5352	62.0679
VISCOSITY			.7405	1.4791	.8064
SPECIFIC HEAT	BTU/LB-F	.9973	.9991	1.0058	.9998
THERMAL COND.	BTU/HR-FT-F				
MOLAR MASS	LB/LBMOL		18.02		18.02
TEMP, AVG & SKIN		116.8	86.1	63.0	84.7
VISCOSITY, AVG & S					
PRESSURE, IN & DES	SIGN PSIA	50.00	165.00	50.00	165.00
PRESSURE DROP, TOI					
VELOCITY, CALC & M	MAX ALLOWED FT	/S .78	10.00	.12	10.00
FOULING RESISTANCE					
FILM COEFFICIENT	BTU/HR-FT				89.19
TOTAL HEAT DUTY RE					.036962
EFF TEMP DIF, DEGF			ASS= .95,BA	FF=1.00)	
OVERALL COEFF REQU			,	•	118.05
CLEAN & FOULED COE			121.3	3	117.87
SHELLS IN SERIES	1 PARALLEL 1	TOTAL EF	F AREA	FT2	7.1
PASSES, SHELL					
SHELL DIAMETER IN.			LL TYPE E		
BAFFLE TYPE H	IORZ SEGMENTL	CROSS PAS	SSES PER SH	ELL PASS	4
SPACING, CENTRAL	IN. 4.309	BAFFLE CU	JT, PCT SHE	LL I.D.	30.00
SPACING, INLET	IN. 4.309	CUT DISTA	ANCE FROM C	ENTER, IN.	.764
SPACING, OUTLET	IN. 4.309				
BAFFLE THICKNESS	IN125	IMPINGEME	ENT BAFFLE	INCLUDED	NO
PAIRS OF SEALING D	DEVICES 1	TUBESHEET	r blank are.	A, %	.0
TUBE TYPE	PLAIN	MATERIAL	E	LECTROLYTI	C COPPER
NO. OF TUBES/SHELL	76	EST MAX	TUBE COUNT		36
TUBE LGTH, OVERALI	FT 1.500	TUBE PITO	СН	IN.	.3125

		CHE433D(40).001		
TUBE LGTH, EFF	FT 1.436	TUBE OUTSIDE DIAM IN.		.250
TUBE LAYOUT	DEG 60	TUBE INSIDE DIAM IN.		.214
PITCH RATIO	1.250	TUBE SURFACE RATIO, OUT/IN	1	.184
SHI NOZZ ID. INSOUT	1 0 1 0	TUBE OUTSIDE DIAM IN. TUBE INSIDE DIAM IN. TUBE SURFACE RATIO, OUT/IN TUBE NOZZ ID, IN&OUT IN.	8	8
SHE NOZZ ID, INGOOT	1.0 1.0	TODE NOBE ID, INGOOT IN.	• 0	• 0
		GODE 0		
* CALCULATED ITEM-				
<del>-</del>	_	t exchanger experiment		
Young model F302DY4E	P		9/2	3/ 3
			CAS	E 63
S U P P L E M	E N T A R	Y RESULTS		
HT PARAMETERS S	SHELL TUBE	SHELLSIDE PERFORMANCE		
WALL CORRECTION 1	1 038 947	NOMINAL VEL, X-FLOW FT/S		.10
PRANDTL NUMBER	7.3 3.8	NOMINAL VEL, WINDOW FT/S		.20
PRANDIL NUMBER	7.3 3.0	NOMINAL VEL, WINDOW FI/S	0 = 0	. 4.0
RYNLD NO, AVG	282. 2161.	CROSSFLOW COEF BTU/HR-FT	2-F 2	90.4
RYNLD NO, IN BUN	204. 2667.	CROSSFLOW COEF BTU/HR-FT WINDOW COEF BTU/HR-FT	2-F 2	92.0
RYNLD NO, OUT BUN	374. 1702.			
FOULNG LAYER IN	.0014 .0014	SHELLSIDE FLOW, % OF TOT	AL	
		SHELLSIDE FLOW, % OF TOT	8	1.59
THERMAL RESISTANCE,	% OF TOTAL	TUBE TO BAFFLE LEAKAGE	A =	3.62
SHELL TUBE FOULI	ING METAL	MAIN CROSSFLOW	B = 6	5.61
40 30 57 06 2 5	56 08	RUNDLE TO SHELL BYPASS	 C = 1	5 25
DOT OVER DESIGN	_ 15	TUBE TO BAFFLE LEAKAGE MAIN CROSSFLOW BUNDLE TO SHELL BYPASS BAFFLE TO SHELL LEAKAGE	c _ 1	5 52
FCI OVER DESIGN	13	BAFFLE TO SHELL LEAKAGE TUBE PASSLANE BYPASS	р — т	0.0
TOT FOUL RESIST	.000217	TUBE PASSLANE BIPASS	r –	.00
DIFF RESIST	000013			
		SHELLSIDE HEAT TRANSFER TOTAL = (BETA) (GAMMA) (FIN)	FACTOR	.S
DIAMETRAL CLEARANC	CES	TOTAL = (BETA) (GAMMA) (FIN)	=	.685
BUNDLE TO SHELL	IN5000	BETA (BAFF CUT FACTOR)	=	.920
		GAMMA (TUBE ROW ENTRY EFCT		
BAFFLE TO SHELL	IN1000	END (HT LOSS IN END ZONE	) =	.994
SHELL NOZZLE DATA	IN OUT	SHELL PRESSURE DROP, % O	F TOTA	L
HT OPP NOZ IN	25	END ZONE	=	3 8
VELOCITY ET/C	.25	WINDOW END ZONE CROSS FLOW INLET NOZZLE OUTLET NOZZLE	_	2 1
VELOCITI F1/5	.00 .00	CROSS FLOW	_	12.2
DENSITY LB/FT3	62.535 62.068	INLET NOZZLE	=	43.2
NOZZ RHO*VSQ LB/FT-S	32 26 26	OULTEL NOZZTE	=	40.8
BUND RHO*VSQ LB/FT-S	52 18 18			
		WEIGHT PER SHELL, LB		
VELOCITY FT/S	1.18 1.17	DRY =		150.
DENSITY LB/FT3	61.291 61.974	WET =		165.
PRESS. DROP %	8.5 5.3			
	- , -			

## *** SPECIAL MESSAGES AND WARNINGS ***

WARNING--TUBESIDE FLUID HAS PASSED THROUGH TRANSITION ZONE. CONSIDER RERUNNING WITH ITEM 132 IN EFFECT.

HEAT TRANSFER COEFF. AT RE = 2000 IS 223.77 BTU/HR-FT2-F HEAT TRANSFER COEFF. AT RE = 10000 IS 1256.69 BTU/HR-FT2-F

□□Washington University ChE433 heat exchanger experiment E0002 P128

roung model F302D1	41				9/23/ 3
					CASE 64
SIZE 4- 18 TYPE BE	M, MULTI-PASS F				
		HOT TU	JBE SIDE	COLD SI	HELL SIDE
TOTAL FLOW RATE  TEMPERATURE DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND.		Tube	BLE LIQ	Shell	L
		SENSI	BLE LIQ	SENS	IBLE LIQ
TOTAL FLOW RATE	KIB/HR		. 800		. 900
101112 12011 14112	1122, 1111	TN	OUT	TN	OIIT
	DECE	140.0	01 (+	10 0	001
TEMPERATURE	DEGF	140.0	91.6^	40.0	82.8^
DENSITY	LB/F"I'3	61.2913	61.9994	62.5352	62.1076
VISCOSITY	CP	.4726	.7574	1.4791	.8379
SPECIFIC HEAT	BTU/LB-F	.9973	.9993	1.0058	1.0001
THERMAL COND.	BTU/HR-FT-F	.3723	.3611	.3466	.3588
MOLAR MASS	LB/LBMOL		18.02		18.02
MOLAR MASS	,				
TEMP, AVG & SKIN VISCOSITY, AVG & S PRESSURE, IN & DES	DECE	115 0	83 7	61 /	82 2
VICCOCITY AND C	DEGI	E001	03.7	1 0022	0436
VISCOSIII, AVG & S	KIN CP	.3091	.0292	1.0933	.0430
PRESSURE, IN & DES	IGN PSIA	50.00	165.00	50.00	165.00
PRESSURE DROP, TOT	& ALLOWED PSI	.12	10.00	.02	10.00
VELOCITY, CALC & M	AX ALLOWED FT/	S .78	10.00	.14	10.00
FOULING RESISTANCE	HR-FT2-F/B	BTU .C	00010	. (	00010
FILM COEFFICIENT	BTII/HR-FT2	Y-F 24	2 08	3	12.16
					12.10
					020506
TOTAL HEAT DUTY RE				4 00\	.038596
EFF TEMP DIF, DEGF					44.8
OVERALL COEFF REQU	IRED BTU/HR-F	T2-F			120.69
OVERALL COEFF REQU CLEAN & FOULED COE	FF BTU/HR-F	T2-F	124.43	3	120.74
SHELLS IN SERIES PASSES, SHELL	1 PARALLEL 1	TOTAL EFF	' AREA	FT2	7.1
PASSES, SHELL	1 TUBE 4	EFFECTIVE	AREA	FT2/SHELL	7.1
SHELL DIAMETER IN.	3 820	TEMA SHET	T TYPE E	: REAR HI	ZAD FXTS
SHEEL BIIMIDIDIK IN.	3.020			, 1(1111( 111	1710
	ODE CECMENIE		AGEG DED GIII	11 DAGG	4
BAFFLE TYPE H SPACING, CENTRAL	ORZ SEGMENTL	CRUSS PAS	SES PER SHE	LLL PASS	4
SPACING, CENTRAL	IN. 4.309	BAFFLE CU	T, PCT SHEI	ць I.D.	30.00
SPACING, INLET SPACING, OUTLET	IN. 4.309	CUT DISTA	NCE FROM CE	ENTER, IN.	.764
SPACING, OUTLET	IN. 4.309				
BAFFLE THICKNESS	IN125	IMPINGEME	ENT BAFFLE	INCLUDED	NO
PAIRS OF SEALING D	EVICES 1	TUBESHEET	BLANK AREA	A, 8	.0
TUBE TYPE	PT.ATN	MATERTAI.	ΕI	ECTROLYTIC	COPPER
NO. OF TUBES/SHELL			UBE COUNT	decinodiii.	36
TUBE LGTH, OVERALL	70	ESI MAX I	OBE COUNT	IN.	2125
TUBE LGTH, OVERALL	FT 1.500	TOBE PITC	H		
TUBE LGTH, EFF	FT 1.436	TUBE OUTS	SIDE DIAM	IN.	.250
TUBE LAYOUT	DEG 60	TUBE INSI	DE DIAM	IN.	.214
PITCH RATIO SHL NOZZ ID, IN&OU	1.250	TUBE SURF	'ACE RATIO,	OUT/IN	1.184
SHL NOZZ ID, IN&OU	T 1.0 1.0	TUBE NOZZ	ID, IN&OUT	IN.	.8 .8
•			•		
* CALCULATED ITE	MHEAT BALANCE	CODE = 8			
□□Washington Unive			er evnorim	an+	F0002 D120
_	_	ac excitally	er evherring	511 L	
Young model F302DY	4 P				9/23/ 3
					CASE 64

