Appendix 6.5 Design for Economic size of Pumping Main

Problem :- Design an economic size of pumping main, given the following data:

1	Water requirements	year	Discharge
	Initial	1989	5 MLD
	Intermediate	2004	7.5 MLD
	Ultimate	2019	10 MLD
2	Length of pumping main	7000m	
3	Static head for pump	50m	
4	Design period	30 years	
5	Combined efficiency of pumping set	60%	
6	Cost of pumping unit	Rs. 2000 per kw	
7	Interest rate	10%	
8	Life of electric motor and pump	15 years	
9	Energy charges	Rs. 1 per unit	
10	Design value of 'C' for C.I. pipe	100	
Solution			
1	Discharge at installation	1st 15 years	2nd 15 years
2	Discharge at the end 15 years	5 MLD	7.5 MLD
3	Average discharge	7.5 MLD	10.0 MLD
		5+7.5/2 =6.25 MLD	7.5+10.0/2 = 8.75 MLD
4	Hours of pumping for discharge at the end of 15 years	23	23
5	Average hours of pumping for average discharge	(23/7.5)x6.25 = 19.17	(23/10)x8.75 = 20.12

6. KW required at 60% combined efficiency of pumping set

$$\frac{7.5 \times 10^6 \times H_1 \times 100 \times 24}{60x60x24x102x60x23} = KW_1 \qquad \frac{10 \times 10^6 \times H_2 \times 100 \times 24}{60x60x24x102x60x23} = KW_2$$

$1.48H_1 = KW_1$ $\qquad$ $1.972H_2 = KW_2$

KW required = $(Q \times H) / 102 \times 1/\eta \times 24/X$

Where,
Q = Discharge at the end of 15 years in 1ps
H = Total head in m for discharge at the end of 15 years
η = Combined efficiency of pumping set
X = Hours of pumping for discharge at the end of 15 years

7. Annual cost in Rs. of electrical energy @ Rs. 1 per unit (KWX average hours of pumping x average days per year x 1.00)
= $KW_1 \times 19.17 \times 365.24 \times 1.00 = 7001.65\ KW_1$ $\quad$ $KW_2 \times 20.12 \times 365.24 \times 1.00 = 7348.63\ KW_2$

8. Pump Cost Captilised
$P_n = C = P_o(1 + r)^n$
$P_o = C/(1+r)^n$

Where,
P_o = Initial (1989) Capitalised investment
C = Amount needed after 15 years, that is , in 2004 to purchase the second stage pumping set.
r = Rate of compound interest
= 10% per year
n = No. of years = 15
$P_o = C/(1+0.1)^{15} = C/4.177$

9. Energy Charges Capitalised

$C_c = C_R \{(1 -(1+r)^{-r})/n\}$

For values n = 15 and r = 10%
$C_C = 7.606\ C_R$
(C_C) $_1$st stage = 7.606 (C_R) 1st stage and
(C_C) 2nd stage = 7.606 (C_R) 2nd stage

Present (1989) energy charges (C_p) for second stage capitalised value i.e for (C_C) 2nd and stage in 2004

$C_P = (C_C)$ 2nd stage / 4.177

10. Table I, II,III show the calculations to arrive the most economical pumping main size for the given data.