

Cost of Hydrogen plant of capacity **std 1million cubic meter per day** in 1985 is **Rs. 3.08\*10<sup>9</sup>**

**Chemical Engineering Plant Cost Index:**

Year	Cost Index
1985	300
2002	401.8 $\approx$ 402

Thus, Present cost of Plant = (original cost)  $\times$  (present cost index)/(past cost index)  
 $= (3.08 \times 10^9) \times (402/300) = \text{Rs. } \underline{4.13 \times 10^9}$

i.e., Fixed Capital Cost (FCI) = Rs. 4.13\*10<sup>9</sup>

**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  $4.13 \times 10^9 = 0.25 \times 4.13 \times 10^9 = \text{Rs. } \underline{1.03 \times 10^9}$

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

Consider the Installation cost = 30% of Purchased equipment cost

$= 30\% \text{ of } 1.03 \times 10^9 = 0.30 \times 1.03 \times 10^9 = \text{Rs. } \underline{3.09 \times 10^8}$

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

Consider the installation cost = 20% of Purchased equipment cost

$$= 20\% \text{ of } 1.03 \times 10^9 = 0.20 \times 1.03 \times 10^9 = \text{Rs. } \underline{2.06 \times 10^8}$$

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

Consider the piping cost = 40% Purchased equipment cost

$$= 40\% \text{ of Purchased equipment cost} = 0.40 \times 1.03 \times 10^9$$

$$= \text{Rs. } \underline{4.12 \times 10^8}$$

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

Consider Electrical cost = 25% of Purchased equipment cost

$$= 25\% \text{ of } 1.03 \times 10^9 = 0.25 \times 1.03 \times 10^9 = \text{Rs. } \underline{2.575 \times 10^8}$$

Hence, cost = Rs. 2.2145 × 10<sup>9</sup> --- (53.61% of FCI)

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

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

$$= 40\% \text{ of } 1.03 \times 10^9 = 0.40 \times 1.03 \times 10^9 = \text{Rs. } \underline{4.12 \times 10^8}$$

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

Consider the cost of service facilities and yard improvement = 70% of PEC

$$= 70\% \text{ of } 1.03 \times 10^9 = 0.70 \times 1.03 \times 10^9 = \text{Rs. } \underline{7.21 \times 10^8}$$

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

Consider the cost of land = 6% PEC = 6% of  $1.03 \times 10^9 = 0.06 \times 1.03 \times 10^9$

$$= \text{Rs. } \underline{0.618 \times 10^8}$$

Or Consider the cost of land = 1.5% of FCI = 1.5% of  $4.13 \times 10^9$

$$= \text{Rs. } \underline{0.6195 \times 10^8}$$

Thus, Direct cost = Rs. 3.41 × 10<sup>9</sup> ----- (82.55% 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  $3.41 \times 10^9$

$$= 0.1 \times 3.41 \times 10^9 = \text{Rs. } \underline{3.41 \times 10^8}$$

**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  $3.41 \times 10^9$   
 $= 0.1 \times 3.41 \times 10^9 = \text{Rs. } \underline{3.41 \times 10^8}$

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

Consider the contingency cost = 10% of Fixed-capital investment  
i.e., Contingency cost = 10% of  $4.13 \times 10^9 = 0.10 \times 4.13 \times 10^9$   
 $= \text{Rs. } \underline{4.13 \times 10^8}$

Thus, Indirect Costs = Rs.  $\underline{1.095 \times 10^9}$  --- (26.51% of FCI)

**III. Fixed Capital Investment:**

Fixed capital investment = Direct costs + Indirect costs  
 $= (3.41 \times 10^9) + (1.095 \times 10^9)$   
i.e., Fixed capital investment = Rs.  $\underline{4.505 \times 10^9}$

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

Consider the Working Capital = 15% of Fixed-capital investment  
i.e., Working capital = 15% of  $4.505 \times 10^9 = 0.15 \times 4.505 \times 10^9$   
 $= \text{Rs. } \underline{6.7575 \times 10^8}$

**V. Total Capital Investment (TCI):**

Total capital investment = Fixed capital investment + Working capital  
 $= (4.505 \times 10^9) + (6.7575 \times 10^8)$   
i.e., Total capital investment = Rs.  $\underline{5.18 \times 10^9}$

