

9. COST ESTIMATION AND ECONOMICS

Cost of **MEK** plant of capacity **35000 TPY** in 1967 is Rs. $3.75 \times 10^6 = \text{Rs. } 1.875 \times 10^8$

Therefore cost of 178200 TPY in 1967 is:

$$\begin{aligned} C_1 &= C_2 (Q_1/Q_2)^{0.6} \\ &= 1.875 \times 10^8 (178200/35000)^{0.6} \\ &= \text{Rs. } 4.9786 \times 10^8 \end{aligned}$$

Chemical Engineering Plant Cost Index:

Cost index in 1967 = 110

Cost index in 2002 = 402

Thus, Present cost of Plant = (original cost) \times (present cost index)/(past cost index)
 $= (4.9786 \times 10^8) \times (402/110) = \text{Rs. } 18.19 \times 10^8$

i.e., Fixed Capital Cost (FCI) = Rs. 18.19×10^8

9.1 Estimation of Capital Investment Cost:

I. **Direct Costs:** material and labour involved in actual installation of complete facility (70-85% of fixed-capital investment)

a) Equipment + installation + instrumentation + piping + electrical + insulation + painting (50-60% of Fixed-capital investment)

1. **Purchased equipment cost (PEC):** (15-40% of Fixed-capital investment)

Consider purchased equipment cost = 25% of Fixed-capital investment
i.e., PEC = 25% of $18.19 \times 10^8 = 0.25 \times 18.19 \times 10^8 = \text{Rs. } 4.547 \times 10^8$

2. **Installation, including insulation and painting:** (25-55% of purchased equipment cost.)

Consider the Installation cost = 40% of Purchased equipment cost
 $= 40\% \text{ of } 4.547 \times 10^8 = 0.40 \times 4.547 \times 10^8 = \text{Rs. } 1.819 \times 10^8$

3. **Instrumentation and controls, installed:** (6-30% of Purchased equipment cost.)

Consider the installation cost = 20% of Purchased equipment cost

$$= 20\% \text{ of } 4.547 \times 10^8 = 0.20 \times 4.547 \times 10^8 = \text{Rs. } 0.9095 \times 10^8$$

4. **Piping installed:** (10-80% of Purchased equipment cost)

Consider the piping cost = 40% Purchased equipment cost

$$= 40\% \text{ of Purchased equipment cost} = 0.40 \times 4.547 \times 10^8$$

$$= \text{Rs. } 1.8188 \times 10^8$$

5. **Electrical, installed:** (10-40% of Purchased equipment cost)

Consider Electrical cost = 25% of Purchased equipment cost

$$= 25\% \text{ of } 4.547 \times 10^8 = 0.25 \times 4.547 \times 10^8 = \text{Rs. } 1.1368 \times 10^8$$

B. Buildings, process and Auxiliary: (10-70% of Purchased equipment cost)

Consider Buildings, process and auxiliary cost = 40% of PEC

$$= 40\% \text{ of } 4.547 \times 10^8 = 0.40 \times 4.547 \times 10^8 = \text{Rs. } 1.819 \times 10^8$$

C. Service facilities and yard improvements: (40-100% of Purchased equipment cost)

Consider the cost of service facilities and yard improvement = 60% of PEC

$$= 60\% \text{ of } 4.547 \times 10^8 = 0.60 \times 4.547 \times 10^8 = \text{Rs. } 2.7285 \times 10^8$$

D. Land: (1-2% of fixed capital investment or 4-8% of Purchased equipment cost)

Consider the cost of land = 6% PEC = 6% of $4.547 \times 10^8 = 0.06 \times 4.547 \times 10^8$

$$= \text{Rs. } 0.2728 \times 10^8$$

Thus, Direct cost = $\text{Rs. } 15.0519 \times 10^8$ ----- (82.74% of FCI)

II. Indirect costs: expenses which are not directly involved with material and labour of actual installation of complete facility (15-30% of Fixed-capital investment)

