ChE 477 Homework Set #2

1. Problem 1, p.73 text

1986 $A = 50\,m^2$ \$6,500
1990 $A = 120\,m^2$ \$11,000
mid-1996 $A = 90\,m^2$?

} similar application @ moderate T & P

Using CEPCI, in 1990:

$$C_{50m^2} = \frac{\$6,500\,(358)}{318} = \$7,318$$

Find K:

$$C_a = K(A_a)^n$$

① find n

$$\frac{C_a}{A_a^n} = \frac{C_b}{A_b^n}$$

$$\frac{7318}{50^n} = \frac{11,000}{120^n}$$

$$\frac{7,318}{11,000} = \frac{50^n}{120^n}$$

$$\frac{7,318}{11,000} = \left(\frac{50}{120}\right)^n$$

$$\ln\frac{7,318}{11,000} = n \ln\left(\frac{50}{120}\right)$$

$$-0.4076 = n\,(-0.8755)$$

$$n = 0.466 \approx 0.47$$

② find K

$$K \approx 1160\ \frac{\$}{(m^2)^{0.47}}$$

$$C_{90m^2} = 1160\,(90^{0.47}) = \$9,615 \text{ in } 1990$$

Using CEPCI, in mid-1996:

$$C_{90m^2} = \frac{\$9,615\,(382)}{358} = \boxed{\$10,260}$$

3. From Appendix A

$$\log_{10} C_p = K_1 + K_2 \log_{10} A + K_3 (\log_{10} A)^2$$

$$C_{BM}^\circ = C_p F_{BM}^\circ = C_p (B_1 + B_2 F_M F_p)$$

$F_p = 1.0$ ← told

pump P-101A

Capacity parameter = A = 5 kW

Table A.7 $K_1 = 3.5793$

" $K_2 = 0.3208$

" $K_3 = 0.02850$

* $\log_{10} C_p = 3.5793 + 0.3208 \log_{10} 5 + 0.02850 (\log_{10} 5)^2$

$\log_{10} C_p \approx 3.8175$

$\boxed{C_p = 6569 \approx \$6,570}$ ✓

Table A.7 $B_1 = 1.80$

$B_2 = 1.51$

Table A.8 $F_M = 1.8$

* $C_{BM}^\circ = C_p F_{BM}^\circ = 6570 (1.80 + 1.51(1.8)(1))$

$\boxed{C_{BM}^\circ = 29683.3 \approx \$29,690}$ ✓

From Table E2.15 $C_p = \$6,500$ } VERIFIED

$C_{BM}^\circ = \$29,700$ }

C_p % diff. $= \frac{6,570 - 6,500}{6,500} (100) = 1.08\%$

C_{BM}° % diff. $= \frac{29,700 - 29,690}{29,700} (100) = 0.034\%$

$C_{BM} = C_p F_{BM}$

$C_{BM} = C_p (B_1 + B_2)$; [Note: $F_p = 1$, $F_M = 1$]

$= 6570 [1.80 + 1.51]$

$= 21,746$

Text, Table E 2.14 B gives $C_{BM} = 21,800$

Date : 9/8/98 Time : 7:57 p

Results for Unit 100 - The Expansion Process

Chemical Engineering Plant Cost Index (CEPCI) = 382

Total Purchased Equipment Cost = $190,000

Total Bare Module Cost (CS and 0 barg) of Plant = $592,000

Total Bare Module Cost of Plant = $670,000

Total Module Cost of Plant = $791,000

Total Grass Roots Cost of Plant = $998,000

This is for Problem #2

From Table E2.15 C_p = $170,100 → 7

C°_{BM} = $670,300 } VERIFIED

C_p % diff. = $\frac{190,000 - 170,100}{170,100}(100) = 11.7\%$

C°_{BM} % diff = $\frac{670,300 - 670,000}{670,300} = 0.0448\%$

C_{Gr} (Text) = $\$998 \times 10^3$.