S U P P L E M E N T A R Y R E S U L T S

HT PARAMETERS SHELL	THE	SHELLSIDE PERFORMANCE	
WALL CORRECTION 1.037			12
PRANDTL NUMBER 7.5			
		CROSSFLOW COEF BTU/HR-FT2-	
DVNID NO TN DIIN 220	2140.	WINDOW COEF BTU/HR-FT2-	-r 315.5
DVNID NO OUT DIN 405	1661	WINDOW COEF BIO/ HR-F12-	-r 313.2
RYNLD NO, OUT BUN 405.			-
FOOLING LATER IN0014		SHELLSIDE FLOW, % OF TOTAL	
MURDAN PROTOGRANCE O OR		HEAT TRANSFER X-FLOW	
		TUBE TO BAFFLE LEAKAGE A	
SHELL TUBE FOULING N	4ETAL	MAIN CROSSFLOW B	= 65.36
38.25 59.05 2.62	.09	BUNDLE TO SHELL BYPASS C	= 15.46
PCT OVER DESIGN	.05	BAFFLE TO SHELL LEAKAGE E TUBE PASSLANE BYPASS F	= 15.45
		TUBE PASSLANE BYPASS F	= .00
DIFF RESIST	.000004		
		SHELLSIDE HEAT TRANSFER FA	
DIAMETRAL CLEARANCES		TOTAL = (BETA) (GAMMA) (FIN)	
BUNDLE TO SHELL IN.		·	
		GAMMA (TUBE ROW ENTRY EFCT)	
BAFFLE TO SHELL IN.	.1000	END (HT LOSS IN END ZONE)	= .994
		SHELL PRESSURE DROP, % OF	
HT UNDR NOZ IN2	25	WINDOW	= 8.8
HT OPP NOZ IN2	25	END ZONE	= 3.7
VELOCITY FT/S .	73 .74	CROSS FLOW	= 3.3
DENSITY LB/FT3 62.53	35 62.108	INLET NOZZLE	= 43.2
NOZZ RHO*VSQ LB/FT-S2	33 33	WINDOW END ZONE CROSS FLOW INLET NOZZLE OUTLET NOZZLE	= 41.0
BUND RHO*VSQ LB/FT-S2 2	22 23		
TUBE NOZZLE DATA	IN OUT	WEIGHT PER SHELL, LB	
VELOCITY FT/S 1.1	18 1.17	DRY =	150.
DENSITY LB/FT3 61.29	91 61.999	DRY = WET =	165.
PRESS. DROP % 8.			

## *** SPECIAL MESSAGES AND WARNINGS ***

WARNING--TUBESIDE FLUID HAS PASSED THROUGH TRANSITION ZONE. CONSIDER RERUNNING WITH ITEM 132 IN EFFECT.

HEAT TRANSFER COEFF. AT RE = 2000 IS 224.02 BTU/HR-FT2-F

HEAT TRANSFER COEFF. AT RE = 10000 IS 1257.56 BTU/HR-FT2-F

SIZE 4- 18 TYPE BEM, MULTI-PASS FLOW, SEGMENTAL BAFFLES, RATING

		HOT TUBE	E SIDE	COLD SHEL	L SIDE
		Tube		Shell	
		SENSIBI	LE LIQ	SENSIBL	E LIQ
TOTAL FLOW RATE	KLB/HR	. 9	900	. 2	0.0
		IN	OUT	IN	OUT
TEMPERATURE	DEGF	140.0	121.3*	40.0	123.8*

DENSITY VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS	LB/FT3 CP BTU/LB-F BTU/HR-FT-F	.4726 .9973 .3723	61.5886 .5589 .9976 .3683	1.4791 1.0058 .3466	.5462 .9975 .3689
TEMP, AVG & SKIN VISCOSITY, AVG & S PRESSURE, IN & DES	KIN CP	130.7 .5129	114.4 .5976	81.9 .8466	113.4 .6033
PRESSURE DROP, TOT VELOCITY, CALC & M.					10.00
FOULING RESISTANCE FILM COEFFICIENT		2-F 31	5.11	13	
TOTAL HEAT DUTY RE EFF TEMP DIF, DEGF OVERALL COEFF REQU CLEAN & FOULED COE	QUIRED MEGBTU/F (LMTD= 40.4,F IRED BTU/HR-F	HR F= .77,BYP <i>F</i> FT2-F	ASS= .85,BA	AFF=1.00)	88.44
SHELLS IN SERIES PASSES, SHELL SHELL DIAMETER IN.	1 TUBE 4	EFFECTIVE	AREA	FT2/SHELL	7.1
BAFFLE TYPE SPACING, CENTRAL SPACING, INLET SPACING, OUTLET BAFFLE THICKNESS PAIRS OF SEALING D	IN. 4.309 IN. 4.309 IN. 4.309 IN125	BAFFLE CU CUT DISTA IMPINGEME	T, PCT SHE NCE FROM C	HELL PASS ELL I.D. CENTER, IN. INCLUDED EA, %	30.00 .764 NO
TUBE TYPE NO. OF TUBES/SHELL TUBE LGTH, OVERALL TUBE LGTH, EFF TUBE LAYOUT PITCH RATIO SHL NOZZ ID, IN&OU	76 FT 1.500 FT 1.436 DEG 60 1.250	EST MAX TO TUBE PITCO TUBE OUTS TUBE INSI	CUBE COUNT CH CIDE DIAM CDE DIAM CACE RATIO,	IN. IN. IN. OUT/IN	36 .3125 .250 .214 1.184
* CALCULATED ITE	rsity ChE433 he		ger experin	nent	E0002 P131 9/23/ 3 CASE 65
S U P P L E	M E N T A	R Y F	R E S U	L T S	011011 00
HT PARAMETERS WALL CORRECTION PRANDTL NUMBER RYNLD NO, AVG RYNLD NO, IN BUN RYNLD NO,OUT BUN FOULNG LAYER IN.	1.049 .975 5.7 3.3 88. 2765. 50. 3001. 136. 2537.	NOMINAI NOMINAI CROSSFI WINDOW	VEL, WINDO	DW FT/S DW FT/S BTU/HR-FT2- BTU/HR-FT2-	.05 -F 137.3 -F 135.4

	HEAT TRANSFER X-FLOW	00 22
TURNUT PROTOTINGS OF TOTAL		
THERMAL RESISTANCE, % OF TOTAL		
SHELL TUBE FOULING METAL		
64.58 33.43 1.93 .06		
PCT OVER DESIGN .60 TOT FOUL RESIST .000217	BAFFLE TO SHELL LEAKAGE E	= 17.61
TOT FOUL RESIST .000217	TUBE PASSLANE BYPASS F :	= .00
DIFF RESIST .000068		
	SHELLSIDE HEAT TRANSFER FA	CTORS
DIAMETRAL CLEARANCES BUNDLE TO SHELL IN5000	TOTAL = (BETA) (GAMMA) (FIN)	= .598
BUNDLE TO SHELL IN5000	BETA (BAFF CUT FACTOR)	= .920
TUBE TO BAFFLE HOLE IN0284	GAMMA (TUBE ROW ENTRY EFCT)	= .650
BAFFLE TO SHELL IN1000		
SHELL NOZZLE DATA IN OUT	SHELL PRESSURE DROP, % OF	TOTAL
SHELL NOZZLE DATA IN OUT HT UNDR NOZ IN25	SHELL PRESSURE DROP, % OF '	TOTAL = 9.6
SHELL NOZZLE DATA IN OUT HT UNDR NOZ IN25 HT OPP NOZ IN25	SHELL PRESSURE DROP, % OF WINDOW END ZONE	TOTAL = 9.6 = 7.2
SHELL NOZZLE DATA IN OUT HT UNDR NOZ IN25 HT OPP NOZ IN25 VELOCITY FT/S .16 .17	SHELL PRESSURE DROP, % OF WINDOW END ZONE CROSS FLOW	TOTAL = 9.6 = 7.2 = 5.6
SHELL NOZZLE DATA IN OUT HT UNDR NOZ IN25 HT OPP NOZ IN25 VELOCITY FT/S .16 .17 DENSITY LB/FT3 62 535 61 551	SHELL PRESSURE DROP, % OF WINDOW END ZONE CROSS FLOW INLET NOZZLE	TOTAL = 9.6 = 7.2 = 5.6 = 41.3
HT UNDR NOZ IN25 HT OPP NOZ IN25 VELOCITY FT/S .16 .17 DENSITY LB/FT3 62.535 61.551	WINDOW END ZONE CROSS FLOW INLET NOZZLE	= 9.6 = 7.2 = 5.6 = 41.3
HT UNDR NOZ IN25 HT OPP NOZ IN25 VELOCITY FT/S .16 .17 DENSITY LB/FT3 62.535 61.551 NOZZ RHO*VSQ LB/FT-S2 1 1	WINDOW END ZONE CROSS FLOW INLET NOZZLE	9.6 7.2 = 5.6 = 41.3
HT UNDR NOZ IN25 HT OPP NOZ IN25 VELOCITY FT/S .16 .17 DENSITY LB/FT3 62.535 61.551	WINDOW END ZONE CROSS FLOW INLET NOZZLE	= 9.6 = 7.2 = 5.6 = 41.3
HT UNDR NOZ IN25 HT OPP NOZ IN25 VELOCITY FT/S .16 .17 DENSITY LB/FT3 62.535 61.551 NOZZ RHO*VSQ LB/FT-S2 1 1 BUND RHO*VSQ LB/FT-S2 1 1	WINDOW END ZONE CROSS FLOW INLET NOZZLE OUTLET NOZZLE	9.6 7.2 5.6 41.3 36.2
HT UNDR NOZ IN25 HT OPP NOZ IN25 VELOCITY FT/S .16 .17 DENSITY LB/FT3 62.535 61.551 NOZZ RHO*VSQ LB/FT-S2 1 1 BUND RHO*VSQ LB/FT-S2 1 1 TUBE NOZZLE DATA IN OUT	WINDOW END ZONE CROSS FLOW INLET NOZZLE OUTLET NOZZLE WEIGHT PER SHELL, LB	= 9.6 = 7.2 = 5.6 = 41.3 = 36.2
HT UNDR NOZ IN25 HT OPP NOZ IN25 VELOCITY FT/S .16 .17 DENSITY LB/FT3 62.535 61.551 NOZZ RHO*VSQ LB/FT-S2 1 1 BUND RHO*VSQ LB/FT-S2 1 1 TUBE NOZZLE DATA IN OUT VELOCITY FT/S 1.33 1.32	WINDOW END ZONE CROSS FLOW INLET NOZZLE OUTLET NOZZLE  WEIGHT PER SHELL, LB DRY =	= 9.6 = 7.2 = 5.6 = 41.3 = 36.2
HT UNDR NOZ IN25 HT OPP NOZ IN25 VELOCITY FT/S .16 .17 DENSITY LB/FT3 62.535 61.551 NOZZ RHO*VSQ LB/FT-S2 1 1 BUND RHO*VSQ LB/FT-S2 1 1 TUBE NOZZLE DATA IN OUT	WINDOW END ZONE CROSS FLOW INLET NOZZLE OUTLET NOZZLE  WEIGHT PER SHELL, LB DRY = WET =	= 9.6 = 7.2 = 5.6 = 41.3 = 36.2

## *** SPECIAL MESSAGES AND WARNINGS ***

WARNING--TUBESIDE FLUID HAS PASSED THROUGH TRANSITION ZONE. CONSIDER RERUNNING WITH ITEM 132 IN EFFECT.

