

8. COST ESTIMATION AND ECONOMICS

Cost of cumene plant of capacity **400 TPD** in 1990 is Rs.**23.4×10⁷**

Therefore cost of 3030 TPD in 1990 is:

$$\begin{aligned}C_1 &= C_2 (Q_1/Q_2)^{0.6} \\ &= 23.4 \times 10^7 (3030/400)^{0.6} \\ &= \text{Rs.} 7.885 \times 10^8\end{aligned}$$

Chemical Engineering Plant Cost Index:

Cost index in 1990 = 357.6

Cost index in 2002 = 402

Thus, Present cost of Plant = (original cost) × (present cost index)/(past cost index)

$$= (7.885 \times 10^8) \times (402/357.6) = \text{Rs. } 8.864 \times 10^8$$

i.e., Fixed Capital Cost (FCI) = Rs. 8.86×10^8

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

$$\text{i.e., PEC} = 25\% \text{ of } 8.86 \times 10^8 = 0.25 \times 8.86 \times 10^8 = \text{Rs. } 2.216 \times 10^8$$

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

Consider the Installation cost = 40% of Purchased equipment cost

$$= 40\% \text{ of } 2.216 \times 10^8 = 0.40 \times 2.216 \times 10^8 = \text{Rs.} 0.8864 \times 10^8$$

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

Consider the installation cost = 20% of Purchased equipment cost

$$= 20\% \text{ of } 2.216 \times 10^8 = 0.20 \times 2.216 \times 10^8 = \text{Rs. } 0.4432 \times 10^8$$

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

Consider the piping cost = 40% Purchased equipment cost
= 40% of Purchased equipment cost = $0.40 \times 2.216 \times 10^8$
= Rs. 0.8864×10^8

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

Consider Electrical cost = 25% of Purchased equipment cost
= 25% of 2.216×10^8 = $0.25 \times 2.216 \times 10^8$ = Rs. 0.554×10^8

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

Consider Buildings, process and auxiliary cost = 40% of PEC
= 40% of 2.216×10^8 = $0.40 \times 2.216 \times 10^8$ = Rs. 0.8864×10^8

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% of 2.216×10^8 = $0.60 \times 2.216 \times 10^8$ = Rs. 1.3296×10^8

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

Consider the cost of land = 6% PEC = 6% of 2.216×10^8 = $0.06 \times 2.216 \times 10^8$
= Rs. 0.1329×10^8

Thus, Direct cost = Rs. 7.3349×10^8 ----- (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 7.3349×10^8
= $0.1 \times 7.3349 \times 10^8$ = Rs. 0.73349×10^8

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 7.3349×10^8
= $0.1 \times 7.3349 \times 10^8$ = 0.73349×10^8

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

Consider the contingency cost = 10% of Fixed-capital investment

$$\begin{aligned} \text{i.e., Contingency cost} &= 10\% \text{ of } 8.86 \times 10^8 = 0.12 \times 8.86 \times 10^8 \\ &= \text{Rs. } 1.0632 \times 10^8 \end{aligned}$$

Thus, Indirect Costs = Rs. 2.5301×10^8 --- (28.54% of FCI)

III. Fixed Capital Investment:

$$\begin{aligned} \text{Fixed capital investment} &= \text{Direct costs} + \text{Indirect costs} \\ &= (7.3349 \times 10^8) + (2.5301 \times 10^8) \end{aligned}$$

$$\text{i.e., Fixed capital investment} = \text{Rs. } 9.865 \times 10^8$$

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

Consider the Working Capital = 15% of Fixed-capital investment

$$\begin{aligned} \text{i.e., Working capital} &= 15\% \text{ of } 9.865 \times 10^8 = 0.15 \times 9.865 \times 10^8 \\ &= \text{Rs. } 1.4797 \times 10^8 \end{aligned}$$

V. Total Capital Investment (TCI):

$$\begin{aligned} \text{Total capital investment} &= \text{Fixed capital investment} + \text{Working capital} \\ &= (9.865 \times 10^8) + (1.4797 \times 10^8) \end{aligned}$$

$$\text{i.e., Total capital investment} = \text{Rs. } 11.3447 \times 10^8$$

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)

$$\begin{aligned} \text{i.e., Depreciation} &= (0.13 \times 9.865 \times 10^8) + (0.03 \times 0.8864 \times 10^8) \\ &= \text{Rs. } 1.309 \times 10^8 \end{aligned}$$

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

Consider the local taxes = 3% of fixed capital investment

$$\text{i.e. Local Taxes} = 0.03 \times 9.865 \times 10^8 = \text{Rs. } 0.2959 \times 10^8$$

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

Consider the Insurance = 0.7% of fixed capital investment

$$\text{i.e. Insurance} = 0.007 \times 9.865 \times 10^8 = \text{Rs. } 0.069 \times 10^8$$

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

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

$$= 10\% \text{ of } ((0.1329 \times 10^8) + (0.8864 \times 10^8))$$

$$\text{Rent} = \text{Rs. } 0.10193 \times 10^8$$

Thus, Fixed Charges = Rs. 1.7758×10^8

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

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

$$\Rightarrow \text{Total product charge} = 1.7758 \times 10^8 / 15\%$$

$$\Rightarrow \text{Total product charge} = 1.7758 \times 10^8 / 0.15$$

$$\Rightarrow \text{Total product charge (TPC)} = \text{Rs. } 11.8388 \times 10^8$$