**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 10% 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)

$$\begin{aligned}\text{i.e., Depreciation} &= (0.10 \times 4.505 \times 10^9) + (0.03 \times 4.505 \times 10^9) \\ &= \text{Rs. } \underline{5.8565 \times 10^8}\end{aligned}$$

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

Consider the local taxes = 3% of fixed capital investment

$$\text{i.e. Local Taxes} = 0.03 \times 4.505 \times 10^9 = \text{Rs. } \underline{1.3515 \times 10^8}$$

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

Consider the Insurance = 0.75% of fixed capital investment

$$\text{i.e. Insurance} = 0.0075 \times 4.505 \times 10^9 = \text{Rs. } \underline{0.025 \times 10^8}$$

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

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

$$= 10\% \text{ of } ((0.618 \times 10^8) + (4.12 \times 10^8))$$

$$= 0.10 \times ((0.618 \times 10^8) + (4.12 \times 10^8))$$

$$\text{Rent} = \text{Rs. } \underline{0.4738 \times 10^8}$$

$$\text{Thus, Fixed Charges} = \text{Rs. } \underline{7.7068 \times 10^8}$$

**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

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

$$\Rightarrow \text{Total product charge} = 7.7068 \times 10^8 / 15\%$$

$$\Rightarrow \text{Total product charge} = 7.7068 \times 10^8 / 0.15$$

$$\Rightarrow \text{Total product charge (TPC)} = \text{Rs. } \underline{5.14 \times 10^9}$$

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

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

$$\Rightarrow \text{Raw material cost} = 25\% \text{ of } 5.14 \times 10^9 = 0.25 \times 5.14 \times 10^9$$

$$\Rightarrow \text{Raw material cost} = \text{Rs. } \underline{1.285 \times 10^9}$$

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

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

$$\Rightarrow \text{operating labour cost} = 12\% \text{ of } 5.14 \times 10^9 = 0.12 \times 5.14 \times 10^9$$

$$\Rightarrow \text{Operating labour cost} = \text{Rs. } \underline{0.6168 \times 10^9}$$

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

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

$$\Rightarrow \text{Direct supervisory and clerical labour cost} = 12\% \text{ of } 0.6168 \times 10^9 \\ = 0.12 \times 0.6168 \times 10^9$$

$$\Rightarrow \text{Direct supervisory and clerical labour cost} = \text{Rs. } \underline{0.74 \times 10^8}$$

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

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

$$\Rightarrow \text{Utilities cost} = 12\% \text{ of } 5.14 \times 10^9 = 0.12 \times 5.14 \times 10^9$$

$$\Rightarrow \text{Utilities cost} = \text{Rs. } \underline{0.6168 \times 10^9}$$

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

Consider the maintenance and repair cost = 6% of fixed capital investment

$$\text{i.e. Maintenance and repair cost} = 0.06 \times 4.505 \times 10^9 = \text{Rs. } \underline{0.2703 \times 10^9}$$

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

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

$$\text{Operating supplies cost} = 15\% \text{ of } 0.2703 \times 10^9 = 0.15 \times 0.2703 \times 10^9$$

$$\text{Operating supplies cost} = \text{Rs. } \underline{0.04 \times 10^9}$$

Or

Consider the cost of Operating supplies = 0.9% of FCI

$$\text{Operating supplies cost} = 0.9\% \text{ of } 4.505 \times 10^9 = 0.009 \times 4.505 \times 10^9$$

$$\text{Operating supplies cost} = \text{Rs. } \underline{0.040 \times 10^9}$$

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

Consider the Laboratory charges = 15% of OL

$$\text{Laboratory charges} = 15\% \text{ of } 0.6168 \times 10^9 = 0.15 \times 0.6168 \times 10^9$$

$$\Rightarrow \text{Laboratory charges} = \text{Rs. } \underline{0.09252 \times 10^9}$$

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

Consider the cost of Patent and royalties = 3% of total product cost

$$\Rightarrow \text{Patent and Royalties} = 3\% \text{ of } 5.14 \times 10^9 = 0.03 \times 5.14 \times 10^9$$

$$\Rightarrow \text{Patent and Royalties cost} = \text{Rs. } \underline{0.1542 \times 10^9}$$

Thus, Direct Production Cost = Rs.  $\underline{3.149 \times 10^9}$  ----- (61.276% 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

Plant overhead cost = 60% of  $((0.6168 \times 10^9) + (0.74 \times 10^8) + (0.2703 \times 10^9))$

Plant overhead cost =  $0.60 \times ((0.6168 \times 10^9) + (0.74 \times 10^8) + (0.2703 \times 10^9))$