HEAT TRANSFER COEFF. AT RE = 2000 IS 218.29 BTU/HR-FT2-F HEAT TRANSFER COEFF. AT RE = 10000 IS 1230.71 BTU/HR-FT2-F

SIZE 4- 18 TYPE BEM, MULTI-PASS FLOW, SEGMENTAL BAFFLES, RATING

	•	•		•	
		HOT TOH	JBE SIDE	COLD SE	HELL SIDE
		Tube		Shell	L
		SENS	IBLE LIQ	SENS	BLE LIQ
TOTAL FLOW RATE	KLB/HR		.900		.300
		IN	OUT	IN	OUT
TEMPERATURE	DEGF	140.0	114.6*	40.0	116.0*
DENSITY	LB/FT3	61.2913	61.6884	62.5352	61.6683
VISCOSITY	CP	.4726	.5962	1.4791	.5883
SPECIFIC HEAT	BTU/LB-F	.9973	.9978	1.0058	.9978
THERMAL COND.	BTU/HR-FT-F	.3723	.3668	.3466	.3671
MOLAR MASS	LB/LBMOL		18.02		18.02
TEMP, AVG & SKIN	DEGF	127.3	108.5	78.0	107.4
VISCOSITY, AVG & S	KIN CP	.5288	.6336	.8868	.6407
PRESSURE, IN & DES	IGN PSIA	50.00	165.00	50.00	165.00

PRESSURE DROP, TOT & ALLOWED PSI VELOCITY, CALC & MAX ALLOWED FT/S		
FOULING RESISTANCE HR-FT2-F/BT FILM COEFFICIENT BTU/HR-FT2-	-F 306.65	.00010 164.07
TOTAL HEAT DUTY REQUIRED MEGBTU/HE EFF TEMP DIF, DEGF (LMTD= 44.6,F= OVERALL COEFF REQUIRED BTU/HR-FT CLEAN & FOULED COEFF BTU/HR-FT	R = .79,BYPASS= .91,BAFF=1.00 F2-F	.022807 32.2 99.13 98.90
SHELLS IN SERIES 1 PARALLEL 1 PASSES, SHELL 1 TUBE 4 SHELL DIAMETER IN. 3.820	EFFECTIVE AREA FT2/SH	IELL 7.1
	CROSS PASSES PER SHELL PAS BAFFLE CUT, PCT SHELL I.D. CUT DISTANCE FROM CENTER,	30.00 IN764
PAIRS OF SEALING DEVICES 1	TUBESHEET BLANK AREA, %	
TUBE LAYOUT DEG 60 PITCH RATIO 1.250	TUBE OUTSIDE DIAM IN.	36 .3125 .250 .214 1.184
* CALCULATED ITEMHEAT BALANCE  UNAshington University ChE433 head  Young model F302DY4P  S U P P L E M E N T A H	at exchanger experiment	9/23/ 3 CASE 66
WALL CORRECTION 1.047 .970 PRANDTL NUMBER 6.0 3.5 RYNLD NO, AVG 127. 2682. RYNLD NO, IN BUN 76. 3001. RYNLD NO, OUT BUN 192. 2379. FOULNG LAYER IN0014 .0014	NOMINAL VEL, WINDOW FT/S CROSSFLOW COEF BTU/HR- WINDOW COEF BTU/HR-	.08 -FT2-F 164.8 -FT2-F 165.6
THERMAL RESISTANCE, % OF TOTAL SHELL TUBE FOULING METAL 59.60 38.18 2.14 .07 PCT OVER DESIGN24 TOT FOUL RESIST .000217 DIFF RESIST000024	TUBE TO BAFFLE LEAKAGE MAIN CROSSFLOW BUNDLE TO SHELL BYPASS BAFFLE TO SHELL LEAKAGE TUBE PASSLANE BYPASS	A = 2.75 B = 69.41 C = 11.42 E = 16.42 F = .00
DIAMETRAL CLEARANCES	SHELLSIDE HEAT TRANSFE TOTAL = (BETA) (GAMMA) (FIN	

BUNDLE TO SHELL	IN.	.5000	BETA (BAFF CUT FACTOR)	= .920
TUBE TO BAFFLE HOLE	IN.	.0284	GAMMA (TUBE ROW ENTRY EFCT)	= .656
BAFFLE TO SHELL	IN.	.1000	END (HT LOSS IN END ZONE)	= .994
SHELL NOZZLE DATA	IN	OUT	SHELL PRESSURE DROP, % OF	TOTAL
HT UNDR NOZ IN.	.25		WINDOW	= 9.2
HT OPP NOZ IN.	.25		END ZONE	= 5.6
			CROSS FLOW	
DENSITY LB/FT3	62.535	61.668	INLET NOZZLE	= 42.5
NOZZ RHO*VSQ LB/FT-S	2 3	3	OUTLET NOZZLE	= 38.1
BUND RHO*VSQ LB/FT-S	2 2	2		
			WEIGHT PER SHELL, LB	
VELOCITY FT/S	1.33	1.32		±00.
DENSITY LB/FT3	61.291	61.688	WET =	165.
PRESS. DROP %	8.9	5.6		

### *** SPECIAL MESSAGES AND WARNINGS ***

WARNING--TUBESIDE FLUID HAS PASSED THROUGH TRANSITION ZONE. CONSIDER RERUNNING WITH ITEM 132 IN EFFECT.

SIZE 4- 18 TYPE BEM, MULTI-PASS FLOW, SEGMENTAL BAFFLES, RATING

HEAT TRANSFER COEFF. AT RE = 2000 IS 219.72 BTU/HR-FT2-F HEAT TRANSFER COEFF. AT RE = 10000 IS 1239.34 BTU/HR-FT2-F

University ChE433 heat exchanger experiment E0002 P134 Young model F302DY4P 9/23/3 CASE 67

0100 1 10 1110 00.	,	J., J_J.		,	
		HOT T	UBE SIDE	COLD SH	ELL SIDE
		Tube		Shell	-
		SENS	IBLE LIQ	SENSI	BLE LIQ
TOTAL FLOW RATE	KLB/HR		.900		.400
		IN	OUT	IN	OUT
TEMPERATURE	DEGF	140.0	109.3*	40.0	108.8*
DENSITY	LB/FT3	51.2913	61.7637	62.5352	61.7719
VISCOSITY	CP	.4726	.6282	1.4791	.6319
SPECIFIC HEAT	BTU/LB-F	.9973	.9981	1.0058	.9981
THERMAL COND.	BTU/HR-FT-F	.3723	.3655	.3466	.3654
MOLAR MASS	LB/LBMOL		18.02		18.02
TEMP, AVG & SKIN	DEGF	124.7	103.3	74.4	102.1
VISCOSITY, AVG & S	KIN CP	.5417	.6681	.9265	.6766
PRESSURE, IN & DES	IGN PSIA	50.00	165.00	50.00	165.00
PRESSURE DROP, TOT	& ALLOWED PSI	.15	10.00	.00	10.00
VELOCITY, CALC & M	AX ALLOWED FT/S	.88	10.00	.06	10.00
FOULING RESISTANCE	HR-FT2-F/BTU	J .	00010	.0	00010