A. Engineering and Supervision: (5-30% of direct costs)

Consider the cost of engineering and supervision = 10% of Direct costs

i.e., cost of engineering and supervision = 10% of 15.0519×10^8

$$= 0.1 \times 15.0519 \times 10^8 = \text{Rs. } 1.50519 \times 10^8$$

B. Construction Expense and Contractor's fee: (6-30% of direct costs)

Consider the construction expense and contractor's fee = 10% of Direct costs

i.e., construction expense and contractor's fee = 10% of 15.0519×10^8

$$= 0.1 \times 15.0519 \times 10^8 = \text{Rs. } 1.50519 \times 10^8$$

C. Contingency: (5-15% of Fixed-capital investment)

Consider the contingency cost = 10% of Fixed-capital investment
i.e., Contingency cost = 10% of $18.19 \times 10^8 = 0.12 \times 18.19 \times 10^8$
= Rs. 3.638×10^8

Thus, Indirect Costs = Rs. 6.64838×10^8 --- (28.54% of FCI)

III. Fixed Capital Investment:

Fixed capital investment = Direct costs + Indirect costs
= $(15.0519 \times 10^8) + (6.64838 \times 10^8)$
i.e., Fixed capital investment = Rs. 21.7×10^8

IV. Working Capital: (10-20% of Fixed-capital investment)

Consider the Working Capital = 15% of Fixed-capital investment
i.e., Working capital = 15% of $21.7 \times 10^8 = 0.15 \times 21.7 \times 10^8$
= Rs. 3.255×10^8

V. Total Capital Investment (TCI):

Total capital investment = Fixed capital investment + Working capital
= $(21.7 \times 10^8) + (3.255 \times 10^8)$
i.e., Total capital investment = Rs. 24.955×10^8

9.2 Estimation of Total Product cost:

I. Manufacturing Cost = Direct production cost + Fixed charges + Plant overhead cost.

A. Fixed Charges: (10-20% total product cost)

i. Depreciation: (depends on life period, salvage value and method of calculation-about 13% of FCI for machinery and equipment and 2-3% for Building Value for Buildings)

Consider depreciation = 13% of FCI for machinery and equipment and 3% for Building Value for Buildings)

i.e., Depreciation = $(0.13 \times 21.7 \times 10^8) + (0.03 \times 1.819 \times 10^8)$
= Rs. 2.8755×10^8

ii. Local Taxes: (1-4% of fixed capital investment)

Consider the local taxes = 3% of fixed capital investment

$$\text{i.e. Local Taxes} = 0.03 \times 21.7 \times 10^8 = \text{Rs. } 0.651 \times 10^8$$

iii. Insurances: (0.4-1% of fixed capital investment)

Consider the Insurance = 0.7% of fixed capital investment

$$\text{i.e. Insurance} = 0.007 \times 21.7 \times 10^8 = \text{Rs. } 0.1519 \times 10^8$$

iv. Rent: (8-12% of value of rented land and buildings)

Consider rent = 10% of value of rented land and buildings

$$= 10\% \text{ of } ((0.2728 \times 10^8) + (1.819 \times 10^8))$$

$$\text{Rent} = \text{Rs. } 2.0918 \times 10^8$$

Thus, Fixed Charges = Rs. 5.7702×10^8

B. Direct Production Cost: (about 60% of total product cost)

Now we have Fixed charges = 10-20% of total product charges – (given)

Consider the Fixed charges = 15% of total product cost

$$\Rightarrow \text{Total product charge} = \text{fixed charges}/15\%$$

$$\Rightarrow \text{Total product charge} = 5.7702 \times 10^8 / 15\%$$

$$\Rightarrow \text{Total product charge} = 5.7702 \times 10^8 / 0.15$$

$$\Rightarrow \text{Total product charge (TPC)} = \text{Rs. } 38.468 \times 10^8$$

i. Raw Materials: (10-50% of total product cost)

