

: COST ESTIMATION:

Acceptable plant design must present a process that is capable of operating under conditions, which will yield profit. Since net profit equals total value minus all expenses, it is essential that the chemical engineer be aware of the many different types of cost involved in the manufacturing processes. Capital must allocate for the direct, plant expenses, such as those for raw material, labor and equipment.

Besides direct expenses many others indirect expenses are incurred, and these must be included if a complete analysis of the total cost is to be obtained. Some examples of these indirect expenses are administrative salary, product distribution cost and cost for interplant communication. A capital investment is required for every industrial process and determination of necessary investment is an important part of a plant design process. The total investment for any process consist fixed capital investment for practical equipment and facilities in the plant plus working capital, which must be available to pay salaries, keep raw material and products on hand, and handle other special items requiring the direct cost outline.

When the cost for any type of commercial process is to be determined, sufficient accuracy has to be provided for reliable decision. There are many factors affecting investment and production cost. These are;

1. source of equipment
2. price fluctuation
3. company policies
4. operating and rate of production
5. governmental policies

Before an industrial plant can be put into operation, a large sum of money must be supplied to purchase and install the necessary machinery and equipment. Land and service facilities must be obtained, and the plant must be erected completely with all piping, controls and services.

The capital needed to supply the necessary manufacturing and plant facilities is called the fixed-capital investment, while that necessary for the operation of plant is termed the working capital. The sum of the fixed capital investment and the working is known as the total capital investment. Generally, the working capital amounts 10-20% of the total capital investment. Following is the breakdown of the fixed capital investment for a chemical process.

DIRECT COST:

1. purchased equipments
2. purchased equipment installation
3. instrumentation and control
4. piping
5. electrical equipment and material
6. building (including services)
7. yard improvement
8. land

INDIRECT COST:

1. engineering supervision
2. construction expenses
3. contractor's fee
4. contingency

TYPES OF CAPITAL COST ESTIMATE:

- Order of magnitude estimate (ratio estimate) based on similar cost data; probable accuracy of this estimate over $\pm 30\%$.
- Study estimate based on knowledge of major items of equipment, probable accuracy of this estimate up to $\pm 30\%$.

- Preliminary estimate(budget authorization estimate scope method): based on sufficient data to permit the estimate to the budget, probable accuracy of this estimate is within $\pm 20\%$.
- Detailed estimate based on complete engineering drawing, specifications and site survey, probable accuracy of this estimate within $\pm 10\%$.

ESTIMATION OF PRESENT PLANT COST

From Dryden, OUTLINES OF CHEMICAL TECHNOLOGY(2ND EDITION)

Appendix: pg; 637

The cost of a 300 TPD styrene plant in 1962 was Rs. 10^9

Again, the Chemical Engineering Plant cost index corresponding to 1962 = 130.

The CE index of 2002 is 402.

Therefore, the present plant cost can be given as

$$\text{Rs.}10^9 \times (402/130) = \text{Rs. } 3.0923 \times 10^9$$

DETAILED COST ANALYSIS

A Direct Costs :

Purchased cost + Installation cost + Instrumentation and controls installation + piping +Electrical installation + building process and auxiliary + service facilities + yard improvement + land.

(1) Purchased equipment cost (15 – 40 % of Fixed Capital Investment).

$$\begin{aligned} \text{Assume 30\% of Fixed Capital Investment} &= 0.30 * 3.0923 * 10^9 \\ &= \text{Rs. } 92.769 * 10^7 \end{aligned}$$

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

$$\text{Considering 40\% of Purchased Cost} = 0.40 * 92.769 * 10^6 = \text{Rs. } 37.1076 * 10^7$$

(3) Instrumentation and controls cost (6-30% of Purchased Cost)

$$\text{Considering 13\% of Purchased Cost} = 0.13 * 92.769 * 10^7 = \text{Rs. } 12.06 * 10^7$$

(4) Piping installation cost (10-80% of Purchased Cost)

$$\text{Assume 45\% of Purchased Cost} = 0.45 * 92.769 * 10^7 = \text{Rs. } 41.705 * 10^7$$

(5) Electrical costs (10-40% of Purchased Cost)

$$\text{Assume 15\% of Purchased Cost} = 0.15 * 92.769 * 10^7 = \text{Rs. } 13.90 * 10^7$$

(6) Building, process and auxiliary (10-70% of Purchased Cost)

$$\text{Assume 40\% of Purchased Cost} = 0.40 * 92.769 * 10^7 = \text{Rs. } 37.0716 * 10^7$$

(7) Service facilities (30-80 % of Purchased Cost)

$$\text{Assume 50\% of Purchased Cost} = 0.50 * 92.769 * 10^7 = \text{Rs. } 46.3395 * 10^7$$

(8) Yard improvement (10-15% of the Purchased Cost)

$$\text{Considering 12\% of the Purchased Cost} = 0.12 * 92.769 * 10^7 = \text{Rs. } 11.12 * 10^7$$

(8) Land (4-8% of Purchased Cost)

$$\text{Assume 6\% of Purchased Cost} = 0.06 * 92.769 * 10^7 = \text{Rs. } 5.56 * 10^7$$

Direct costs = Rs. $2.975 * 10^9$

B Indirect costs

Engineering supervision + .Construction expenses + Contractor fee + Contingency plan

1. Engineering and supervision (5-30% of Direct Cost)

$$\text{Assume 15\% of Direct Cost} = 0.15 * 2.975 * 10^9 = \text{Rs. } 44.625 * 10^7$$

