COST ESTIMATION AND ECONOMIC ANALYSIS

A preliminary economic analysis is performed for the overall plan. Due to lack of recent data, different cost estimates are done based on cost indices and capacity. However, the present analysis will give a fair idea about the profitability of the plant.

Now we have,

Cost of Isoamyl Alcohol plant of capacity **100 TPD** in 1971 is Rs.$\mathbf{1\times10^8}$.

Chemical Engineering Plant Cost Index:

Year	Cost Index
1971	132.0
2002	401.8 ≈ 402

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

$= (1\times10^8) \times (402/132) =$ Rs. 3.0455×10^8

i.e., Fixed Capital Cost (FCI) = Rs. 3.0455×10^8

8.1 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 $3.0455\times10^8 = 0.25 \times 3.0455\times10^8$ = Rs. 0.7614×10^8
2. **Installation, including insulation and painting:** (25-55% of purchased equipment cost.)
   Consider the Installation cost = 30% of Purchased equipment cost
   = 30% of $0.7614\times10^8 = 0.30 \times 0.7614\times10^8$ = Rs.0.2284×10^8

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

Consider the installation cost = 20% of Purchased equipment cost

= 20% of 0.7614×10^8 = $0.20 \times 0.7614\times10^8$ = Rs. $\underline{0.1523\times10^8}$

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

Consider the piping cost = 40% Purchased equipment cost

= 40% of Purchased equipment cost = $0.40 \times 0.7614\times10^8$

= Rs. $\underline{0.3046\times10^8}$

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

Consider Electrical cost = 25% of Purchased equipment cost

= 25% of 0.7614×10^8 = $0.25 \times 0.7614\times10^8$ = Rs. $\underline{0.1904\times10^8}$

Hence, cost =Rs. $\underline{1.6371\times10^8}$ --- (53.76% of FCI)

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

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

= 40% of 0.7614×10^8 = $0.40 \times 0.7614\times10^8$ = Rs. $\underline{0.3046\times10^8}$

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% of 0.7614×10^8 = $0.70 \times 0.7614\times10^8$ = Rs. $\underline{0.5330\times10^8}$

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

Consider the cost of land = 6% PEC = 6% of 0.7614×10^8 = $0.06 \times 0.7614\times10^8$

= Rs. $\underline{0.0457\times10^8}$

Or Consider the cost of land = 1.5% of FCI = 1.5% of 3.0455×10^8

= Rs. $\underline{0.0457\times10^8}$

Thus, Direct cost = Rs. $\underline{2.5204\times10^8}$ ----- (82.76% 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 2.5204×10^8

$= 0.1\times2.5204\times10^8$ = Rs. $\underline{0.252\times10^8}$

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 2.5204×10^8

$= 0.1\times2.5204\times10^8$ = Rs. $\underline{0.252\times10^8}$

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

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

i.e., Contingency cost = 10% of $3.0455\times10^8 = 0.10 \times 3.0455\times10^8$

= Rs. $\underline{0.3046\times10^8}$

Thus, Indirect Costs = Rs. $\underline{0.8086\times10^8}$ --- (26.55% of FCI)

III. Fixed Capital Investment:

Fixed capital investment = Direct costs + Indirect costs

$= (2.5204\times10^8) + (0.8086\times10^8)$

i.e., Fixed capital investment = Rs. $\underline{3.3290\times10^8}$

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

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

i.e., Working capital = 15% of $3.3290\times10^8 = 0.15 \times 3.3290\times10^8$

= Rs. $\underline{0.4994\times10^8}$

V. Total Capital Investment (TCI):

Total capital investment = Fixed capital investment + Working capital

$= (3.3290\times10^8) + (0.4992\times10^8)$

i.e., Total capital investment = Rs. $\underline{3.8284\times10^8}$

8.2 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)

i.e., Depreciation = $(0.10\times3.3290\times10^8) + (0.03\times0.3046\times10^8)$

