Chapter 5

5.1 The spreadsheet on the next page shows the cash flows.

a. Non-Discounted Cash Flow Diagram Shown on next page.

b. (i) Cumulative cash position (CCP) = \$ 78×10^6
Cumulative cash ratio (CCR) = (78+135)/135 = 1.58

CCP = \$ 78×10^6
CCR = 1.58

(ii) Payback period (PBP) = 4.6 years

PBP = 4.6 years

(iii) Rate of return on investment (ROROI) = 7.8 % p.a.

ROROI = 7.8% p.a.

c. Discounted Cash Flow Diagram Shown on next page.

d. (i) Net present value (NPV) = 0
Present value ratio (PVR) = 0

NPV = \$ 0
PVR = 0

(ii) Discounted payback period (DPBP)= 7.2 years
discounted Land + W.C. = -5 + (-50)/1.08^2 = -\$ 30.7×10^6 this is located on the discounted cash flow diagram as the DPBP.

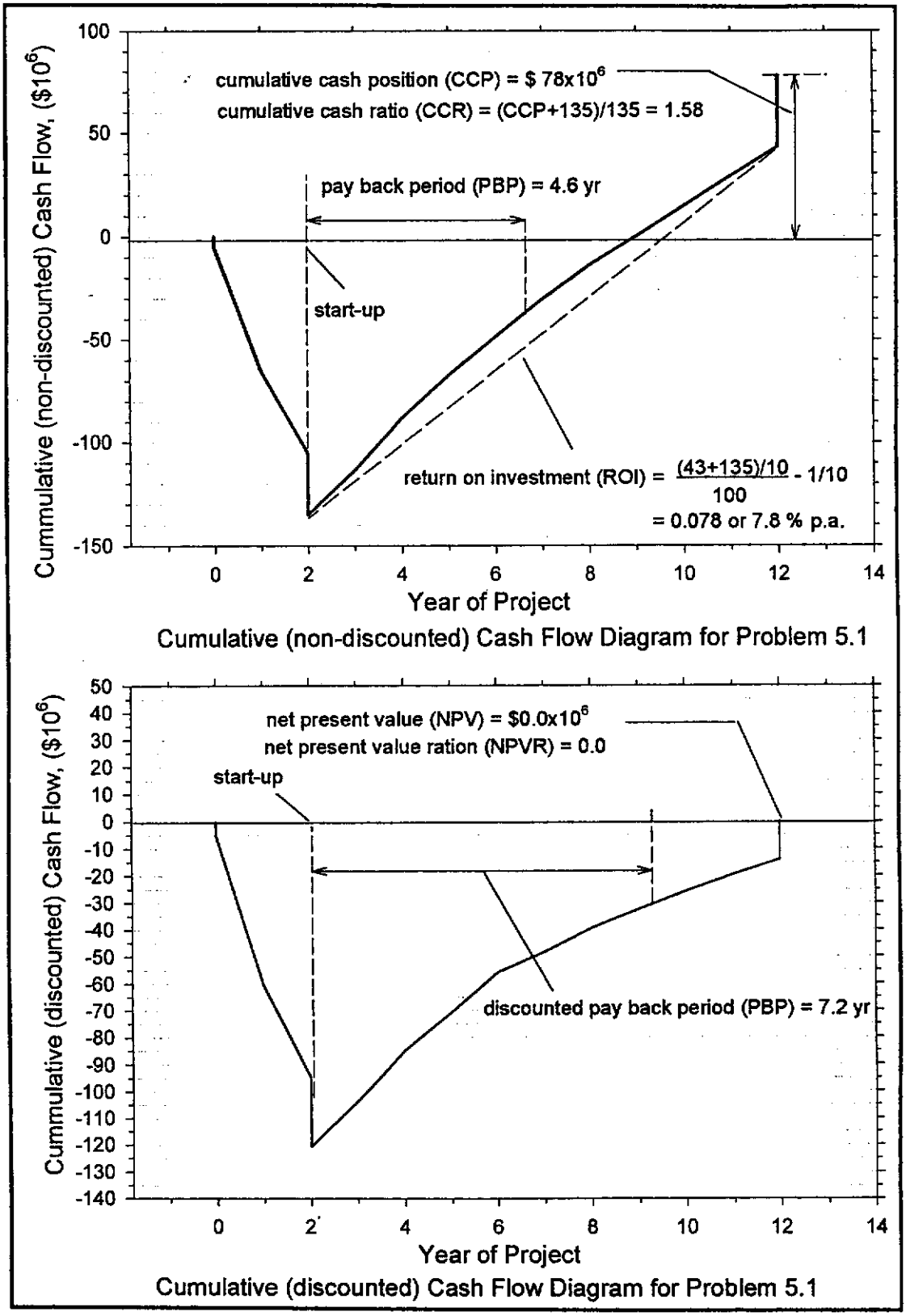
DPBP = 7.2 years

(iii) Discounted cash flow rate of return (DCFROR) = 8% (7.99%)

DCFROR = 8% p.a.