Plant overhead cost = Rs.  $0.9611 \times 10^9$

Or

Consider the plant overhead cost = 11% of total product cost

Cost of Plant overhead = 11% of  $5.14 \times 10^9$

⇒ Plant overhead costs =  $0.11 \times 5.14 \times 10^9$

⇒ Plant overhead costs = Rs.  $0.5654 \times 10^9$

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

Manufacture cost =  $(2.4124 \times 10^8) + (0.5927 \times 10^8) + (0.4385 \times 10^8)$

Manufacture cost = Rs.  $4.485 \times 10^9$

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

**A. Administrative costs:** (about 15% of costs for operating labour, supervision, and maintenance or 2-6% of total product cost); includes costs for executive salaries, clerical wages, legal fees, office supplies, and communications.

Consider the Administrative costs = 15% of OL, DS & CL, and M & R

Administrative costs = 15% of  $((0.6168 \times 10^9) + (0.74 \times 10^8) + (0.2703 \times 10^9))$

Administrative costs =  $15\% \times ((0.6168 \times 10^9) + (0.74 \times 10^8) + (0.2703 \times 10^9))$

Administrative costs = Rs.  $0.144 \times 10^9$

Or

Consider the Administrative costs = 2.77% of total product cost

Administrative costs = 2.77% of  $5.14 \times 10^9$

⇒ Administrative costs =  $0.0277 \times 5.14 \times 10^9$

⇒ Administrative costs = Rs.  $0.144 \times 10^9$

**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 = 11% of total product cost

Distribution and selling costs = 11% of  $5.14 \times 10^9$

⇒ Distribution and selling costs =  $0.11 \times 5.14 \times 10^9$

⇒ Distribution and Selling costs = Rs.  $0.5654 \times 10^9$

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

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

$$\text{Research and Development costs} = 5\% \text{ of } 5.14 \times 10^9$$

$$\Rightarrow \text{Research and development costs} = 0.05 \times 5.14 \times 10^9$$

$$\Rightarrow \text{Research and Development costs} = \text{Rs. } \underline{0.257 \times 10^9}$$

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

Consider interest = 5% of total capital investment

$$\text{i.e. interest} = 5\% \text{ of } 5.18 \times 10^9 = 0.05 \times 5.18 \times 10^9$$

$$\text{Interest} = \text{Rs. } \underline{0.259 \times 10^9}$$

Thus, General Expenses = Rs.  $1.2254 \times 10^9$

**IV. Total Product cost** = Manufacture cost + General Expenses

$$= (4.485 \times 10^9) + (1.2254 \times 10^9)$$

$$\text{Total product cost} = \text{Rs. } \underline{5.71 \times 10^9}$$

This value is greater than the assumed value of Rs.  $5.14 \times 10^9$  and hence acceptable.

**V. Gross Earnings/Income:**

Wholesale Selling Price of hydrogen gas per cubic meter = \$ 0.60 (USD)

Let 1 USD = Rs. 48.957 as on (30/04/2002)

Hence Wholesale Selling Price of hydrogen per cubic meter

$$= 0.60 \times 48.957 = \text{Rs. } \underline{28.98}$$

Total Income = Selling price  $\times$  Quantity of product manufactured

$$= (28.98/\text{m}^3) \times (1 \times 10^6 \text{m}^3/\text{day}) \times (300 \text{ days}/\text{year})$$

$$\text{Total Income} = \text{Rs. } \underline{8.694 \times 10^9}$$

Gross income = Total Income – Total Product Cost

$$= (8.694 \times 10^9) - (5.71 \times 10^9)$$

$$\text{Gross Income} = \text{Rs. } \underline{2.984 \times 10^9}$$

Let the Tax rate be 45% (common)

Taxes = 45% of Gross income

$$= 45\% \text{ of } 2.984 \times 10^9 = 0.45 \times 2.984 \times 10^9$$

$$\text{Taxes} = \text{Rs. } \underline{1.3428 \times 10^9}$$

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

$$\text{Net profit} = (2.984 \times 10^9) - (1.3428 \times 10^9) = \text{Rs. } \underline{1.6412 \times 10^9}$$

**Rate of Return:**

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

$$\text{Rate of Return} = 1.6412 \times 10^9 \times 100 / (5.18 \times 10^9)$$

$$\text{Rate of Return} = \underline{31.68\%}$$