Chapter 8

COST ESTIMATION AND ECONOMICS

Calculation of fixed capital cost:

The Chemical Engineering Plant cost Index (CEPI):

In 1969 = 119.0

In 2002 = 402.0

Let us assume that the plant is running for 325 days a year.

From literature, the capital cost for the proposed plant should range between $124 and $253 per annual ton.

Lets take value of 1$ = Rs 50.

Lets take capital cost = $200 per annual ton.

= Rs 10000 per annual ton.

Total tones of polystyrene produced every year = 325 * 250

= 81250tones/year.

Therefore the capital cost for proposed plant in 1969 is = 81250*10000

$= Rs.8.125*10^8$

The fixed capital cost for the proposed plant in 2002 $= 8.125*10^8*\frac{402}{119}$

$= Rs\ 274.47*10^7$

= Rs 274.47crores.

Estimation of Capital Investment Cost:

I. **Direct Costs:** material and labour involved in actual installation of complete facility (70-90% 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

   i.e., PEC = 30% of $274.47\times10^7 = 0.30 \times 274.47\times10^7 = Rs.\ 82.341\times10^7$

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

Consider the Installation cost = 35% of Purchased equipment cost

$= 35\% \text{ of } 82.341\times10^7$

$= 0.35 \times 82.341\times10^7$

$= \text{Rs.}28.819\times10^7$

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

Consider the installation cost = 15% of Purchased equipment cost

$= 15\% \text{ of } \times 82.341\times10^7$

$= 0.15 \times 82.341\times10^7$

$= \text{Rs.}12.35\text{x}10^7$

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

Consider the piping cost = 35% Purchased equipment cost

= 35% of Purchased equipment cost

$= 0.35 \times 82.341\times10^7$

$= \text{Rs. } 28.81\text{x}10^7$

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

Consider Electrical cost = 25% of Purchased equipment cost

$= 25\% \text{ of } 82.341\times10^7$

$= 0.25 \times 82.341\times10^7$

$= \text{Rs.}20.585\text{x}10^7$

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

Consider Buildings, process and auxiliary cost

= 30% of PEC

$= 30\% \text{ of } 82.341\times10^7$

$= 0.30 \times 82.341 \times 10^7$

$= Rs.24.7x10^7$

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

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

$= 50\%$ of 82.341×10^7

$= 0.50 \times 82.341 \times 10^7$

$= Rs\ 41.17x10^7$

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

Consider the cost of land $= 6\%$ PEC

$= 6\%$ of 82.341×10^7

$= 0.06 \times 82.341 \times 10^7$

$= Rs.\ 4.94x10^7$

Thus, Direct cost = $Rs.243.67x10^7$ ----- (88.9% of FCI)

6. **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 243.67×10^7

$= 0.1 \times 243.67 \times 10^7 = Rs\ 24.367\ x10^7$

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 $243.67x10^7$

$= 0.1 \times 243.67 \times 10^7 = Rs\ 24.367\ x10^7$

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

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

i.e., Contingency cost = 10% of $243.67 \times 10^7 = Rs.24.367x10^7$

Thus, Indirect Costs = Rs. 73.101×10^7 --- (26.63% of FCI)

7. Fixed Capital Investment:

Fixed capital investment = Direct costs + Indirect costs

$= (243.67 \times 10^7) + (73.101 \times 10^7)$

i.e., Fixed capital investment = Rs. 316.771×10^7

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

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

i.e., Working capital = 15% of 316.771×10^7

$= 0.15 \times 316.771 \times 10^7$

$=$ Rs. 47.516×10^7

V. Total Capital Investment (TCI):

Total capital investment = Fixed capital investment + Working capital

$= (316.771 \times 10^7) + (47.516 \times 10^7)$

i.e., Total capital investment = Rs. 364.29×10^7.

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 = 12%of FCI for machinery and equipment and 4%for Building Value for Buildings)

i.e., Depreciation = $(0.12 \times 82.341 \times 10^7) + (0.04 \times 24.7 \times 10^7)$

$=$ Rs. 10.8689×10^7

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

Consider the local taxes = 3% of fixed capital investment

i.e. Local Taxes = $0.03 \times 316.771 \times 10^7$ = Rs. 9.503×10^7

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

Consider the Insurance = 0.6% of fixed capital investment

i.e. Insurance = $0.006 \times 316.771 \times 10^7$ = Rs. 1.901×10^7

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

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

= 10% of $((24.7 \times 10^7) + (4.94 \times 10^7))$

= $0.10 \times ((24.7 \times 10^7) + (4.94 \times 10^7))$

Rent = Rs. 2.964×10^7

Thus, Fixed Charges = Rs. 25.23×10^7

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

- ⇨ Total product charge = fixed charges/15%
- ⇨ Total product charge = $25.23 \times 10^7/15\%$
- ⇨ Total product charge = $25.23 \times 10^7/0.15$
- ⇨ Total product charge(TPC) = Rs. 168.25×10^7