Problem 5.1 - Analysis, Synthesis, and Design of Chemical Processes by R.Turton, R.C.Bailie, W.B.Whiting, and J.A.Shaeiwitz

Year	Cap. Inv.	Revenue	COMd	depreciat'n	(1-COMd-d)(1-t)+d	Cash Flow	Cum CF	i=8%pa Disc CF	Cum Disc CF	i=7.99%pa	Disc CF	Cum Disc CF
0	-5					-5.00	-5.00	-5.00	-5.00	1.08	-5.00	-5.00
1	-60					-60.00	-65.00	-55.56	-60.56	1.08	-55.56	-60.56
2	-70					-70.00	-135.00	-60.01	-120.57	1.08	-60.02	-120.59
3		35	13	20	21.3	21.30	-113.70	16.91	-103.66	1.08	16.91	-103.67
4		35	13	32	25.5	25.50	-88.20	18.74	-84.92	1.08	18.75	-84.92
5		35	13	19.2	21.0	21.02	-67.18	14.31	-70.61	1.08	14.31	-70.61
6		35	13	11.52	18.3	18.33	-48.85	11.55	-59.06	1.08	11.56	-59.05
7		35	13	11.52	18.3	18.33	-30.52	10.70	-48.36	1.08	10.70	-48.35
8		35	13	5.76	16.3	16.32	-14.20	8.82	-39.55	1.08	8.82	-39.53
9		35	13		14.3	14.30	0.10	7.15	-32.39	1.08	7.16	-32.37
10		35	13		14.3	14.30	14.40	6.62	-25.77	1.08	6.63	-25.74
11		35	13		14.3	14.30	28.70	6.13	-19.64	1.08	6.14	-19.60
12	35	35	13		14.3	49.30	78.00	19.58	-0.06	1.08	19.60	0.00


Cummulative (non-discounted) Cash Flow, (10^6)
100
50
0
-50
-100
-150
cumulative cash position (CCP) = $ 78x10^6
cumulative cash ratio (CCR) = (CCP+135)/135 = 1.58
pay back period (PBP) = 4.6 yr
start-up
return on investment (ROI) = (43+135)/10 / 100 - 1/10
= 0.078 or 7.8 % p.a.
0
2
4
6
8
10
12
14
Year of Project
Cumulative (non-discounted) Cash Flow Diagram for Problem 5.1
Cummulative (discounted) Cash Flow, (10^6)
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
net present value (NPV) = $0.0x10^6
net present value ration (NPVR) = 0.0
start-up
discounted pay back period (PBP) = 7.2 yr
0
2
4
6
8
10
12
14
Year of Project
Cumulative (discounted) Cash Flow Diagram for Problem 5.1

5.2 The same approach as Problem 5.1 is used here, except that the method of depreciation is Straight line (SL) over 7 years. Spreadsheet and cash flow diagrams are shown on following pages.

a. Non-Discounted Cash Flow Diagram Shown on next page.

b. (i) Cumulative cash position (CCP) = \$ 78×10^6 - same as Problem 5.1
Cumulative cash ratio (CCR) = (78+135)/135 = 1.58 - same as Problem 5.1

CCP = \$ 78×10^6
CCR = 1.58

(ii) Payback period (PBP) = 5.1 years
(slightly longer than Problem 5.1 due to SL vs MACRS)

PBP = 5.1 years

(iii) Rate of return on investment (ROROI) = 7.8 % p.a. - same as Problem 5.1

ROROI = 7.8% p.a.

c. Discounted Cash Flow Diagram Shown on next page.

d. (i) Net present value (NPV) = -\$ 2.09×10^6
Present value ratio (PVR) = 0.98

NPV = -\$ 2.09×10^6
PVR = 0.98

(ii) Discounted payback period (DPBP)= 7.6 years
discounted Land + W.C. = $-5 + (-50)/1.08^2$ = -\$ 30.7×10^6 this is located on the discounted cash flow diagram as the DPBP.