2. Construction expenses and contractors feed(6-30% of Direct Cost)

$$\text{Assume 10\% of Direct Cost} = 0.10 * 2.975 * 10^9 = \text{Rs. } 29.75 * 10^7$$

3. Contractor fee (2-7% of the Direct Cost)

$$\text{Assume 4\% of the Direct Cost} = 0.04 * 2.975 * 10^9 = \text{Rs. } 11.899 * 10^7$$

4. Contingency costs (5- 15% of Present Cost)

$$\text{Assume 12\% of Present Cost} = 0.12 * 2.975 * 10^9 = \text{Rs. } 35.70 * 10^7$$

Indirect costs = Rs. $1.21974 * 10^9$

C. Fixed Capital Investments

$$= \text{Direct} + \text{Indirect costs}$$

$$= \text{Rs. } 4.195 * 10^9$$

D. Working Capital (10-20% of Fixed Capital Investment)

$$\begin{aligned} \text{Assume 15\% of Fixed Capital Investment} &= 0.15 * 4.195 * 10^9 \\ &= \text{Rs. } 62.921 * 10^7 \end{aligned}$$

. Total Capital Investment

$$= \text{Total Fixed Capital} + \text{Working Capital Investment.}$$

$$= \text{Rs. } 4.8242 * 10^9$$

ESTIMATION OF MANUFACTURING COST

I. Fixed Cost:

1. Depreciation

10% of Fixed Capital Investment for machinery and 3% of building value for building = Rs $43.8036 * 10^7$

2. Local taxes (3-4% of Fixed Capital Investment)

Assumed value, 4% of Fixed Capital Investment = Rs. $16.78 * 10^7$

3. Insurances (0.4 – 1 % of Fixed Capital Investment)

Assumed value, 0.6% of Fixed Capital Investment = Rs. 2.517×10^7

4. Rent (8-12% of the rented land and buildings)

Assumed value, 10% of building value = Rs. 41.95×10^7

Fixed Charges = 18% of Product Cost = Rs. 1.0505×10^9

Total Product Cost = Rs. 5.836×10^9

II Direct Production

(1) Raw materials (10-50% of Total Product Cost)

Assumed value, 30% of Total Product Cost = $0.3 \times 5.836 \times 10^9 = \text{Rs. } 1.7508 \times 10^9$

(2) Operating labour(10-20% of Total Product Cost)

Assumed value, 15% of Total Product Cost = $0.15 \times 5.836 \times 10^9 = \text{Rs. } 87.54 \times 10^7$

(3) Direct supervisory and electrical labour(10-25% of Operating labour)

Assumed value, 12% of Operating labour = $0.12 \times 87.54 \times 10^7 = \text{Rs. } 10.505 \times 10^7$

(4) Utilities (10-20% of Total Product Cost)

Assumed value, 13% of Total Product Cost = $0.13 \times 5.836 \times 10^9 = \text{Rs. } 75.87 \times 10^7$

(5) Maintenance and repairs (2-10% of Fixed Capital Investment)

Assumed value, 8% of Fixed Capital Investment = Rs. 33.56×10^7

(6) Operating supplies (10-20% of cost of maintenance and repair)

Assumed value, 15% = $0.15 \times 33.56 \times 10^7 = \text{Rs. } 5.034 \times 10^7$

(7) Laboratory charges (0-20% of operating labour)

Assumed value, 15% of Operating labour = Rs. 13.131×10^7

(8) Patents and royalties (2-6% of Total Product Cost)

Assumed value, 5% of Total Product Cost = Rs. 29.18×10^7

Direct Production cost = Sum of (1), (2), (3), (4), (5), (6), (7) and (8)
= Rs. 2.5657×10^9

III Plant overhead costs

(50-70% of Operating labour + Direct supervisory + Maintenance Cost)

Considering 60% , Overhead Plant Cost = Rs. 4.4058×10^9

∴, Total Manufacturing Cost = I + II + III
= Rs. 4.4058×10^9

2. **General Expenses** (includes administration expenses, distribution prices and also R&D costs)

A Administration Cost (40-60% of the Operating Labour Cost)

Assuming 50% , the Administration Cost = Rs. 43.77×10^7

B Distribution Cost (2-20% of Total product Cost)

Assuming 10% of the Product Cost, cost estimated as = Rs. 58.36×10^7

C Research & development cost:

Assuming 3% of the Production Cost = Rs. 17.508

∴, General expenses = A + B + C = Rs. 1.1964×10^9

3. **Total product cost**

= Manufacturing cost + general expenses
= Rs. 5.6022×10^9

4. **Current selling price**

Cost of Styrene = Rs. 80 / kg

Total selling price per annum = Rs. $(300 \times 10^3) \times 300 \times 80$

$$= \text{Rs. } 7.2 \times 10^9 \text{ /annum.}$$

5. Gross earnings

$$= \text{Total selling price} - \text{Total product cost}$$

$$= \text{Rs. } 1.5978 \times 10^9 \text{ /annum}$$

6. Tax

Assume the the local tax rate 40%,

$$\text{Tax on the gross earning} = 0.4 * 1.5978 * 10^9$$

$$= \text{Rs. } 639.12 * 10^6$$

7. Net profits

$$= \text{Gross earnings} - \text{tax} = \text{Rs. } 958.68 * 10^6$$

Rate of return

$$= (\text{Net profit/ fixed capital investment}) = 19.87\%$$

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