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

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

- ⇨ Raw material cost = 25% of $168.25 \times 10^7 = 0.25 \times 168.25 \times 10^7$
- ⇨ Raw material cost = Rs. 42.06×10^7

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

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

- ⇨ operating labour cost = 15% of $168.25 \times 10^7 = 0.15 \times 168.25 \times 10^7$
- ⇨ Operating labour cost = Rs. 25.2375×10^7

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

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

⇨ Direct supervisory and clerical labour cost = 12% of 25.2375×10^7

⇨ $= 0.12 \times 25.2375 \times 10^7$

Direct supervisory and clerical labour cost = Rs. 3.0285×10^7

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

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

⇨ Utilities cost= 12% of $168.25 \times 10^7 = 0.12 \times 168.25 \times 10^7$

⇨ Utilities cost = Rs. 20.19×10^7

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

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

i.e. Maintenance and repair cost = $0.05 \times 316.771 \times 10^7 =$ Rs. 15.8386×10^7

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

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

Operating supplies cost = 15% of $15.8386 \times 10^7 = 0.15 \times 15.8386 \times 10^7$

Operating supplies cost = Rs. 2.376×10^7

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

Consider the Laboratory charges = 15% of OL

⇨ Laboratory charges = 15% of 25.2375×10^7

$= 0.15 \times 25.2375 \times 10^7$

Laboratory charges = Rs. 3.7856×10^7

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

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

⇨ Patent and Royalties = 4% of 168.25×10^7

⇨ $= 0.04 \times 168.25 \times 10^7$

Patent and Royalties cost = Rs 6.73×10^7

Thus, Direct Production Cost = Rs. 119.246×10^7 ----- (70% 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 $((25.2375 \times 10^7) + (3.0285 \times 10^7) + (15.8386 \times 10^7))$

Plant overhead cost = $0.60 \times ((25.2375 \times 10^7) + (3.0285 \times 10^7) + (15.8386 \times 10^7))$

Plant overhead cost = Rs. 26.463×10^7

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

Manufacture cost = $(119.246 \times 10^7) + (25.23 \times 10^7) + (26.463 \times 10^7)$

Manufacture cost = Rs. 170.939×10^7

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

- ⇨ Administrative costs = $0.05 \times 168.25 \times 10^7$
- ⇨ Administrative costs = Rs. 8.4125×10^7

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 = 15% of total product cost

- ⇨ Distribution and selling costs = 15% of 168.25×10^7
- ⇨ Distribution and selling costs = $0.15 \times 168.25 \times 10^7$
- ⇨ Distribution and Selling costs = Rs. 25.2375×10^7

B. 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 $168.25x10^7$

⇨ Research and development costs = $0.05 \times 168.25x10^7$

⇨ Research and Development costs = Rs. $8.4125x10^7$

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

Consider interest = 5% of total capital investment

i.e. interest = 5% of $364.29x10^7$.

$= 0.05 \times 364.29x10^7$.

Interest = Rs. $18.2145x10^7$

Thus, General Expenses = Rs. $60.277x10^7$

IV. Total Product cost = Manufacture cost + General Expenses

$= (170.939x10^7) + (60.277x10^7)$

Total product cost = Rs. $231.216x10^7$

V. Gross Earnings/Income:

Wholesale Selling Price of Polystyrene per ton = $ 800 (USD)

Let 1 USD = Rs. 50.00

Hence Wholesale Selling Price of Polystyrene per ton. = 800 ×50 = Rs 40000

Total Income = Selling price × Quantity of product manufactured

= 40000 × (250 T/day) × (325days/year)

Total Income = Rs.$3.25x10^9$

Gross income = Total Income – Total Product Cost

$= (3.25x10^9) – (231.216x10^7)$

Gross Income = Rs. 937.84×10^6

Let the Tax rate be 45% (common)

Taxes = 40% of Gross income

= 40% of 937.84×10^6 = $0.40\times937.84\times10^6$

Taxes = Rs. 375.136×10^6

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

Net profit = $(937.84\times10^6) – (375.136 \times10^6)$ = Rs. 562.704×10^6

Rate of Return:

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

Rate of Return = $562.704\times10^6\times100/ (364.29\times10^7)$

Rate of Return = 15.44%

Break-even Analysis:

Data available:

Annual Direct Production Cost = Rs.119.246×10^7

Annual Fixed charges, overhead and general expenses = Rs. 1.1197×10^9

Total Annual sales = Rs. 3.25×10^9

Wholesale Selling Price of polystyrene per ton. = Rs. 40000

Direct production cost per ton of polystyrene = $(119.246\times10^7)/ (3.25 \times 10^9/40000)$

= Rs. 14676.43 per ton

Let ‘n’ TPA be the break even production rate.

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

$(1.1197\times10^9) + (14676.43 \times n) = (40000\times n)$

=> n = 44215.72 tons/year

n = 136 tons/day = 136 TPD

Hence, the break-even production rate is 136 TPD or 54.42% of the considered plant capacity.