DPBP = 7.6 years

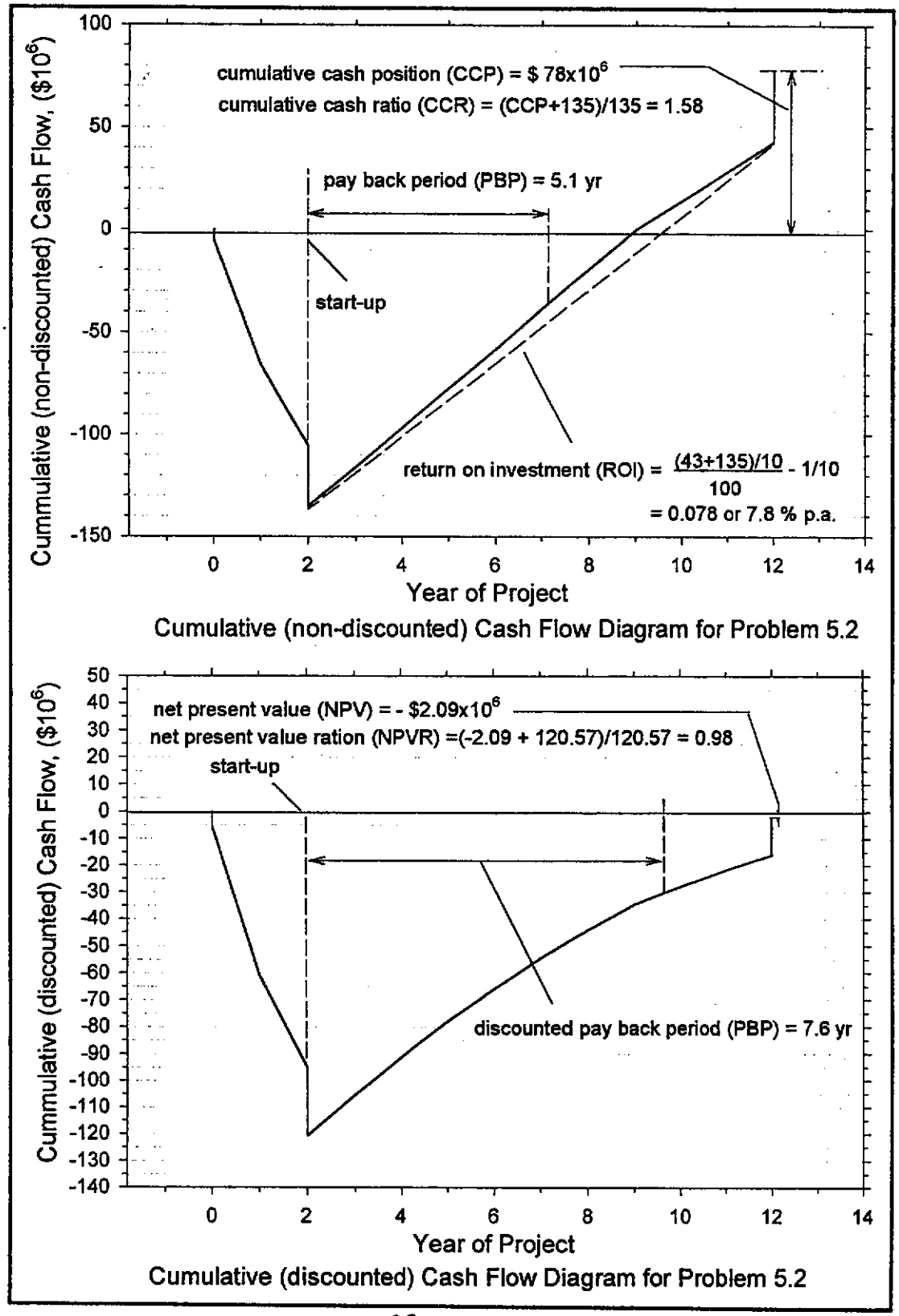
(iii) Discounted cash flow rate of return (DCFROR) = 7.67%

DCFROR = 7.67% p.a.

Note: all economic indicators show that when discounting is taken into account the MACRS improves the profitability of the project compared with SL. So better to use MACRS.

Problem 5.2 - Analysis, Synthesis, and Design of Chemical Processes by R.Turton, R.C.Bailie, W.B.Whiting, and J.A.Shaeiwitz