Consider the cost of raw materials = 25% of total product cost

$$\Rightarrow \text{Raw material cost} = 25\% \text{ of } 7.0126 \times 10^8 = 0.25 \times 34.468 \times 10^8$$

$$\Rightarrow \text{Raw material cost} = \text{Rs. } 8.617 \times 10^8$$

ii. Operating Labour (OL): (10-20% of total product cost)

Consider the cost of operating labour = 12% of total product cost

$$\Rightarrow \text{operating labour cost} = 12\% \text{ of } 34.468 \times 10^8 = 0.12 \times 34.468 \times 10^8$$

$$\Rightarrow \text{Operating labour cost} = \text{Rs. } 4.1361 \times 10^8$$

iii. Direct Supervisory and Clerical Labour (DS & CL): (10-25% of OL)

Consider the cost for Direct supervisory and clerical labour = 12% of OL

$$\begin{aligned} \Rightarrow \text{Direct supervisory and clerical labour cost} &= 12\% \text{ of } 4.1361 \times 10^8 \\ &= 0.12 \times 4.1361 \times 10^8 \end{aligned}$$

$$\Rightarrow \text{Direct supervisory and clerical labour cost} = \text{Rs. } 0.4963 \times 10^8$$

iv. Utilities: (10-20% of total product cost)

Consider the cost of Utilities = 12% of total product cost

$$\Rightarrow \text{Utilities cost} = 12\% \text{ of } 34.468 \times 10^8 = 0.12 \times 34.468 \times 10^8$$

$$\Rightarrow \text{Utilities cost} = \text{Rs. } 4.1361 \times 10^8$$

v. Maintenance and repairs (M & R): (2-10% of fixed capital investment)

Consider the maintenance and repair cost = 5% of fixed capital investment

$$\text{i.e. Maintenance and repair cost} = 0.05 \times 21.7 \times 10^8 = \text{Rs. } 1.085 \times 10^8$$

vi. Operating Supplies: (10-20% of M & R or 0.5-1% of FCI)

Consider the cost of Operating supplies = 15% of M & R

$$\text{Operating supplies cost} = 15\% \text{ of } 1.085 \times 10^8 = 0.15 \times 1.085 \times 10^8$$

$$\text{Operating supplies cost} = \text{Rs. } 0.1627 \times 10^8$$

vii. Laboratory Charges: (10-20% of OL)

Consider the Laboratory charges = 15% of OL

$$\text{Laboratory charges} = 15\% \text{ of } 4.1361 \times 10^8 = 0.15 \times 4.1361 \times 10^8$$

$$\Rightarrow \text{Laboratory charges} = \text{Rs. } 0.6204 \times 10^8$$

viii. Patent and Royalties: (0-6% of total product cost)

Consider the cost of Patent and royalties = 4% of total product cost

$$\Rightarrow \text{Patent and Royalties} = 4\% \text{ of } 38.468 \times 10^8 = 0.04 \times 38.468 \times 10^8$$

$$\Rightarrow \text{Patent and Royalties cost} = \text{Rs. } 1.1540 \times 10^8$$

Thus, Direct Production Cost = Rs. 20.4076×10^8 ----- (61% of TPC)

C. Plant overhead Costs (50-70% of Operating labour, supervision, and maintenance or 5-15% of total product cost); includes for the following: general plant upkeep and overhead, payroll overhead, packaging, medical services, safety and protection, restaurants, recreation, salvage, laboratories, and storage facilities.