= Rs. $\underline{0.4328\times10^8}$

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

Consider the local taxes = 3% of fixed capital investment

i.e. Local Taxes = $0.03\times3.3290\times10^8$ = Rs. $\underline{0.0999\times10^8}$

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

Consider the Insurance = 0.75% of fixed capital investment

i.e. Insurance = $0.0075\times3.3290\times10^8$ = Rs. $\underline{0.025\times10^8}$

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

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

= 10% of $((0.3046\times10^8) + (0.0457\times10^8))$

= $0.10\times ((0.3046\times10^8) + (0.0457\times10^8))$

Rent = Rs. $\underline{0.035x10^8}$

Thus, Fixed Charges = Rs. $\underline{0.5927\times10^8}$

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

⇨ Total product charge = fixed charges/15%

⇨ Total product charge = $0.5927\times10^8/15\%$

⇨ Total product charge = $0.5927\times10^8/0.15$

⇨ Total product charge(TPC) = Rs. $\underline{3.9513\times10^8}$

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 $3.9513\times10^8 = 0.25\times3.9513\times10^8$

⇨ Raw material cost = Rs. $\underline{0.9878\times10^8}$

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

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

⇨ operating labour cost = 12% of $3.9513\times10^8 = 0.12\times3.9513\times10^8$

⇨ Operating labour cost = Rs. $\underline{0.4742\times10^8}$

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 0.4742×10^8

$= 0.12\times0.4742\times10^8$

⇨ Direct supervisory and clerical labour cost = Rs. $\underline{0.0569\times10^8}$

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

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

⇨ Utilities cost= 12% of $3.9513\times10^8 = 0.12\times3.9513\times10^8$

⇨ Utilities cost = Rs. $\underline{0.4742\times10^8}$

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

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

i.e. Maintenance and repair cost = $0.06\times3.3290\times10^8$ = Rs. $\underline{0.1997\times10^8}$

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 $0.1997\times10^8 = 0.15\times0.1997\times10^8$

Operating supplies cost = Rs. $\underline{0.03\times10^8}$

Or

Consider the cost of Operating supplies = 0.9% of FCI

Operating supplies cost = 0.9% of 3.3290×10^8 = 0.009 $\times3.3290\times10^8$

Operating supplies cost = Rs. $\underline{0.03\times10^8}$

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

Consider the Laboratory charges = 15% of OL

Laboratory charges = 15% of 0.4742×10^8= $0.15\times0.4742\times10^8$

⇨ Laboratory charges = Rs. $\underline{0.0711\times10^8}$

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

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

⇨ Patent and Royalties = 3% of 3.9513×10^8 = $0.03\times3.9513\times10^8$

⇨ Patent and Royalties cost = Rs. $\underline{0.1185\times10^8}$

Thus, Direct Production Cost = Rs. $\underline{2.4124\times10^8}$ ----- (60.05% 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 $((0.4742\times10^8) + (0.0569\times10^8) + (0.1997\times10^8))$

Plant overhead cost = 60% × $((0.4742\times10^8) + (0.0569\times10^8) + (0.1997\times10^8))$

Plant overhead cost = 0.60 × $((0.4742\times10^8) + (0.0569\times10^8) + (0.1997\times10^8))$

Plant overhead cost = Rs. $\underline{0.4385\times10^8}$

Or

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

Cost of Plant overhead = 11% of 3.9513×10^8

⇨ Plant overhead costs = 0.11 × 3.9513×10^8

⇨ Plant overhead costs = Rs. $\underline{0.4385\times10^8}$

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

Manufacture cost = $(2.4124\times10^8) + (0.5927\times10^8) + (0.4385\times10^8)$

Manufacture cost = Rs. $\underline{3.4436\times10^8}$

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 $((0.4742\times10^8) + (0.0569\times10^8) + (0.1997\times10^8))$

