

COST ESTIMATION AND ECONOMICS

Given in the literature is the cost versus size Nomograph, from which the cost of cane sugar plant within the crushing capacity between 500 – 5000 TPD can be calculated.

The cost for 5000 TPD crushing capacity plant with Chemical Engineering Plant Cost Index (CE) =130 (Basis = 1957 -59; CE = 100) is as follows:

$$\text{Cost for 5000 TPD crushing capacity} = \text{Rs. } 10.25 \times 10^7 \text{ /-}$$

To find present cost:

A cost index is merely an index value for a given point in time showing the cost at that time relative to a certain base time. If the cost at some time in past is known, the equivalent cost at the present time can be determined by multiplying the original cost by the ratio of the present index value to the index value applicable when the original cost was obtained.

Obtained from the Internet that Chemical Engineering Plant Cost Index is given as:

Cost index in 2002 = 402

Original cost value is obtained when cost index was 130.

Thus,

$$\begin{aligned} \text{Present cost of Plant} &= (\text{original cost}) \times \{(\text{present cost index})/(\text{past cost index})\} \\ &= (10,25,00,000 \text{ /-}) \times (402/130) = \text{Rs. } 31.70 \times 10^7 \text{ /-} \end{aligned}$$

$$\text{Fixed Capital Investment (FCI)} = \text{Rs. } 31.70 \times 10^7 \text{ /-}$$

Generally fixed capital investment cost is 85% of total capital investment.

$$\text{Therefore Total Capital Investment} = (\text{FCI})/0.85 = 37.29 \times 10^7 \text{ Rs.}$$

Estimation of Total Capital Investment Cost:

(I) Direct Costs:

(A) 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)

a. Purchased equipment cost (PEC):

$$\text{RANGE} = 15-40\% \text{ of Fixed-capital investment}$$

$$\text{Let Purchased Equipment Cost} = 30\% \text{ of Fixed-capital investment}$$

$$\text{PEC} = 30\% \text{ of Rs. } 31.70 \times 10^7 \text{ /-}$$

$$= \text{Rs. } 9.51 \times 10^7 \text{ /-}$$

b. Installation, including insulation and painting:

$$\text{RANGE} = 25-55\% \text{ of purchased equipment cost.}$$

Let Installation Cost = 35% of Purchased equipment cost
= 35% of Rs. 9.51×10^7 /-
= Rs. 3.33×10^7 /-

c. Instrumentation and controls, installed:

RANGE = 6-30% of Purchased equipment cost.
Let Instrumentation Cost = 10% of Purchased equipment cost
= 10% of Rs. 9.51×10^7 /-
= Rs. 0.951×10^7 /-

d. Piping Installed:

RANGE = 10-80% of Purchased equipment cost
Let Piping Cost = 40% of Purchased equipment cost
= 40% of Rs. 9.51×10^7 /-
= Rs. 3.804×10^7 /-

e. Electrical, installed:

RANGE = 10-40% of Purchased equipment cost
Let Electrical cost = 25% of Purchased equipment cost
= 25% of Rs. 9.51×10^7 /-
= Rs. 2.3775×10^7 /-

Therefore Total cost for (A) = Rs. 19.9725×10^7 /-

(B) Buildings, process and Auxiliary:

RANGE = 10-70% of Purchased equipment cost
Let Buildings, process and auxiliary cost = 30% of PEC
= 30% of Rs. 9.51×10^7 /-
= Rs. 2.853×10^7 /-

(C) Service facilities and yard improvements:

RANGE = 40-100% of Purchased equipment cost
Let Facilities and yard improvement cost = 50% of PEC
= 50% of Rs. 9.51×10^7 /-
= Rs. 4.755×10^7 /-

(D) Land:

RANGE = 4-8% of Purchased equipment cost
Let the cost of land = 6% of PEC
= 6% of Rs. 9.51×10^7 /-
= Rs. 0.5706×10^7 /-

Therefore Total Direct Cost = 28.1511×10^7 /-

(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:

RANGE = 5-30% of Direct costs
Let the cost of engineering and supervision = 10% of Direct costs
= 10% of Rs. 28.1511×10^7 /-
= Rs. 2.815×10^7 /-

(B) Construction Expense and Contractor's fee:

RANGE = 6-30% of Direct costs
Let construction expense & contractor's fee = 15% of Direct costs
= 15% of Rs. 28.1511×10^7 /-
= Rs. 4.223×10^7 /-

(C) Contingency:

RANGE = 5-15% of Fixed-capital investment
Let the contingency cost = 8% of Fixed-capital investment
= 8% of 31.70×10^7 /-
= Rs. 2.536×10^7 /-

Thus, Total Indirect Costs = Rs. 9.574×10^7 /-

(III) Fixed Capital Investment:

Fixed capital investment = Direct costs + Indirect costs
= Rs 37.7251×10^7 /-

(IV) Working Capital:

RANGE = (10-20% of Total-capital investment)
Let the Working Capital = 15% of Total-capital investment
= 15% of 37.29×10^7 /-
= $0.15 \times 37.29 \times 10^7$ /-
= Rs. 5.5935×10^7 /-

(V) Total Capital Investment (TCI):

Total capital investment = Fixed capital investment + Working capital
= 43.3186×10^7 /-

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 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 2.5% for Building Value for Buildings)

$$\begin{aligned} \text{i.e. Depreciation} &= (0.10 \times 37.7251 \times 10^7) + (0.025 \times 2.853 \times 10^7) \\ &= \text{Rs. } 3.8443 \times 10^7 \text{ /-} \end{aligned}$$

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

Consider the local taxes = 2% of fixed capital investment

$$\text{i.e. Local Taxes} = 0.02 \times 37.7251 \times 10^7 = \text{Rs. } 0.7545 \times 10^7 \text{ /-}$$