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

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

$$\Rightarrow \text{Raw material cost} = 25\% \text{ of } 11.8388 \times 10^8 = 0.25 \times 11.8388 \times 10^8$$

$$\Rightarrow \text{Raw material cost} = \text{Rs. } 2.9597 \times 10^8$$

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

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

$$\Rightarrow \text{operating labour cost} = 12\% \text{ of } 11.8388 \times 10^8 = 0.12 \times 11.8388 \times 10^8$$

$$\Rightarrow \text{Operating labour cost} = \text{Rs. } 1.4206 \times 10^8$$

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

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

$$\begin{aligned} \Rightarrow \text{Direct supervisory and clerical labour cost} &= 12\% \text{ of } 1.4206 \times 10^8 \\ &= 0.12 \times 1.4206 \times 10^8 \end{aligned}$$

$$\Rightarrow \text{Direct supervisory and clerical labour cost} = \text{Rs. } 0.1704 \times 10^8$$

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

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

$$\Rightarrow \text{Utilities cost} = 12\% \text{ of } 11.8388 \times 10^8 = 0.12 \times 11.8388 \times 10^8$$

$$\Rightarrow \text{Utilities cost} = \text{Rs. } 1.4206 \times 10^8$$

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

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

$$\text{i.e. Maintenance and repair cost} = 0.05 \times 9.865 \times 10^8 = \text{Rs. } 0.4932 \times 10^8$$

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

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

$$\text{Operating supplies cost} = 15\% \text{ of } 0.4935 \times 10^8 = 0.15 \times 0.4935 \times 10^8$$

$$\text{Operating supplies cost} = \text{Rs. } 0.07398 \times 10^8$$

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

Consider the Laboratory charges = 15% of OL

$$\text{Laboratory charges} = 15\% \text{ of } 1.4206 \times 10^8 = 0.15 \times 1.4206 \times 10^8$$

$$\Rightarrow \text{Laboratory charges} = \text{Rs. } 0.2131 \times 10^8$$

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

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

$$\Rightarrow \text{Patent and Royalties} = 4\% \text{ of } 11.8388 \times 10^8 = 0.04 \times 11.8388 \times 10^8$$

$$\Rightarrow \text{Patent and Royalties cost} = \text{Rs. } 0.4735 \times 10^8$$

Thus, Direct Production Cost = Rs. 7.225×10^8 ----- (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

$$\text{Plant overhead cost} = 60\% \text{ of } ((1.4206 \times 10^8) + (0.1704 \times 10^8) + (0.4932 \times 10^8))$$

$$\text{Plant overhead cost} = \text{Rs. } 2.084 \times 10^8$$

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

$$\text{Manufacture cost} = (7.225 \times 10^8) + (9.865 \times 10^8) + (2.084 \times 10^8)$$

$$\text{Manufacture cost} = \text{Rs. } 19.1742 \times 10^8$$

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

$$\Rightarrow \text{Administrative costs} = 0.05 \times 11.838 \times 10^8$$

$$\Rightarrow \text{Administrative costs} = \text{Rs. } 0.5919 \times 10^8$$

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

Distribution and selling costs = 15% of 11.838×10^8

$$\Rightarrow \text{Distribution and selling costs} = 0.15 \times 11.838 \times 10^8$$

$$\Rightarrow \text{Distribution and Selling costs} = \text{Rs. } 1.7757 \times 10^8$$

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

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

Research and Development costs = 5% of 11.838×10^8

$$\Rightarrow \text{Research and development costs} = 0.05 \times 11.838 \times 10^8$$

$$\Rightarrow \text{Research and Development costs} = \text{Rs. } 0.5919 \times 10^8$$

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

Consider interest = 5% of total capital investment

$$\text{i.e. interest} = 5\% \text{ of } 11.3447 \times 10^8 = 0.05 \times 11.3447 \times 10^8$$

$$\text{Interest} = \text{Rs. } 0.5672 \times 10^8$$

Thus, General Expenses = $\text{Rs. } 3.5267 \times 10^8$

IV. Total Product cost = Manufacture cost + General Expenses

$$= (19.1742 \times 10^8) + (3.5267 \times 10^8)$$

$$\text{Total product cost} = \text{Rs. } 22.7009 \times 10^8$$

V. Gross Earnings/Income:

Wholesale Selling Price of cumene per kg = Rs.49

Total Income = Selling price × Quantity of product manufactured

$$= 49 \times 100000000$$

Total Income = Rs. 49×10^7

Gross income = Total Income – Total Product Cost

$$= (49 \times 10^7) - (11.8388 \times 10^7)$$

Gross Income = Rs. 37.1612×10^7

Let the Tax rate be 45% (common)

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

Net profit = $37.1612 \times 10^7 (1-0.45) = \text{Rs. } 20.4386 \times 10^7$

Rate of Return:

Rate of return = Net profit × 100 / Total Capital Investment

Rate of Return = $2.04386 \times 10^8 \times 100 / (11.3447 \times 10^8)$

Rate of Return = 18.01%