TOTAL HEAT DUTY REQUIRED MEGBTU/HR .027527 EFF TEMP DIF, DEGF (LMTD= 47.8,F= .81,BYPASS= .92,BAFF=1.00) 35.8

192.90

FILM COEFFICIENT BTU/HR-FT2-F 300.04

		che433b(40).OUT
OVERALL COEFF REQUIRED	BTU/HR-F7	T2-F 107.48
CLEAN & FOULED COEFF	BTU/HR-FT	Γ2-F 110.08 107.58
	·	
SHELLS IN SERIES 1 PARAI	· T 🗗 1	TOTAL EFF AREA FT2 7.1
PASSES, SHELL 1 TUBE		
SHELL DIAMETER IN.	3.820	TEMA SHELL TYPE E ; REAR HEAD FXTS
BAFFLE TYPE HORZ SI	EGMENTL	CROSS PASSES PER SHELL PASS 4
SPACING, CENTRAL IN.	4.309	BAFFLE CUT, PCT SHELL I.D. 30.00
SPACING, INLET IN.		CUT DISTANCE FROM CENTER, IN764
SPACING, OUTLET IN.		, , , , , , , , , , , , , , , , , , , ,
BAFFLE THICKNESS IN.		IMPINGEMENT BAFFLE INCLUDED NO
PAIRS OF SEALING DEVICES	Τ	TUBESHEET BLANK AREA, % .0
	PLAIN	MATERIAL ELECTROLYTIC COPPER
NO. OF TUBES/SHELL	76	EST MAX TUBE COUNT 36
TUBE LGTH, OVERALL FT	1.500	TUBE PITCH IN3125
TUBE LGTH, EFF FT		TUBE OUTSIDE DIAM IN250
TUBE LAYOUT DEG		TUBE INSIDE DIAM IN214
PITCH RATIO		TUBE SURFACE RATIO, OUT/IN 1.184
SHL NOZZ ID, IN&OUT 1.0	1.0	TUBE NOZZ ID, IN&OUT IN8 .8
* CALCULATED ITEMHEAT	r BALANCE	CODE = 8
□□Washington University (	ChE433 hea	at exchanger experiment E0002 P135
Young model F302DY4P		9/23/ 3
		CASE 67
SUPPLEME	I T A I	R Y R E S U L T S
HT PARAMETERS SHELL	TUBE	SHELLSIDE PERFORMANCE
HT PARAMETERS SHELL WALL CORRECTION 1.045	TUBE	SHELLSIDE PERFORMANCE NOMINAL VEL, X-FLOW FT/S .05
HT PARAMETERS SHELL WALL CORRECTION 1.045 PRANDTL NUMBER 6.3	TUBE .966 3.5	SHELLSIDE PERFORMANCE NOMINAL VEL,X-FLOW FT/S .05 NOMINAL VEL,WINDOW FT/S .10
HT PARAMETERS SHELL WALL CORRECTION 1.045	TUBE .966 3.5	SHELLSIDE PERFORMANCE NOMINAL VEL,X-FLOW FT/S .05 NOMINAL VEL,WINDOW FT/S .10
HT PARAMETERS SHELL WALL CORRECTION 1.045 PRANDTL NUMBER 6.3	TUBE .966 3.5 2618.	SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S .05  NOMINAL VEL, WINDOW FT/S .10  CROSSFLOW COEF BTU/HR-FT2-F 193.7
HT PARAMETERS SHELL WALL CORRECTION 1.045 PRANDTL NUMBER 6.3 RYNLD NO, AVG 163. RYNLD NO, IN BUN 102.	TUBE .966 3.5 2618. 3001.	SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S .05  NOMINAL VEL, WINDOW FT/S .10  CROSSFLOW COEF BTU/HR-FT2-F 193.7  WINDOW COEF BTU/HR-FT2-F 194.8
HT PARAMETERS SHELL WALL CORRECTION 1.045 PRANDTL NUMBER 6.3 RYNLD NO, AVG 163. RYNLD NO, IN BUN 102. RYNLD NO,OUT BUN 238.	TUBE .966 3.5 2618. 3001. 2258.	SHELLSIDE PERFORMANCE  NOMINAL VEL,X-FLOW FT/S .05  NOMINAL VEL,WINDOW FT/S .10  CROSSFLOW COEF BTU/HR-FT2-F 193.7  WINDOW COEF BTU/HR-FT2-F 194.8
HT PARAMETERS SHELL WALL CORRECTION 1.045 PRANDTL NUMBER 6.3 RYNLD NO, AVG 163. RYNLD NO, IN BUN 102. RYNLD NO,OUT BUN 238.	TUBE .966 3.5 2618. 3001. 2258.	SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S .05  NOMINAL VEL, WINDOW FT/S .10  CROSSFLOW COEF BTU/HR-FT2-F 193.7  WINDOW COEF BTU/HR-FT2-F 194.8  SHELLSIDE FLOW, % OF TOTAL
HT PARAMETERS SHELL WALL CORRECTION 1.045 PRANDTL NUMBER 6.3 RYNLD NO, AVG 163. RYNLD NO, IN BUN 102. RYNLD NO,OUT BUN 238. FOULNG LAYER IN0014	TUBE .966 3.5 2618. 3001. 2258. .0014	SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S .05  NOMINAL VEL, WINDOW FT/S .10  CROSSFLOW COEF BTU/HR-FT2-F 193.7  WINDOW COEF BTU/HR-FT2-F 194.8  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.49
HT PARAMETERS SHELL WALL CORRECTION 1.045 PRANDTL NUMBER 6.3 RYNLD NO, AVG 163. RYNLD NO, IN BUN 102. RYNLD NO,OUT BUN 238. FOULNG LAYER IN0014 THERMAL RESISTANCE, % OF	TUBE .966 3.5 2618. 3001. 2258. .0014	SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S .05  NOMINAL VEL, WINDOW FT/S .10  CROSSFLOW COEF BTU/HR-FT2-F 193.7  WINDOW COEF BTU/HR-FT2-F 194.8  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.49  TUBE TO BAFFLE LEAKAGE A = 2.99
HT PARAMETERS SHELL WALL CORRECTION 1.045 PRANDTL NUMBER 6.3 RYNLD NO, AVG 163. RYNLD NO, IN BUN 102. RYNLD NO,OUT BUN 238. FOULNG LAYER IN0014 THERMAL RESISTANCE, % OF SHELL TUBE FOULING N	TUBE .966 3.5 2618. 3001. 2258. .0014 TOTAL	SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S .05  NOMINAL VEL, WINDOW FT/S .10  CROSSFLOW COEF BTU/HR-FT2-F 193.7  WINDOW COEF BTU/HR-FT2-F 194.8  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.49  TUBE TO BAFFLE LEAKAGE A = 2.99  MAIN CROSSFLOW B = 68.38
HT PARAMETERS SHELL WALL CORRECTION 1.045 PRANDTL NUMBER 6.3 RYNLD NO, AVG 163. RYNLD NO, IN BUN 102. RYNLD NO,OUT BUN 238. FOULNG LAYER IN0014 THERMAL RESISTANCE, % OF SHELL TUBE FOULING N 55.14 42.45 2.33	TUBE .966 3.5 2618. 3001. 2258. .0014 TOTAL METAL .08	SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S .05  NOMINAL VEL, WINDOW FT/S .10  CROSSFLOW COEF BTU/HR-FT2-F 193.7  WINDOW COEF BTU/HR-FT2-F 194.8  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.49  TUBE TO BAFFLE LEAKAGE A = 2.99  MAIN CROSSFLOW B = 68.38  BUNDLE TO SHELL BYPASS C = 12.51
HT PARAMETERS SHELL WALL CORRECTION 1.045 PRANDTL NUMBER 6.3 RYNLD NO, AVG 163. RYNLD NO, IN BUN 102. RYNLD NO,OUT BUN 238. FOULNG LAYER IN0014 THERMAL RESISTANCE, % OF SHELL TUBE FOULING N 55.14 42.45 2.33	TUBE .966 3.5 2618. 3001. 2258. .0014 TOTAL METAL .08	SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S .05  NOMINAL VEL, WINDOW FT/S .10  CROSSFLOW COEF BTU/HR-FT2-F 193.7  WINDOW COEF BTU/HR-FT2-F 194.8  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.49  TUBE TO BAFFLE LEAKAGE A = 2.99  MAIN CROSSFLOW B = 68.38  BUNDLE TO SHELL BYPASS C = 12.51
HT PARAMETERS SHELL WALL CORRECTION 1.045 PRANDTL NUMBER 6.3 RYNLD NO, AVG 163. RYNLD NO, IN BUN 102. RYNLD NO,OUT BUN 238. FOULNG LAYER IN0014 THERMAL RESISTANCE, % OF SHELL TUBE FOULING N 55.14 42.45 2.33	TUBE .966 3.5 2618. 3001. 2258. .0014 TOTAL METAL .08	SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S .05  NOMINAL VEL, WINDOW FT/S .10  CROSSFLOW COEF BTU/HR-FT2-F 193.7  WINDOW COEF BTU/HR-FT2-F 194.8  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.49  TUBE TO BAFFLE LEAKAGE A = 2.99  MAIN CROSSFLOW B = 68.38  BUNDLE TO SHELL BYPASS C = 12.51
HT PARAMETERS SHELL WALL CORRECTION 1.045 PRANDTL NUMBER 6.3 RYNLD NO, AVG 163. RYNLD NO, IN BUN 102. RYNLD NO,OUT BUN 238. FOULNG LAYER IN0014  THERMAL RESISTANCE, % OF SHELL TUBE FOULING No. 100. 55.14 42.45 2.33 PCT OVER DESIGN TOT FOUL RESIST	TUBE .966 3.5 2618. 3001. 2258. .0014 TOTAL METAL .08 .09	SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S .05  NOMINAL VEL, WINDOW FT/S .10  CROSSFLOW COEF BTU/HR-FT2-F 193.7  WINDOW COEF BTU/HR-FT2-F 194.8  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.49  TUBE TO BAFFLE LEAKAGE A = 2.99  MAIN CROSSFLOW B = 68.38  BUNDLE TO SHELL BYPASS C = 12.51  BAFFLE TO SHELL LEAKAGE E = 16.12  TUBE PASSLANE BYPASS F = .00
HT PARAMETERS SHELL WALL CORRECTION 1.045 PRANDTL NUMBER 6.3 RYNLD NO, AVG 163. RYNLD NO, IN BUN 102. RYNLD NO,OUT BUN 238. FOULNG LAYER IN0014  THERMAL RESISTANCE, % OF SHELL TUBE FOULING N 55.14 42.45 2.33 PCT OVER DESIGN TOT FOUL RESIST DIFF RESIST	TUBE .966 3.5 2618. 3001. 22580014  TOTAL 4ETAL .08 .09 .000217 .000009	SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S .05  NOMINAL VEL, WINDOW FT/S .10  CROSSFLOW COEF BTU/HR-FT2-F 193.7  WINDOW COEF BTU/HR-FT2-F 194.8  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.49  TUBE TO BAFFLE LEAKAGE A = 2.99  MAIN CROSSFLOW B = 68.38  BUNDLE TO SHELL BYPASS C = 12.51  BAFFLE TO SHELL LEAKAGE E = 16.12  TUBE PASSLANE BYPASS F = .00
HT PARAMETERS SHELL WALL CORRECTION 1.045 PRANDTL NUMBER 6.3 RYNLD NO, AVG 163. RYNLD NO, IN BUN 102. RYNLD NO,OUT BUN 238. FOULNG LAYER IN0014  THERMAL RESISTANCE, % OF SHELL TUBE FOULING N 55.14 42.45 2.33 PCT OVER DESIGN TOT FOUL RESIST DIFF RESIST	TUBE .966 3.5 2618. 3001. 22580014  TOTAL 4ETAL .08 .09 .000217 .000009	SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S .05  NOMINAL VEL, WINDOW FT/S .10  CROSSFLOW COEF BTU/HR-FT2-F 193.7  WINDOW COEF BTU/HR-FT2-F 194.8  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.49  TUBE TO BAFFLE LEAKAGE A = 2.99  MAIN CROSSFLOW B = 68.38  BUNDLE TO SHELL BYPASS C = 12.51  BAFFLE TO SHELL LEAKAGE E = 16.12  TUBE PASSLANE BYPASS F = .00