Year	Cap. Inv.	Revenue	COMd	depreciat'n	(1-COMd-d)(1-t)+d	Cash Flow	Cum CF	i=8%pa Disc CF	Cum DCF	i=7.67%pa	Disc CF	Cum DCF
0	-5					-5	-5	-5	-5	1.0767	-5	-5
1	-60					-60	-65	-55.56	-60.56	1.0767	-55.7258	-60.73
2	-70					-70	-135	-60.01	-120.57	1.0767	-60.3822	-121.11
3		35	13	14.28571	19.3	19.3	-115.7	15.32	-105.25	1.0767	15.46227	-105.65
4		35	13	14.28571	19.3	19.3	-96.4	14.19	-91.06	1.0767	14.36079	-91.28
5		35	13	14.28571	19.3	19.3	-77.1	13.14	-77.93	1.0767	13.33779	-77.95
6		35	13	14.28571	19.3	19.3	-57.8	12.16	-65.76	1.0767	12.38765	-65.56
7		35	13	14.28571	19.3	19.3	-38.5	11.26	-54.50	1.0767	11.5052	-54.05
8		35	13	14.28571	19.3	19.3	-19.2	10.43	-44.08	1.0767	10.68562	-43.37
9		35	13	14.28571	19.3	19.3	0.1	9.65	-34.42	1.0767	9.924414	-33.44
10		35	13		14.3	14.3	14.4	6.62	-27.80	1.0767	6.8295	-26.61
11		35	13		14.3	14.3	28.7	6.13	-21.66	1.0767	6.342992	-20.27
12	35	35	13		14.3	49.3	78	19.58	-2.09	1.0767	20.31002	0.04



Cumulative (non-discounted) Cash Flow Diagram for Problem 5.2

Cumulative (discounted) Cash Flow Diagram for Problem 5.2

Project 2

PBP = 2 + (11.1 - 8)/(12 - 8) = 2.78 years

PBP_2 = 2.78 yr

d. As explained earlier a high interest rate (discount rate) *i* favors project 2. This is due to the fact that major +ve cash flows for Project 1 occur late in the project.

5.8 Compare alternatives using the *EAOC*.

Equipment	n	*EAOC = -FCI(A/P,i,n) - YOC*
A	4 yr	$-6(0.1)(1.1)^4/(1.1^4 - 1) - 1.7 =$ **- $ 3.59×10³/yr**
B	7 yr	$-12(0.1)(1.1)^7/(1.1^7 - 1) - 1.3 =$ - $ 3.76×10³/yr
C	8 yr	$-15(0.1)(1.1)^8/(1.1^8 - 1) - 1.0 =$ - $ 3.81×10³/yr

Choose Equipment A

5.9

$EAOC_A = -5(0.12)(1.12)^4/(1.12^4 - 1) - 0.75 = -2.40\times10^3$/yr

$EAOC_B = -10(0.12)(1.12)^7/(1.12^7 - 1) - 0.45 = -2.64\times10^3$/yr

Choose Equipment A

5.10 Consider a comparison between the pump and control valve (cv) and variable speed (vs) pump only, since all other costs are the same.

Alternative A = pump + cv FCI = $ 32,000, Op. Cost = $ 9,300/yr, n = 8yr
Alternative B = vs pump FCI = 42,000, Op. Cost = $ 6,000/yr, n = 6yr

$EAOC_A = -32(0.1)(1.1^8)/(1.1^8 - 1) - 9.3 = \$-15.3\times10^3$/yr

$EAOC_B = -42(0.1)(1.1^6)/(1.1^6 - 1) - 6.0 = \$-15.6\times10^3$/yr

Choose pump and control valve

5.11 Purchase cost of pump = $ 15,000
installation cost of pump = (0.5)(15000) = $ 7,500
P = 15,000 + 7,500 = $ 22,500
i = 8% pa, n = 4 yr

$$Capitalized\ Cost = P\frac{(1+i)^n}{(1+i)^n - 1} = 22.5\frac{(1.08)^4}{(1.08)^4 - 1} = \$84.9\times10^3$$

Capitalized Cost = $ 84,900

5.21 Ignore tax rate and depreciation since we are looking at a 10% **before tax** criterion of profitability.

$EAOC = 150(0.1)(1.1)^{10}/(1.1^{10} - 1) - 30 = -\$\ 5.59\times10^3/yr$

Since *EAOC* is negative the investment is good.

Invest in Heat Exchanger

5.22 a. $FCI_{base} = \$\ 11.9\times10^6$

Net revenue $= (11.1 - 3.16 - 0.299)\times10^6 = \$\ 7.641\times10^6/yr$

$NPV = -11.9 + 7.641(P/A, i, n) = -11.9 + (7.641)(1.15^{12} - 1)/\{(0.15)(1.15)^{12}\}$
$= -11.9 + (7.641)(5.4206) = \$29.52\times10^6$

Recommend Construction of Plant

b. Look at incremental investments for alternatives

Alternative 1

$INPV = -1.02 + (0.299 - 0.206)(5.4206) = -\$\ 0.516\times10^6 < 0$ do not invest

Alternative 2

$INPV = -0.05 + (0.299 - 0.258)(5.4206) = -\$\ 0.278\times10^6 < 0$ do not invest

Do not invest in either alternative

c. $INPV = 0 = -2.0 + X(5.4206)$

$X = (2.0)/(5.4206) = \$\ 0.369\times10^6/yr$

Yearly savings must be at least $\$\ 0.369\times10^6/yr$