Administrative costs = 15% × $((0.4742\times10^8) + (0.0569\times10^8) + (0.1997\times10^8))$

Administrative costs = 0.15 × $((0.4742\times10^8) + (0.0569\times10^8) + (0.1997\times10^8))$

Administrative costs = Rs. $\underline{0.1096\times10^8}$

Or

Consider the Administrative costs = 2.77% of total product cost

Administrative costs = 2.77% of 3.9513×10^8

⇨ Administrative costs = $0.0277 \times 3.9513\times10^8$

⇨ Administrative costs = Rs. $\underline{0.1096\times10^8}$

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 3.9513×10^8

⇨ Distribution and selling costs = $0.11 \times 3.9513\times10^8$

⇨ Distribution and Selling costs = Rs. $\underline{0.4346\times10^8}$

C. 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 3.9513×10^8

⇨ Research and development costs = $0.05 \times 3.9513\times10^8$

⇨ Research and Development costs = Rs. $\underline{0.1976\times10^8}$

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

Consider interest = 5% of total capital investment

i.e. interest = 5% of $3.8284\times10^8 = 0.05\times3.8284\times10^8$

Interest = Rs. $\underline{0.9141\times10^8}$

Thus, General Expenses = Rs. $\underline{0.9332\times10^8}$

IV. Total Product cost = Manufacture cost + General Expenses

$= (3.4436\times10^8) + (0.9332\times10^8)$

Total product cost = Rs. $\underline{4.3768\times10^8}$

This value is greater than the assumed value of Rs. $\underline{3.9513\times10^8}$ and hence acceptable.

V. Gross Earnings/Income:

Wholesale Selling Price of Isoamyl Alcohol per kg. = $ $\underline{0.70}$ (USD)

Let 1 USD = Rs. $\underline{50.00}$

Hence Wholesale Selling Price of Isoamyl Alcohol per kg. = 0.7 ×50 = Rs. $\underline{35.00}$

Total Income = Selling price × Quantity of product manufactured

= (35 1/kg) × (100 T/day) x (1000 kg/T) × (300 days/year)

Total Income = Rs. $\underline{1.05\times10^9}$

Gross income = Total Income – Total Product Cost

$= (1.05\times10^9) – (4.3768\times10^8)$

Gross Income = Rs. $\underline{6.1232\times10^8}$

Let the Tax rate be $\underline{45\%}$ (common)

Taxes = 45% of Gross income

= 45% of $6.1232\times10^8 = 0.45\times6.1232\times10^8$

Taxes = Rs. $\underline{2.7554\times10^8}$

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

Net profit = $(6.1232\times10^8) – (2.7554\times10^8)$ = Rs. $\underline{3.3678\times10^8}$

(a) Rate of Return:

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

Rate of Return = $3.3678\times10^{8}\times100/\ (3.8284\times10^{8})$

Rate of Return = 87.97%

(b) Break even Analysis:

Data available:

Annual Direct Production Cost = Rs.2.4124×10^{8}

Annual Fixed charges, overhead and general expenses = Rs. 1.9644×10^{8}

Total Annual sales = Rs. 1.05×10^{9}

Wholesale Selling Price of Isoamyl Alcohol per kg. = Rs. 35.00

Direct production cost per kg. of Isoamyl alcohol = $(2.4124\times10^{8})/\ (1.05\times10^{9}/35)$

= Rs. 8.0413 per kg.

Let 'n' TPA be the break even production rate.

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

$(1.9644\times10^{8}) + (8.0413\times n) = (35\times n)$

$\Rightarrow (26.9587\times n) = 1.9644\times10^{8}$

$\Rightarrow n = 1.9644\times10^{8}\ /26.9587$

$n = 7.2867\times10^{6}$ kg/year

n = 7286.7 tons/year

n = 24.289 tons/day = 24.289 TPD

Hence, the break even production rate is 24.289 TPD or 24.289% of the considered plant capacity.