HT PARAMETERS SHELL WALL CORRECTION 1.045 PRANDTL NUMBER 6.3 RYNLD NO, AVG 163. RYNLD NO, IN BUN 102. RYNLD NO,OUT BUN 238. FOULNG LAYER IN0014  THERMAL RESISTANCE, % OF SHELL TUBE FOULING N 55.14 42.45 2.33 PCT OVER DESIGN TOT FOUL RESIST DIFF RESIST	TUBE .966 3.5 2618. 3001. 22580014  TOTAL 4ETAL .08 .09 .000217 .000009	SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S .05  NOMINAL VEL, WINDOW FT/S .10  CROSSFLOW COEF BTU/HR-FT2-F 193.7  WINDOW COEF BTU/HR-FT2-F 194.8  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.49  TUBE TO BAFFLE LEAKAGE A = 2.99  MAIN CROSSFLOW B = 68.38  BUNDLE TO SHELL BYPASS C = 12.51  BAFFLE TO SHELL LEAKAGE E = 16.12  TUBE PASSLANE BYPASS F = .00
HT PARAMETERS SHELL WALL CORRECTION 1.045 PRANDTL NUMBER 6.3 RYNLD NO, AVG 163. RYNLD NO, IN BUN 102. RYNLD NO,OUT BUN 238. FOULNG LAYER IN0014  THERMAL RESISTANCE, % OF SHELL TUBE FOULING N 55.14 42.45 2.33 PCT OVER DESIGN TOT FOUL RESIST DIFF RESIST  DIAMETRAL CLEARANCES BUNDLE TO SHELL IN.	TUBE .966 3.5 2618. 3001. 2258. .0014 TOTAL METAL .08 .09 .000217 .000009	SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S .05  NOMINAL VEL, WINDOW FT/S .10  CROSSFLOW COEF BTU/HR-FT2-F 193.7  WINDOW COEF BTU/HR-FT2-F 194.8  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.49  TUBE TO BAFFLE LEAKAGE A = 2.99  MAIN CROSSFLOW B = 68.38  BUNDLE TO SHELL BYPASS C = 12.51  BAFFLE TO SHELL LEAKAGE E = 16.12  TUBE PASSLANE BYPASS F = .00  SHELLSIDE HEAT TRANSFER FACTORS  TOTAL = (BETA) (GAMMA) (FIN) = .622  BETA (BAFF CUT FACTOR) = .920
HT PARAMETERS SHELL WALL CORRECTION 1.045 PRANDTL NUMBER 6.3 RYNLD NO, AVG 163. RYNLD NO, IN BUN 102. RYNLD NO,OUT BUN 238. FOULNG LAYER IN0014  THERMAL RESISTANCE, % OF SHELL TUBE FOULING N 55.14 42.45 2.33 PCT OVER DESIGN TOT FOUL RESIST DIFF RESIST  DIAMETRAL CLEARANCES BUNDLE TO SHELL IN. TUBE TO BAFFLE HOLE IN.	TUBE .966 3.5 2618. 3001. 2258. .0014 TOTAL METAL .08 .09 .000217 .000009	SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S .05  NOMINAL VEL, WINDOW FT/S .10  CROSSFLOW COEF BTU/HR-FT2-F 193.7  WINDOW COEF BTU/HR-FT2-F 194.8  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.49  TUBE TO BAFFLE LEAKAGE A = 2.99  MAIN CROSSFLOW B = 68.38  BUNDLE TO SHELL BYPASS C = 12.51  BAFFLE TO SHELL LEAKAGE E = 16.12  TUBE PASSLANE BYPASS F = .00  SHELLSIDE HEAT TRANSFER FACTORS  TOTAL = (BETA) (GAMMA) (FIN) = .622  BETA (BAFF CUT FACTOR) = .920  GAMMA (TUBE ROW ENTRY EFCT) = .676
HT PARAMETERS SHELL WALL CORRECTION 1.045 PRANDTL NUMBER 6.3 RYNLD NO, AVG 163. RYNLD NO, IN BUN 102. RYNLD NO,OUT BUN 238. FOULNG LAYER IN0014  THERMAL RESISTANCE, % OF SHELL TUBE FOULING N 55.14 42.45 2.33 PCT OVER DESIGN TOT FOUL RESIST DIFF RESIST  DIAMETRAL CLEARANCES BUNDLE TO SHELL IN. TUBE TO BAFFLE HOLE IN.	TUBE .966 3.5 2618. 3001. 2258. .0014 TOTAL METAL .08 .09 .000217 .000009	SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S .05  NOMINAL VEL, WINDOW FT/S .10  CROSSFLOW COEF BTU/HR-FT2-F 193.7  WINDOW COEF BTU/HR-FT2-F 194.8  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.49  TUBE TO BAFFLE LEAKAGE A = 2.99  MAIN CROSSFLOW B = 68.38  BUNDLE TO SHELL BYPASS C = 12.51  BAFFLE TO SHELL LEAKAGE E = 16.12  TUBE PASSLANE BYPASS F = .00  SHELLSIDE HEAT TRANSFER FACTORS  TOTAL = (BETA) (GAMMA) (FIN) = .622  BETA (BAFF CUT FACTOR) = .920
HT PARAMETERS SHELL WALL CORRECTION 1.045 PRANDTL NUMBER 6.3 RYNLD NO, AVG 163. RYNLD NO, IN BUN 102. RYNLD NO,OUT BUN 238. FOULNG LAYER IN0014  THERMAL RESISTANCE, % OF SHELL TUBE FOULING NOT SHELL TUBE FOULING NOT SHELL TUBE STOLEMENT TO THE SHELL TUBE SHELL TUBE TO SHELL TO SHE SHELL TO SHE	TUBE .966 3.5 2618. 3001. 22580014  TOTAL 4ETAL .08 .09 .000217 .000009  .5000 .0284 .1000	SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S .05  NOMINAL VEL, WINDOW FT/S .10  CROSSFLOW COEF BTU/HR-FT2-F 193.7  WINDOW COEF BTU/HR-FT2-F 194.8  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.49  TUBE TO BAFFLE LEAKAGE A = 2.99  MAIN CROSSFLOW B = 68.38  BUNDLE TO SHELL BYPASS C = 12.51  BAFFLE TO SHELL LEAKAGE E = 16.12  TUBE PASSLANE BYPASS F = .00  SHELLSIDE HEAT TRANSFER FACTORS  TOTAL = (BETA) (GAMMA) (FIN) = .622  BETA (BAFF CUT FACTOR) = .920  GAMMA (TUBE ROW ENTRY EFCT) = .676  END (HT LOSS IN END ZONE) = .994
HT PARAMETERS SHELL WALL CORRECTION 1.045 PRANDTL NUMBER 6.3 RYNLD NO, AVG 163. RYNLD NO, IN BUN 102. RYNLD NO,OUT BUN 238. FOULNG LAYER IN0014  THERMAL RESISTANCE, % OF SHELL TUBE FOULING NOT SHELL TUBE FOULING NOT STATE TO SHELL TO SHELL IN.  DIAMETRAL CLEARANCES BUNDLE TO SHELL IN. BAFFLE TO SHELL IN.	TUBE .966 3.5 2618. 3001. 22580014  TOTAL 4ETAL .08 .09 .000217 .000009  .5000 .0284 .1000	SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S .05  NOMINAL VEL, WINDOW FT/S .10  CROSSFLOW COEF BTU/HR-FT2-F 193.7  WINDOW COEF BTU/HR-FT2-F 194.8  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.49  TUBE TO BAFFLE LEAKAGE A = 2.99  MAIN CROSSFLOW B = 68.38  BUNDLE TO SHELL BYPASS C = 12.51  BAFFLE TO SHELL LEAKAGE E = 16.12  TUBE PASSLANE BYPASS F = .00  SHELLSIDE HEAT TRANSFER FACTORS  TOTAL = (BETA) (GAMMA) (FIN) = .622  BETA (BAFF CUT FACTOR) = .920  GAMMA (TUBE ROW ENTRY EFCT) = .676  END (HT LOSS IN END ZONE) = .994
HT PARAMETERS SHELL WALL CORRECTION 1.045 PRANDTL NUMBER 6.3 RYNLD NO, AVG 163. RYNLD NO, IN BUN 102. RYNLD NO,OUT BUN 238. FOULNG LAYER IN0014  THERMAL RESISTANCE, % OF SHELL TUBE FOULING NOTE OF SHELL TUBE FOULING NOTE OF THE STANCE OF SHELL TUBE SHELL TUBE TO SHELL IN. TOT FOUL RESIST DIFF RESIST  DIAMETRAL CLEARANCES BUNDLE TO SHELL IN. TUBE TO BAFFLE HOLE IN. BAFFLE TO SHELL IN. SHELL NOZZLE DATA HT UNDR NOZ IN22	TUBE .966 3.5 2618. 3001. 2258. .0014 TOTAL METAL .08 .09 .000217 .000009	SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S .05  NOMINAL VEL, WINDOW FT/S .10  CROSSFLOW COEF BTU/HR-FT2-F 193.7  WINDOW COEF BTU/HR-FT2-F 194.8  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.49  TUBE TO BAFFLE LEAKAGE A = 2.99  MAIN CROSSFLOW B = 68.38  BUNDLE TO SHELL BYPASS C = 12.51  BAFFLE TO SHELL LEAKAGE E = 16.12  TUBE PASSLANE BYPASS F = .00  SHELLSIDE HEAT TRANSFER FACTORS  TOTAL = (BETA) (GAMMA) (FIN) = .622  BETA (BAFF CUT FACTOR) = .920  GAMMA (TUBE ROW ENTRY EFCT) = .676  END (HT LOSS IN END ZONE) = .994  SHELL PRESSURE DROP, % OF TOTAL  WINDOW = 9.0
HT PARAMETERS SHELL WALL CORRECTION 1.045 PRANDTL NUMBER 6.3 RYNLD NO, AVG 163. RYNLD NO, IN BUN 102. RYNLD NO,OUT BUN 238. FOULNG LAYER IN0014  THERMAL RESISTANCE, % OF SHELL TUBE FOULING NOTE OF SHELL TUBE FOULING NOTE OF SHELL TOWN TOTE OF SHELL TOWN TOWN TOWN TOWN TOWN TOWN TOWN TOWN	TUBE .966 3.5 2618. 3001. 2258. .0014 TOTAL METAL .08 .09 .000217 .000009	SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S .05  NOMINAL VEL, WINDOW FT/S .10  CROSSFLOW COEF BTU/HR-FT2-F 193.7  WINDOW COEF BTU/HR-FT2-F 194.8  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.49  TUBE TO BAFFLE LEAKAGE A = 2.99  MAIN CROSSFLOW B = 68.38  BUNDLE TO SHELL BYPASS C = 12.51  BAFFLE TO SHELL LEAKAGE E = 16.12  TUBE PASSLANE BYPASS F = .00  SHELLSIDE HEAT TRANSFER FACTORS  TOTAL = (BETA) (GAMMA) (FIN) = .622  BETA (BAFF CUT FACTOR) = .920  GAMMA (TUBE ROW ENTRY EFCT) = .676  END (HT LOSS IN END ZONE) = .994  SHELL PRESSURE DROP, % OF TOTAL  WINDOW = 9.0  END ZONE = 5.0
HT PARAMETERS SHELL WALL CORRECTION 1.045 PRANDTL NUMBER 6.3 RYNLD NO, AVG 163. RYNLD NO, IN BUN 102. RYNLD NO,OUT BUN 238. FOULNG LAYER IN0014  THERMAL RESISTANCE, % OF SHELL TUBE FOULING NOTE OF SHELL TUBE FOULING NOTE OF THE STANCE OF SHELL TUBE SHELL TUBE TO SHELL IN. TOT FOUL RESIST DIFF RESIST  DIAMETRAL CLEARANCES BUNDLE TO SHELL IN. TUBE TO BAFFLE HOLE IN. BAFFLE TO SHELL IN. SHELL NOZZLE DATA HT UNDR NOZ IN22	TUBE .966 3.5 2618. 3001. 2258. .0014 TOTAL METAL .08 .09 .000217 .000009 .5000 .0284 .1000	SHELLSIDE PERFORMANCE  NOMINAL VEL, X-FLOW FT/S .05  NOMINAL VEL, WINDOW FT/S .10  CROSSFLOW COEF BTU/HR-FT2-F 193.7  WINDOW COEF BTU/HR-FT2-F 194.8  SHELLSIDE FLOW, % OF TOTAL  HEAT TRANSFER X-FLOW 81.49  TUBE TO BAFFLE LEAKAGE A = 2.99  MAIN CROSSFLOW B = 68.38  BUNDLE TO SHELL BYPASS C = 12.51  BAFFLE TO SHELL LEAKAGE E = 16.12  TUBE PASSLANE BYPASS F = .00  SHELLSIDE HEAT TRANSFER FACTORS  TOTAL = (BETA) (GAMMA) (FIN) = .622  BETA (BAFF CUT FACTOR) = .920  GAMMA (TUBE ROW ENTRY EFCT) = .676  END (HT LOSS IN END ZONE) = .994  SHELL PRESSURE DROP, % OF TOTAL  WINDOW = 9.0  END ZONE = 5.0  CROSS FLOW = 4.2