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

Consider the Insurance = 0.6% of fixed capital investment

$$\text{i.e. Insurance} = \text{Rs. } 0.2264 \times 10^7 \text{ /-}$$

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

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

$$= \text{Rs. } 0.2853 \times 10^7 \text{ /-}$$

Thus, Total Fixed Charges = Rs. 5.1105×10^7 /-

(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 cost = Total fixed charges/0.15

$$\text{Total product cost} = 5.1105 \times 10^7 / 0.15$$

$$\text{Total product cost (TPC)} = \text{Rs. } 34.07 \times 10^7 \text{ /-}$$

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

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

$$\text{Raw material cost} = 25\% \text{ of } 34.07 \times 10^7 = \text{Rs. } 8.5175 \times 10^7 \text{ /-}$$

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

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

$$\begin{aligned} \text{Operating labour cost} &= 12\% \text{ of } 34.07 \times 10^7 = 0.12 \times 34.07 \times 10^7 \\ &= \text{Rs. } 4.0884 \times 10^7 \text{ /-} \end{aligned}$$

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

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

$$\begin{aligned} \text{Direct supervisory and clerical labour cost} &= 12\% \text{ of } 4.0884 \times 10^7 \text{ /-} \\ &= 0.12 \times 4.0884 \times 10^7 \text{ /-} \end{aligned}$$

$$\text{Direct supervisory and clerical labour cost} = \text{Rs. } 0.4906 \times 10^7 \text{ /-}$$

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

Consider the cost of Utilities = 12% of total product cost
Utilities cost = 12% of $34.07 \times 10^7 = 0.12 \times 34.07 \times 10^7$ /-
= Rs. 4.0884×10^7 /-

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 = $0.05 \times 37.7251 \times 10^7 = \text{Rs. } 1.8863 \times 10^7$ /-

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 $1.8863 \times 10^7 = 0.15 \times 1.8863 \times 10^7$ /-
= Rs. 0.2829×10^7 /-

vii. Laboratory Charges: (10-20% of OL)
Consider the Laboratory charges = 14% of OL
Laboratory charges = 14% of $4.0884 \times 10^7 = 0.5724 \times 10^7$ /-

viii. Patent and Royalties: (0-6% of total product cost)
Consider the cost of Patent and royalties = 2% of total product cost
Patent and Royalties = 2% of $34.07 \times 10^7 = 0.6814 \times 10^7$ /-

Thus, Direct Production Cost = Rs. 20.6079×10^7 /-

(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 = 10% of Total Product Cost
Plant overhead cost = 10% of 34.07×10^7 /-
= Rs. 3.407×10^7 /-

Thus, Manufacturing cost = Direct production cost + Fixed charges + Plant overhead costs
Manufacture cost = $(20.6079 \times 10^7) + (5.1105 \times 10^7) + (3.407 \times 10^7)$
Manufacture cost = Rs. 29.1254×10^7 /-

(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
Administrative costs = $0.05 \times 34.07 \times 10^7$
Administrative costs = Rs. 1.7035×10^7 /-

(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

$$\begin{aligned}\text{Distribution and selling costs} &= 15\% \text{ of } 34.07 \times 10^7 \text{ /-} \\ &= 0.15 \times 34.07 \times 10^7 \\ &= \text{Rs. } 5.1105 \times 10^7 \text{ /-}\end{aligned}$$

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

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

$$\begin{aligned}\text{Research and Development costs} &= 5\% \text{ of } 34.07 \times 10^7 \text{ /-} \\ &= 0.05 \times 34.07 \times 10^7 \\ &= \text{Rs. } 1.7035 \times 10^7 \text{ /-}\end{aligned}$$

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

Consider interest = 5% of total capital investment

$$\begin{aligned}\text{i.e. interest} &= 5\% \text{ of } 43.3186 \times 10^7 = 0.05 \times 43.3186 \times 10^7 \\ &= \text{Rs. } 2.1660 \times 10^7 \text{ /-}\end{aligned}$$

Thus, General Expenses = Rs. 10.6835×10^7 /-

(III) Total Product cost = Manufacture cost + General Expenses

$$= (29.1254 \times 10^7) + (10.6835 \times 10^7)$$

Therefore Total product cost = Rs. 39.8089×10^7 /-

Gross Earnings/Income:

Wholesale Selling Price of cane sugar per T = Rs. 8000 /-

As we know sugar factory operates only 120 - 200 days in a year and the production of cane sugar per hour is 26.4818 T per hour (from material balance). The working hours per day are 20.

Assuming factory operates only 150 days in a year.

Total Income = Selling price per T \times Quantity of product manufactured (T/year)

$$= 8000 \times (26.4818 \times 20) \text{ T/day} \times 150 \text{ days/year}$$

Total Income = Rs. 63.56×10^7 /-

Gross income = Total Income – Total Product Cost

$$= (63.56 \times 10^7) - (39.8089 \times 10^7)$$

Gross Income = Rs. 23.75×10^7 /-

Let the Tax rate be 40%.

Taxes = 40% of Gross income

$$= 40\% \text{ of } 23.75 \times 10^7 = 0.40 \times 23.75 \times 10^7$$

Taxes = Rs. 9.50×10^7 /-

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

$$\text{Net profit} = (23.75 \times 10^7) \times (1 - 0.40) = \text{Rs. } 14.25 \times 10^7 \text{ /-}$$

Rate of Return:

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

Rate of Return = $(14.25 \times 10^7 \times 100) / (43.3186 \times 10^7)$

Rate of Return = 32.89%

Payout period = (FCI)/(Net profit + Depreciation)

= $(37.7251 \times 10^7) / (14.25 \times 10^7 + 3.8443 \times 10^7)$

= 2 years