

ECONOMICS

Cost of Soda ash plant of capacity 10000 TPA in 1971 is Rs. 3×10^6 .

Chemical Engineering Plant Cost Index:

Cost index in 1971 = 132

Cost index in 2002 = 402

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

$$= (3 \times 10^6) \times (402/132) = \text{Rs. } 8.74 \times 10^6$$

i.e., Fixed Capital Cost (FCI) = Rs. 8.74×10^6

Estimation of Capital Investment Cost:

I. Direct Costs: material and labor 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 = 30% of Fixed-capital investment

$$\begin{aligned} \text{i.e., PEC} &= 30\% \text{ of } 8.74 \times 10^6 = 0.3 \times 8.74 \times 10^6 \\ &= \text{Rs. } 2.622 \times 10^6 \end{aligned}$$

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

Consider the Installation cost = 40% of Purchased equipment cost

$$= 40\% \text{ of } 2.622 \times 10^6 = 0.40 \times 2.622 \times 10^6 = \text{Rs. } 1.05 \times 10^6$$

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

Consider the installation cost = 15% of Purchased equipment cost

$$= 15\% \text{ of } \times = 0.15 \times 2.622 \times 10^6 = \text{Rs. } \underline{0.393 \times 10^6}$$

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

Consider the piping cost = 40% Purchased equipment cost

$$\begin{aligned} &= 40\% \text{ of Purchased equipment cost} = 0.40 \times 2.622 \times 10^6 \\ &= \text{Rs. } \underline{1.04 \times 10^6} \end{aligned}$$

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

Consider Electrical cost = 25% of Purchased equipment cost

$$= 25\% \text{ of } 2.622 \times 10^6 = 0.25 \times 2.622 \times 10^6 = \text{Rs. } \underline{0.655 \times 10^6}$$

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

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

$$= 40\% \text{ of } 2.622 \times 10^6 = 0.40 \times 2.622 \times 10^6 = \text{Rs. } \underline{1.048 \times 10^6}$$

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

Consider the cost of service facilities and yard improvement = 50% of PEC

$$= 50\% \text{ of } 1.3325 \times 10^8 = 0.50 \times 2.622 \times 10^6 = \text{Rs. } \underline{1.311 \times 10^6}$$

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

$$\begin{aligned}\text{Consider the cost of land} &= 6\% \text{ PEC} = 6\% \text{ of } 1.3325 \times 10^8 \\ &= 0.06 \times 2.622 \times 10^6 \\ &= \text{Rs } \underline{0.1311 \times 10^6}\end{aligned}$$

Thus, Direct cost = Rs. 8.5651 x 10⁶

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 = 15% of Direct costs

$$\begin{aligned}\text{i.e., cost of engineering and supervision} &= 15\% \text{ of } 4.41 \times 10^8 \\ &= 0.15 \times 8.5651 \times 10^6 = \text{Rs. } \underline{1.275 \times 10^6}\end{aligned}$$

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 8.5651 x 10⁶

$$= 0.1 \times 8.5651 \times 10^6 = \text{Rs. } \underline{0.85 \times 10^6}$$

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

Consider the contingency cost = 5% of Fixed-capital investment

$$\text{i.e., Contingency cost} = 5\% \text{ of } 5.33 \times 10^8 = 0.05 \times 8.5651 \times 10^6$$

$$= \text{Rs. } \underline{0.425 \times 10^6}$$

Thus, Indirect Costs = Rs. $\underline{2.72 \times 10^6}$

III. Fixed Capital Investment:

$$\begin{aligned} \text{Fixed capital investment} &= \text{Direct costs} + \text{Indirect costs} \\ &= (2.72 \times 10^6) + (8.5651 \times 10^6) \end{aligned}$$

i.e., Fixed capital investment = Rs. $\underline{11.23 \times 10^6}$

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

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

$$\begin{aligned} \text{i.e., Working capital} &= 15\% \text{ of } 5.9316 \times 10^8 = 0.15 \times 11.23 \times 10^6 \\ &= \text{Rs. } \underline{1.6845 \times 10^8} \end{aligned}$$

V. Total Capital Investment (TCI):

$$\begin{aligned} \text{Total capital investment} &= \text{Fixed capital investment} + \text{Working capital} \\ &= (11.23 \times 10^6) + (1.6845 \times 10^6) \end{aligned}$$

i.e., Total capital investment = Rs. $\underline{12.91 \times 10^6}$

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 = 10% of FCI for machinery and equipment and 3% for Building Value for Buildings)

$$\begin{aligned} \text{i.e., Depreciation} &= (0.10 \times 11.23 \times 10^6) + (0.03 \times 1.048 \times 10^6) \\ &= \text{Rs. } \underline{1.154 \times 10^6} \end{aligned}$$

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

Consider the local taxes = 4% of fixed capital investment

$$\text{i.e. Local Taxes} = 0.04 \times 11.23 \times 10^6 = \text{Rs. } \underline{0.674 \times 10^6}$$

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

Consider the Insurance = 0.6% of fixed capital investment

$$\text{i.e. Insurance} = 0.006 \times 11.23 \times 10^6 = \text{Rs. } \underline{0.0674 \times 10^6}$$

iv. Rent: (8-12% of value of fixed capital investment)

Consider rent = 10% of value of fixed capital investment

$$= 0.10 \times 11.23 \times 10^6$$

$$\text{Rent} = \text{Rs. } \underline{1.123 \times 10^6}$$

$$\text{Thus, Fixed Charges} = \text{Rs. } \underline{2.794 \times 10^8}$$

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

Consider the Fixed charges = 15% of total product cost

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

$$\Rightarrow \text{Total product charge} = 2.794 \times 10^6 / 15\%$$

$$\Rightarrow \text{Total product charge} = 2.794 \times 10^6 / 0.15$$

$$\Rightarrow \text{Total product charge (TPC)} = \text{Rs. } \underline{18.63 \times 10^6}$$