NOZZ RHO*VSQ LB/FT-S2 6 6 OUTLET NOZZLE = 39.0
BUND RHO*VSQ LB/FT-S2 4 4 TUBE NOZZLE DATA IN OUT WEIGHT PER SHELL, LB

VELOCITY FT/S 1.33 1.32 DRY = 150.

(1 001 61 764 WET = 165.

PRESS. DROP % 8.8 5.6

### *** SPECIAL MESSAGES AND WARNINGS ***

WARNING--TUBESIDE FLUID HAS PASSED THROUGH TRANSITION ZONE. CONSIDER RERUNNING WITH ITEM 132 IN EFFECT.

> HEAT TRANSFER COEFF. AT RE = 2000 IS 220.95 BTU/HR-FT2-F HEAT TRANSFER COEFF. AT RE = 10000 IS 1244.90 BTU/HR-FT2-F

□□Washington University ChE433 heat exchanger experiment E0002 P136 Young model F302DY4P 9/23/ 3 CASE 68

SIZE 4- 18 TYPE BEM MULTI-PASS FLOW SEGMENTAL BAFFLES BATTING

HOT TUBE SIDE COLD SHE	LL SIDE
Tube Shell	
SENSIBLE LIQ SENSIB	LE LIQ
TOTAL FLOW RATE KLB/HR SENSIBLE LIQ SENSIB  .900 .	
IN OUT IN	OUT
TEMPERATURE DEGF 140.0 105.0* 40.0	102.7*
DENSITY LB/FT3 61.2913 61.8235 62.5352	61.8553
VISCOSITY CP .4726 .6563 1.4791	
SPECIFIC HEAT BTU/LB-F .9973 .9983 1.0058	
THERMAL COND. BTU/HR-FT-F .3723 .3645 .3466	.3639
THERMAL COND. BTU/HR-FT-F .3723 .3645 .3466 MOLAR MASS LB/LBMOL 18.02	18.02
TEMP, AVG & SKIN DEGF 122.5 99.0 71.3	97.7
VISCOSITY, AVG & SKIN CP .5527 .6992 .9619	
PRESSURE, IN & DESIGN PSIA 50.00 165.00 50.00	165.00
·	
PRESSURE DROP, TOT & ALLOWED PSI .15 10.00 .01	10.00
	10.00
FOULING RESISTANCE HR-FT2-F/BTU .00010 .00	010
FILM COEFFICIENT BTU/HR-FT2-F 294.49 219	.59
TOTAL HEAT DUTY REQUIRED MEGBTU/HR	.031390
EFF TEMP DIF, DEGF (LMTD= 49.9,F= .83,BYPASS= .93,BAFF=1.00)	38.4
OVERALL COEFF REQUIRED BTU/HR-FT2-F	114.46
CLEAN & FOULED COEFF BTU/HR-FT2-F 117.26	114.32
SHELLS IN SERIES 1 PARALLEL 1 TOTAL EFF AREA FT2	7.1
PASSES, SHELL 1 TUBE 4 EFFECTIVE AREA FT2/SHELL	7.1
SHELL DIAMETER IN. 3.820 TEMA SHELL TYPE E ; REAR HEA	D FXTS
BAFFLE TYPE HORZ SEGMENTL CROSS PASSES PER SHELL PASS	4
SPACING, CENTRAL IN. 4.309 BAFFLE CUT, PCT SHELL I.D.	30.00

		ne433b(40).001	
SPACING, INLET IN. 4.	.309 C1	UT DISTANCE FROM CENTER, IN	N764
SPACING, OUTLET IN. 4.	. 309		***
BAFFLE THICKNESS IN			
PAIRS OF SEALING DEVICES	1 1	UBESHEET BLANK AREA, %	. 0
TUBE TYPE PI	LAIN M	ATERIAL ELECTROLY	TIC COPPER
TUBE TYPE PL NO. OF TUBES/SHELL	76 E		
TUBE LGTH, OVERALL FT 1.	.500 TI	ST MAX TUBE COUNT UBE PITCH IN.	.3125
TUBE LGTH, EFF FT 1.	436 TI		
TUBE LAYOUT DEG		UBE INSIDE DIAM IN.	.214
PITCH RATIO 1.			
SHL NOZZ ID, IN&OUT 1.0	1.0 T	UBE NOZZ ID, IN&OUT IN.	.8 .8
,		, , , , , , , , , , , , , , , , , , , ,	
* CALCULATED ITEMHEAT BA			
$\square\square$ Washington University ChE4	133 heat	exchanger experiment	E0002 P137
Young model F302DY4P			9/23/ 3
			CASE 68
S U P P L E M E N T	A R	Y RESULTS	
WE DIDINGED OUT !			
HT PARAMETERS SHELL	TUBE	SHELLSIDE PERFORMANCE	.07
WALL CORRECTION 1.044	.962	NOMINAL VEL, X-FLOW FT/S	.0/
PRANDIL NUMBER 6.6	3.6	NOMINAL VEL, WINDOW FT/S	.13
PRANDTL NUMBER 6.6 RYNLD NO, AVG 196. 2	2566.	CROSSFLOW COEF BTU/HR-F"	12-F 220.5
RINLD NO, IN BUN 12/. 3	5001.	WINDOW COEF BTU/HR-F	12-F 221.8
RYNLD NO, OUT BUN 280. 2	2161.	0,000	
FOULNG LAYER IN0014 .	.0014	SHELLSIDE FLOW, % OF TO:	l'AL
TUTDAN DEGLETATION OF THE		HEAT TRANSFER X-FLOW	81.58
THERMAL RESISTANCE, % OF TOT	'AL	TUBE TO BAFFLE LEAKAGE	
SHELL TUBE FOULING META	УГ	MAIN CROSSFLOW	B = 67.54
51.48 45.96 2.48 .0	10	BUNDLE TO SHELL BYPASS	C = 13.40
PCT OVER DESIGN TOT FOUL RESIST .00	12	BAFFLE TO SHELL LEAKAGE	E = 15.88
TOT FOUL RESIST .00	00217	TUBE PASSLANE BYPASS	F. = .00
DIFF RESIST00	0011		
		SHELLSIDE HEAT TRANSFER	
DIAMETRAL CLEARANCES BUNDLE TO SHELL IN.	E 0 0 0	TOTAL = (BETA) (GAMMA) (FIN) BETA (BAFF CUT FACTOR)	
TUBE TO BAFFLE HOLE IN.	.0284	GAMMA (TUBE ROW ENTRY EFC.	
BAFFLE TO SHELL IN.			
BAFFLE TO SHELL IN.	.1000	END (HI LOSS IN END ZONI	1)994
SHELL NOZZLE DATA IN	TUO	SHELL PRESSURE DROP. % (	OF TOTAL
HT UNDR NOZ IN25	001	WINDOW	= 8.8
HT OPP NOZ IN25		END ZONE	= 4.6
VELOCITY FT/S .41			= 3.9
DENSITY LB/FT3 62.535 6			= 43.0
NOZZ RHO*VSQ LB/FT-S2 10			= 39.6
BUND RHO*VSQ LB/FT-S2 7		COTEST NOBELS	33.0
	•		
TUBE NOZZLE DATA IN	OUT	WEIGHT PER SHELL, LB	
VELOCITY FT/S 1.33	1.32	DRY =	= 150.
DENSITY LB/FT3 61.291 6			= 165.
PRESS. DROP % 8.8			

# *** SPECIAL MESSAGES AND WARNINGS ***

WARNING--TUBESIDE FLUID HAS PASSED THROUGH TRANSITION ZONE. CONSIDER RERUNNING WITH ITEM 132 IN EFFECT.

> HEAT TRANSFER COEFF. AT RE = 2000 IS 221.80 BTU/HR-FT2-F HEAT TRANSFER COEFF. AT RE = 10000 IS 1249.17 BTU/HR-FT2-F

□□Washington University ChE433 heat exchanger experiment E0002 P138

Young model F302D		neat exchang	ger experim		9/23/ 3 CASE 69
SIZE 4- 18 TYPE B	EM, MULTI-PASS	FLOW, SEGME	ENTAL BAFFL		
2102 1 10 1112 2		HOT TU			
		Tube SENSI	BLE LIO	SENS	IBLE LIO
TOTAL FLOW RATE	KLB/HR		.900		.600
	,	IN	OUT	IN	OUT
TEMPERATURE	DEGF	140.0	101.6*	40.0	97.4*
TEMPERATURE DENSITY	LB/FT3	61.2913	61.8706	62.5352	61.9254
VISCOSITY	CP	.4726	.6805	1.4791	.7111
SPECIFIC HEAT	BTU/LB-F	.9973	.9986		
THERMAL COND.			.3636		
MOLAR MASS			18.02		18.02
110 2111 11110 0	25, 251102				
TEMP, AVG & SKIN	DEGF	120.8	95.3	68.7	93.9
VISCOSITY, AVG &					
PRESSURE, IN & DE					
PRESSURE DROP, TO	T & ALLOWED PS	ST .15	10.00	. 01	10.00
VELOCITY, CALC &					
		., 5	10.00	• • •	10.00
FOULING RESISTANC	E HR-FT2-F/	BTU .C	00010	. (	00010
FILM COEFFICIENT					44.74
TOTAL HEAT DUTY R	EOUIRED MEGBTU/	/HR			.034510
EFF TEMP DIF, DEG			ASS= .94,BA	FF=1.00)	
OVERALL COEFF REQ			,	,	119.37
CLEAN & FOULED CO			123.1	2	119.80
				_	
SHELLS IN SERIES	1 PARALLEL 1	TOTAL EFE	F AREA	FT2	7.1
PASSES, SHELL					
SHELL DIAMETER IN					
		-		•	
BAFFLE TYPE	HORZ SEGMENTL	CROSS PAS	SSES PER SH	ELL PASS	4
SPACING, CENTRAL					
SPACING, INLET		CUT DISTA	ANCE FROM C		
SPACING, OUTLET		001 21011	11.02 11.011 0		• , 0 1
BAFFLE THICKNESS		TMPTNGEME	ENT BAFFLE	TNCLUDED	NO
PAIRS OF SEALING		TUBESHEET			.0
TAINS OF SHABING	DHVICHS	1000011001	DDANN AND	, o	• •
TUBE TYPE	PT.ATM	MATERIAL	F.	I.ECTROI.YTT	C COPPER
NO. OF TUBES/SHEL		EST MAX T			36
TUBE LGTH, OVERAL				IN.	.3125
TUBE LGTH, EFF	FT 1.436				.250
TODE LGIN, EFF	1.430	1005 0013	אארת החדר	T 1/ •	. 200