Consider the plant overhead cost = 60% of OL, DS & CL, and M & R

$$\text{Plant overhead cost} = 60\% \text{ of } ((4.1361 \times 10^8) + (0.4963 \times 10^8) + (1.085 \times 10^8))$$

$$\text{Plant overhead cost} = \text{Rs. } 3.4304 \times 10^8$$

Thus, Manufacture cost = Direct production cost + Fixed charges + Plant overhead costs.

$$\text{Manufacture cost} = (38.468 \times 10^8) + (5.7702 \times 10^8) + (3.4304 \times 10^8)$$

$$\text{Manufacture cost} = \text{Rs. } 47.6686 \times 10^8$$

II. General Expenses = Administrative costs + distribution and selling costs
+ research and development costs

A. Administrative costs:(2-6% of total product cost)

Consider the Administrative costs = 5% of total product cost

$$\Rightarrow \text{Administrative costs} = 0.05 \times 38.468 \times 10^8$$

$$\Rightarrow \text{Administrative costs} = \text{Rs. } 1.9234 \times 10^8$$

B. Distribution and Selling costs: (2-20% of total product cost); includes costs for sales offices, salesmen, shipping, and advertising.

Consider the Distribution and selling costs = 15% of total product cost

$$\text{Distribution and selling costs} = 15\% \text{ of } 38.468 \times 10^8$$

$$\Rightarrow \text{Distribution and selling costs} = 0.15 \times 38.468 \times 10^8$$

$$\Rightarrow \text{Distribution and Selling costs} = \text{Rs. } 5.7702 \times 10^8$$

C. Research and Development costs: (about 5% of total product cost)

Consider the Research and development costs = 5% of total product cost

$$\text{Research and Development costs} = 5\% \text{ of } 38.468 \times 10^8$$

$$\Rightarrow \text{Research and development costs} = 0.05 \times 38.468 \times 10^8$$

$$\Rightarrow \text{Research and Development costs} = \text{Rs. } 1.9234 \times 10^8$$

D. Financing (interest): (0-10% of total capital investment)

Consider interest = 5% of total capital investment

$$\text{i.e. interest} = 5\% \text{ of } 24.955 \times 10^8 = 0.05 \times 24.955 \times 10^8$$

$$\text{Interest} = \text{Rs. } 1.2477 \times 10^8$$

Thus, General Expenses = Rs. 10.8647×10^8

IV. Total Product cost = Manufacture cost + General Expenses

$$= (47.6686 \times 10^8) + (10.8647 \times 10^8)$$

$$\text{Total product cost} = \text{Rs. } 58.5333 \times 10^8$$

V. Gross Earnings/Income:

Wholesale Selling Price of MEK per kg = Rs.40

Total Income = Selling price \times Quantity of product manufactured

$$= 40 \times 1.782 \times 10^8$$

Total Income = Rs. 71.28×10^8

Gross income = Total Income – Total Product Cost

$$= (71.28 \times 10^8) - (58.533 \times 10^8)$$

Gross Income = Rs. 12.747×10^8

Let the Tax rate be 45% (common)

Net Profit = Gross income - Taxes = Gross income \times (1- Tax rate)

Net profit = $12.747 \times 10^8 (1-0.45) = \text{Rs. } 7.01085 \times 10^8$

Rate of Return:

Rate of return = Net profit $\times 100$ / Total Capital Investment

Rate of Return = $7.01085 \times 10^8 \times 100 / (24.935 \times 10^8)$

Rate of Return = 28.11%

Break-even Analysis:

Data available:

Annual Direct Production Cost = Rs. 38.468×10^8

Annual Fixed charges, overhead and general expenses = Rs. 5.7702×10^8

Total Annual sales = Rs. 71.28×10^8

Wholesale Selling Price MEK per ton. = Rs. 40000

Direct production cost per ton of MEK = $(5.7702 \times 10^8) / (71.28 \times 10^8 / 40000)$
= Rs. 3238.047 per ton

Let 'n' TPA be the break even production rate.

Number of tons needed for a break-even point is given by

$$(5.7702 \times 10^8) + (3238.047 \times n) = (40000 \times n)$$

=> n = 15696.1193 tons/year

n = 47.5639 tons/day = 47.5639 TPD

Hence, the break-even production rate is 47.5639 TPD or 10% of the considered plant capacity.