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

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

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

$$\Rightarrow \text{Raw material cost} = 25\% \text{ of } 18.63 \times 10^6$$

$$\Rightarrow = 0.25 \times 18.63 \times 10^6$$

$$\Rightarrow \text{Raw material cost} = \text{Rs. } \underline{5.589 \times 10^6}$$

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

Consider the cost of operating labour = 15% of total product cost

$$\Rightarrow \text{Operating labour cost} = 15\% \text{ of } 18.63 \times 10^6 = 0.15 \times 18.63 \times 10^6$$

$$\Rightarrow \text{Operating labour cost} = \text{Rs. } \underline{2.79 \times 10^6}$$

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

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

$$\Rightarrow \text{Direct supervisory and clerical labour cost} = 12\% \text{ of } 2.79 \times 10^6 \\ = 0.12 \times 2.79 \times 10^6$$

$$\Rightarrow \text{Direct supervisory and clerical labour cost} = \text{Rs. } \underline{0.335 \times 10^6}$$

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

Consider the cost of Utilities = 15% of total product cost

$$\Rightarrow \text{Utilities cost} = 15\% \text{ of } 18.63 \times 10^6 = 0.12 \times 18.63 \times 10^6$$

$$\Rightarrow \text{Utilities cost} = \text{Rs. } \underline{2.79 \times 10^6}$$

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

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

$$\text{i.e. Maintenance and repair cost} = 0.05 \times 11.23 \times 10^6 \\ = \text{Rs. } \underline{0.5615 \times 10^6}$$

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

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

$$\text{Operating supplies cost} = 15\% \text{ of } 0.5615 \times 10^6 = 0.15 \times 0.5615 \times 10^6$$

$$\text{Operating supplies cost} = \text{Rs. } \underline{0.08422 \times 10^6}$$

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

Consider the Laboratory charges = 15% of OL

$$\text{Laboratory charges} = 15\% \text{ of } 2.79 \times 10^6 = 0.15 \times 2.79 \times 10^6$$

$$\Rightarrow \text{Laboratory charges} = \text{Rs. } \underline{0.4185 \times 10^6}$$

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

Consider the cost of Patent and royalties = 5% of total product cost

$$\Rightarrow \text{Patent and Royalties} = 5\% \text{ of } 18.63 \times 10^6$$

$$\Rightarrow = 0.05 \times 18.63 \times 10^6$$

$$\Rightarrow \text{Patent and Royalties cost} = \text{Rs. } \underline{0.9315 \times 10^6}$$

Thus, Direct Production Cost = Rs. 13.49×10^6

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

$$\text{Plant overhead cost} = 0.60 \times ((2.79 \times 10^6) + (0.335 \times 10^6) + (0.5615 \times 10^6))$$

$$\text{Plant overhead cost} = \text{Rs. } \underline{2.212 \times 10^6}$$

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

$$\text{Manufacture cost} = (2.794 \times 10^6) + (13.49 \times 10^6) + (2.212 \times 10^6)$$

Manufacture cost = Rs. 18.496×10^6

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

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

Consider the Administrative costs = 5% of total product cost

$$\Rightarrow \text{Administrative costs} = 0.05 \times 2.79 \times 10^6$$

$$\Rightarrow \text{Administrative costs} = \text{Rs. } \underline{0.1395 \times 10^8}$$

A. 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 = 10% of total product cost

$$\Rightarrow \text{Distribution and selling costs} = 10\% \text{ of } 18.63 \times 10^6$$

$$\Rightarrow \text{Distribution and selling costs} = 0.15 \times 18.63 \times 10^6$$

$$\Rightarrow \text{Distribution and Selling costs} = \text{Rs. } \underline{1.863 \times 10^6}$$

C. Research and Development costs: (about 3% of total product cost)

Consider the Research and development costs = 3% of total product cost

$$\text{Research and Development costs} = 3\% \text{ of } 18.63 \times 10^6$$

$$\Rightarrow \text{Research and development costs} = 0.05 \times 18.63 \times 10^6$$

$$\Rightarrow \text{Research and Development costs} = \text{Rs. } \underline{0.5589 \times 10^6}$$

Thus, General Expenses = Rs. 2.5614×10^6

IV. Total Product cost = Manufacture cost + General Expenses

$$= (18.496 \times 10^6) + (2.5615 \times 10^6)$$

$$\text{Total product cost} = \text{Rs. } \underline{21.057 \times 10^8}$$

V. Gross Earnings/Income:

Wholesale Selling Price of chlorine per ton = \$ 60 (USD)

Let 1 USD = Rs. 50.00

Hence, Wholesale Selling Price of chlorine per ton. = 60×50
= Rs3000

Total Income = Selling price \times Quantity of product manufactured
= 3000×10000

Total Income = Rs. 30×10^6

Gross income = Total Income – Total Product Cost
= $(30 \times 10^6) - (21.057 \times 10^6)$

Gross Income = Rs. 8.943×10^6

Let the Tax rate be 45% (common)

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

Net profit = $8.943 \times 10^6 (1 - 0.45) = \text{Rs } 4.92 \times 10^6$

Rate of Return:

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

Rate of Return = $4.92 \times 10^6 \times 100 / (12.91 \times 10^6)$

Rate of Return = 38.0%