	UBE INSIDE DIAM IN214
	UBE SURFACE RATIO, OUT/IN 1.184
SHL NOZZ ID, IN&OUT 1.0 1.0 T	UBE NOZZ ID, IN&OUT IN8 .8
* CALCULATED ITEMHEAT BALANCE C	
	exchanger experiment E0002 P139
Young model F302DY4P	9/23/ 3
	CASE 69
S U P P L E M E N T A R	Y RESULTS
HT PARAMETERS SHELL TUBE	SHELLSIDE PERFORMANCE
	NOMINAL VEL, X-FLOW FT/S .08
	NOMINAL VEL, WINDOW FT/S .15
	CROSSFLOW COEF BTU/HR-FT2-F 245.7
	WINDOW COEF BTU/HR-FT2-F 247.2
RYNLD NO, OUT BUN 318. 2084.	
FOULNG LAYER IN0014 .0014	SHELLSIDE FLOW, % OF TOTAL
	HEAT TRANSFER X-FLOW 81.62
THERMAL RESISTANCE, % OF TOTAL	TUBE TO BAFFLE LEAKAGE A = 3.35
	MAIN CROSSFLOW $B = 66.80$
48.40 48.92 2.60 .09	BUNDLE TO SHELL BYPASS C = 14.14
PCT OVER DESIGN .36	BAFFLE TO SHELL LEAKAGE E = 15.71
TOT FOUL RESIST .000217	BAFFLE TO SHELL LEAKAGE E = 15.71 TUBE PASSLANE BYPASS F = .00
DIFF RESIST .000030	
	SHELLSIDE HEAT TRANSFER FACTORS
	SHELLSIDE HEAT TRANSFER FACTORS  TOTAL = (BETA) (GAMMA) (FIN) = .656
	BETA (BAFF CUT FACTOR) = .920
	GAMMA (TUBE ROW ENTRY EFCT) = .713
BAFFLE TO SHELL IN1000	END (HT LOSS IN END ZONE) = .994
SHELL NOZZLE DATA IN OUT	SHELL PRESSURE DROP, % OF TOTAL
HT OPP NOZ IN 25	$END \ ZONE = 4 \ 3$
VELOCITY FT/S .49 .49	CROSS FLOW = 3.7
DENSITY LB/FT3 62.535 61.925	INLET NOZZLE = 43.2
NOZZ RHO*VSO LB/FT-S2 14 15	WINDOW = 8.8 END ZONE = 4.3 CROSS FLOW = 3.7 INLET NOZZLE = 43.2 OUTLET NOZZLE = 40.1
BUND RHO*VSQ LB/FT-S2 10 10	
TUBE NOZZLE DATA IN OUT	WEIGHT PER SHELL, LB
VELOCITY FT/S 1.33 1.32	DRY = $150.$
DENSITY LB/FT3 61.291 61.871	WET = $165.$
PRESS. DROP % 8.7 5.5	

## *** SPECIAL MESSAGES AND WARNINGS ***

WARNING--TUBESIDE FLUID HAS PASSED THROUGH TRANSITION ZONE. CONSIDER RERUNNING WITH ITEM 132 IN EFFECT.

HEAT TRANSFER COEFF. AT RE = 2000 IS 222.45 BTU/HR-FT2-F HEAT TRANSFER COEFF. AT RE = 10000 IS 1252.13 BTU/HR-FT2-F

CASE 70

					CASE 70
SIZE 4- 18 TYPE BEM, MULTI-	-PASS FL	OW, SEGME	NTAL BAFFL	ES, RATING	
		HOT TU	BE SIDE	COLD S	HELL SIDE
				Shel	
			BLE LIQ		IBLE LIQ
TOTAL FLOW RATE KLB/HR			.900		.700
			OUT		
TEMPERATURE DEGF					
DENSITY LB/FT3					
VISCOSITY CP			.7029		
SPECIFIC HEAT BTU/LB-					
THERMAL COND. BTU/HR-					
MOLAR MASS LB/LBMO	L		18.02		18.02
TEMP, AVG & SKIN DEG	r				
VISCOSITY, AVG & SKIN CP					
PRESSURE, IN & DESIGN PSIZ					
INDUCTE, IN & DESIGN ISIA		30.00	103.00	30.00	103.00
PRESSURE DROP, TOT & ALLOW	ED PSI	.15	10.00	.01	10.00
VELOCITY, CALC & MAX ALLOW					
FOULING RESISTANCE HR-					00010
FILM COEFFICIENT BTU					68.89
					005050
TOTAL HEAT DUTY REQUIRED MI					.037259
EFF TEMP DIF, DEGF (LMTD=			.SS= .94,BA		
OVERALL COEFF REQUIRED B'			107 0		124.74
CLEAN & FOULED COEFF B'	ru/HK-FT	Z-F.	127.9	9	124.33
SHELLS IN SERIES 1 PARALL	EL 1	TOTAL EFF	' AREA	FT2	7.1
PASSES, SHELL 1 TUBE					
SHELL DIAMETER IN.					
BAFFLE TYPE HORZ SEGI	MENTL	CROSS PAS	SES PER SH	ELL PASS	4
SPACING, CENTRAL IN.					
SPACING, INLET IN.		CUT DISTA	NCE FROM C	ENTER, IN.	.764
SPACING, OUTLET IN.	4.309				
BAFFLE THICKNESS IN.			NT BAFFLE		NO
PAIRS OF SEALING DEVICES	1	TUBESHEET	BLANK ARE	A, %	.0
TUBE TYPE	PLAIN :	Mampptat			C CODDED
NO. OF TUBES/SHELL		MATERIAL	UBE COUNT	LECTROLYTI	C COPPER 36
TUBE LGTH, OVERALL FT		TUBE PITC			
TUBE LGTH, EFF FT					.250
TUBE LAYOUT DEG					
			ACE RATIO,		
SHL NOZZ ID, IN&OUT 1.0			ID, IN&OU		
1.0	•	_ 0 10	,	,	.0
* CALCULATED ITEMHEAT	BALANCE	CODE = 8			
□□Washington University Ch			er experim	ent	E0002 P141
Young model F302DY4P					9/23/ 3
					CASE 70
SUPPLEMEN	T A R	V D	E S U	т т с	

HT PARAMETERS					
WALL CORRECTION					
PRANDTL NUMBER			L VEL, WINDOW		
RYNLD NO, AVG					
RYNLD NO, IN BUN			COEF E	STU/HR-FT2-E	271.6
RYNLD NO, OUT BUN					
FOULNG LAYER IN.	.0014 .0014				
			RANSFER X-FI		
THERMAL RESISTAN					
SHELL TUBE FO					
45.72 51.50	2.70 .09	BUNDLE	TO SHELL BY	PASS C =	= 14.83
PCT OVER DESIGN	33	BAFFLE	TO SHELL LE	BAKAGE E =	= 15.59
TOT FOUL RESIST			ASSLANE BYPA	SS F =	00
DIFF RESIST	000027	7			
		SHEL	LSIDE HEAT I	RANSFER FAC	CTORS
DIAMETRAL CLEA					
BUNDLE TO SHELL	IN500	00 BETA	(BAFF CUT FA	CTOR) =	920
TUBE TO BAFFLE HO	OLE IN028	34 GAMMA	(TUBE ROW EN	TRY EFCT) =	731
BAFFLE TO SHELL	IN100	00 END	(HT LOSS IN	END ZONE) =	994
SHELL NOZZLE D	O NI ATA	JT SHEL	L PRESSURE D	ROP, % OF T	TOTAL
HT UNDR NOZ IN.	.25	WINDOW	1	=	= 8.8
HT OPP NOZ IN.	.25	END ZO	NE	=	4.0
VELOCITY FT/	5 .57 .5	S8 CROSS	FLOW	=	= 3.5
DENSITY LB/FT					
NOZZ RHO*VSQ LB/	FT-S2 20 2	20 OUTLET	NOZZLE	=	= 40.5
BUND RHO*VSQ LB/	FT-S2 13 1	13			
TUBE NOZZLE DA	TA IN OU	JT WEIG	HT PER SHELL	, LB	
VELOCITY FT/	1.33 1.3	32 DRY		=	150.
DENSITY LB/FT	8 61.291 61.91	L1 WET		=	165.
PRESS. DROP %	8.7 5.	. 5			
*** SPECIAL MESS	AGES AND WARNING	GS ***			
WARNINGTUBESID	E FLUID HAS PASS	SED THROUGH	TRANSITION	ZONE. CONS	SIDER
RERUNNII	NG WITH ITEM 132	2 IN EFFECT	•		
HEAT TR	ANSFER COEFF. AT	T RE = 200	0 IS 222.89	BTU/HR-FT2	2-F
HEAT TR	ANSFER COEFF. AT	T RE = 1000	0 IS 1254.82	BTU/HR-FT2	2-F
□□Washington Uni	versity ChE433 h	neat exchan	ger experime	ent E	E0002 P142
Young model F302					9/23/ 3
					CASE 71
SIZE 4- 18 TYPE	BEM, MULTI-PASS	FLOW, SEGM	ENTAL BAFFLE	S, RATING	
				COLD SHE	ELL SIDE
		Tube		Shell	
			IBLE LIQ	SENSIE	BLE LIQ
TOTAL FLOW RATE	KLB/HR		.900		.800
		IN	OUT		OUT
TEMPERATURE	DEGF	140.0	96.1*		
DENSITY			61.9432		

DEGF 140.0 96.1* 40.0 89.2* LB/FT3 61.2913 61.9432 62.5352 62.0297

DENSITY

VISCOSITY SPECIFIC HEAT THERMAL COND. MOLAR MASS	CP BTU/LB-F BTU/HR-FT-F	.9973	.7216 .9990 .3623	1.4791 1.0058 .3466	.9995 .3605
TEMP, AVG & SKIN VISCOSITY, AVG & S PRESSURE, IN & DES	KIN CP	.5767	89.3 .7775	1.0481	87.8 .7911
PRESSURE DROP, TOT VELOCITY, CALC & M	& ALLOWED PSI MAX ALLOWED FT/	.15 s .88	10.00	.01	10.00
FOULING RESISTANCE FILM COEFFICIENT		-F 282	.55		0010 2.45
TOTAL HEAT DUTY RE EFF TEMP DIF, DEGF OVERALL COEFF REQU CLEAN & FOULED COE	QUIRED MEGBTU/H (LMTD= 53.4,F IRED BTU/HR-F	TR '= .86,BYPAS 'T2-F	S= .94,BAE	FF=1.00)	128.01
SHELLS IN SERIES PASSES, SHELL SHELL DIAMETER IN.	1 TUBE 4	EFFECTIVE A	AREA	FT2/SHELL	7.1
BAFFLE TYPE E SPACING, CENTRAL SPACING, INLET SPACING, OUTLET BAFFLE THICKNESS PAIRS OF SEALING D	IN. 4.309 IN. 4.309 IN. 4.309 IN125	BAFFLE CUT CUT DISTANG IMPINGEMENT	, PCT SHEI CE FROM CE I BAFFLE I	LL I.D. ENTER, IN.	30.00 .764 NO
TUBE TYPE NO. OF TUBES/SHELL TUBE LGTH, OVERALL TUBE LGTH, EFF TUBE LAYOUT PITCH RATIO SHL NOZZ ID, IN&OU	76 FT 1.500 FT 1.436 DEG 60 1.250	TUBE PITCH TUBE OUTSIN TUBE INSIDE TUBE SURFACE	DE DIAM E DIAM CE RATIO,	IN. IN. IN. OUT/IN	36 .3125 .250 .214 1.184
* CALCULATED ITE	rsity ChE433 he		r experime	ent	E0002 P143 9/23/ 3 CASE 71
HT PARAMETERS WALL CORRECTION PRANDTL NUMBER RYNLD NO, AVG RYNLD NO, IN BUN RYNLD NO,OUT BUN FOULNG LAYER IN.	SHELL TUBE 1.040 .951 7.2 3.8 288. 2459. 204. 3001. 388. 1965.	SHELLS: NOMINAL NOMINAL NOMINAL NOMINAL NOMINAL NOMINDOW CO	IDE PERFORVEL,X-FLOW VEL,WINDOW W COEF E	RMANCE V FT/S V FT/S BTU/HR-FT2- BTU/HR-FT2- % OF TOTAL	F 295.3

THERMAL RESISTANCE, % OF TOTAL	TUBE TO BAFFLE LEAKAGE A = 3.65
SHELL TUBE FOULING METAL	MAIN CROSSFLOW $B = 65.61$
	BUNDLE TO SHELL BYPASS $C = 15.26$
PCT OVER DESIGN .21	BAFFLE TO SHELL LEAKAGE E = 15.49 TUBE PASSLANE BYPASS F = .00
TOT FOUL RESIST .000217	TUBE PASSLANE BYPASS $F = .00$
DIFF RESIST .000017	
	SHELLSIDE HEAT TRANSFER FACTORS
DIAMETRAL CLEARANCES	TOTAL = (BETA) (GAMMA) (FIN) = $.689$
BUNDLE TO SHELL IN5000	TOTAL = (BETA) (GAMMA) (FIN) = .689  BETA (BAFF CUT FACTOR) = .920
TUBE TO BAFFLE HOLE IN028	GAMMA (TUBE ROW ENTRY EFCT) = .749
	END (HT LOSS IN END ZONE) = .994
	SHELL PRESSURE DROP, % OF TOTAL
HT UNDR NOZ IN25	WINDOW = 8.8 END ZONE = 3.8
HT OPP NOZ IN25	END ZONE = 3.8
VELOCITY FT/S .65 .60	CROSS FLOW = 3.3 INLET NOZZLE = 43.3
DENSITY LB/FT3 62.535 62.030	INLET NOZZLE = 43.3
	OUTLET NOZZLE = 40.8
BUND RHO*VSQ LB/FT-S2 18 18	3
	WEIGHT PER SHELL, LB
VELOCITY FT/S 1.33 1.32	2 DRY = 150. 3 WET = 165.
PRESS. DROP % 8.6 5.4	1

# *** SPECIAL MESSAGES AND WARNINGS ***

WARNING--TUBESIDE FLUID HAS PASSED THROUGH TRANSITION ZONE. CONSIDER RERUNNING WITH ITEM 132 IN EFFECT.

HEAT TRANSFER COEFF. AT RE = 2000 IS 223.28 BTU/HR-FT2-F HEAT TRANSFER COEFF. AT RE = 10000 IS 1256.35 BTU/HR-FT2-F

SIZE 4- 18 TYPE BEM, MULTI-PASS FLOW, SEGMENTAL BAFFLES, RATING

		HOT TU	JBE SIDE	COLD SH	HELL SIDE	
		Tube		Shell	-	
		SENSI	BLE LIQ	SENSI	BLE LIQ	
TOTAL FLOW RATE	KLB/HR	.900			.900	
		IN	OUT	IN	OUT	
TEMPERATURE	DEGF	140.0	93.9*	40.0	85.9*	
DENSITY	LB/FT3	61.2913	61.9710	62.5352	62.0703	
VISCOSITY	CP	.4726	.7389	1.4791	.8082	
SPECIFIC HEAT	BTU/LB-F	.9973	.9991	1.0058	.9998	
THERMAL COND.	BTU/HR-FT-F	.3723	.3617	.3466	.3597	
MOLAR MASS	LB/LBMOL		18.02		18.02	
TEMP, AVG & SKIN	DEGF	116.9	86.8	62.9	85.2	
VISCOSITY, AVG & SI	KIN CP	.5828	.7998	1.0710	.8146	
PRESSURE, IN & DES	IGN PSIA	50.00	165.00	50.00	165.00	

	che433b(40).OUT	
PRESSURE DROP, TOT & ALLOWED PSI		
VELOCITY, CALC & MAX ALLOWED FT/S	.88 10.00	.14 10.00
FOULING RESISTANCE HR-FT2-F/BT	U .00010	.00010
FILM COEFFICIENT BTU/HR-FT2-		315.87
		_
TOTAL HEAT DUTY REQUIRED MEGBTU/HF	8	.041407
EFF TEMP DIF, DEGF (LMTD= 54.0,F=	.86,BYPASS= .95,BAFF	=1.00) 44.1
OVERALL COEFF REQUIRED BTU/HR-FT		131.32
CLEAN & FOULED COEFF BTU/HR-FT	'2-F 136.03	131.78
SHELLS IN SERIES 1 PARALLEL 1	TOTAL EFF AREA F	T2 7.1
	EFFECTIVE AREA F	
	TEMA SHELL TYPE E	
	CROSS PASSES PER SHEL	
	BAFFLE CUT, PCT SHELL	I.D. 30.00
SPACING, INLET IN. 4.309	CUT DISTANCE FROM CEN	TER, IN764
SPACING, OUTLET IN. 4.309		
BAFFLE THICKNESS IN125	IMPINGEMENT BAFFLE IN	
PAIRS OF SEALING DEVICES 1	TUBESHEET BLANK AREA,	% .0
TUBE TYPE PLAIN	MATERIAL ELE	CTROLYTIC COPPER
NO. OF TUBES/SHELL 76	EST MAX TUBE COUNT	36
TUBE LGTH, OVERALL FT 1.500	TUBE PITCH	IN3125
	TUBE OUTSIDE DIAM	IN250
	TUBE INSIDE DIAM	IN214
	TUBE SURFACE RATIO, O	
SHL NOZZ ID, IN&OUT 1.0 1.0	TUBE NOZZ ID, IN&OUT	IN8 .8
* CALCULATED ITEMHEAT BALANCE	CODE - 8	
□□Washington University ChE433 hea		t E0002 P145
Young model F302DY4P	onenanger enperamen	9/23/ 3
3		CASE 72
S U P P L E M E N T A F	RY RESUL	T S
	SHELLSIDE PERFORM	
WALL CORRECTION 1.039 .949 PRANDTL NUMBER 7.4 3.8		
RYNLD NO, AVG 317. 2433.		
RYNLD NO, IN BUN 229. 3001.		
RYNLD NO, OUT BUN 420. 1919.	WINDON COLL DI	0,111(1121 010:5
FOULNG LAYER IN0014 .0014	SHELLSIDE FLOW, %	OF TOTAL
	HEAT TRANSFER X-FLO	
THERMAL RESISTANCE, % OF TOTAL	TUBE TO BAFFLE LEAK	$AGE \qquad A = 3.77$
SHELL TUBE FOULING METAL		
41.25 55.80 2.86 .09	BUNDLE TO SHELL BYP.	$ASS \qquad C = 15.46$
PCT OVER DESIGN .35 TOT FOUL RESIST .000217	BAFFLE TO SHELL LEA	KAGE E = 15.41
		S   F = .00
DIFF RESIST .000027	SHELLSIDE HEAT TR	VMCEED EVCHUDS
DIAMETRAL CLEARANCES	OUTTOINE UTAL IK	WNOLFY LWCIOKO
	TOTAI. = (RETA) (CAMMA	(FIN) = 706
BUNDLE TO SHELL IN5000	TOTAL = (BETA) (GAMMA BETA (BAFF CUT FAC	(FIN) = .706 TOR) = .920

			0110 1002 (10) 1001		
TUBE TO BAFFLE HOLE	IN.	.0284	GAMMA (TUBE ROW ENTRY EFCT)	=	.767
BAFFLE TO SHELL	IN.	.1000	END (HT LOSS IN END ZONE)	=	.994
SHELL NOZZLE DATA	IN	OUT	SHELL PRESSURE DROP, % OF	TOT	'AL
HT UNDR NOZ IN.	.25		WINDOW	=	8.8
HT OPP NOZ IN.	.25		END ZONE	=	3.6
VELOCITY FT/S	.73	.74	CROSS FLOW	=	3.2
DENSITY LB/FT3	62.535	62.070	INLET NOZZLE	=	43.3
NOZZ RHO*VSQ LB/FT-	S2 33	33	OUTLET NOZZLE	=	41.0
BUND RHO*VSQ LB/FT-	S2 22	23			
TUBE NOZZLE DATA	IN	OUT	WEIGHT PER SHELL, LB		
VELOCITY FT/S	1.33	1.31	DRY =		150.
DENSITY LB/FT3	61.291	61.971	WET =		165.
PRESS. DROP %	8.6	5.4			

### *** SPECIAL MESSAGES AND WARNINGS ***

WARNING--TUBESIDE FLUID HAS PASSED THROUGH TRANSITION ZONE. CONSIDER RERUNNING WITH ITEM 132 IN EFFECT.

HEAT TRANSFER COEFF. AT RE = 2000 IS 223.58 BTU/HR-FT2-F HEAT TRANSFER COEFF. AT RE = 10000 IS 1257.62 BTU/HR-FT2-F