Chapter 5
Lecture # 1-4

- **Overview of Section 2.**

- **Overview of Chapter 4.**

- **Classification of Capital Cost Estimate.**

Overview of Section 2

Title: **Engineering Economic Analysis of Chemical Processes**

Topics:

1) **Estimation of Capital Cost (Chapter 5)**

   Equipment cost, cost vs. size, cost vs. inflation, cost indexes, total fixed capital investment, CAPCOST.

Overview of Section 2

Topics:

2) Estimation of Manufacturing Cost (Chapter 6)

Methods to relate the total cost of manufacturing to five elements: 1) fixed capital investment, 2) cost of operating labor, 3) cost of raw materials, 4) cost of utilities, and 5) cost of waste treatment .

Overview of Section 2

Topics:

3) Engineering Economic Analysis (Chapter 7)

simple and compound interest, effective and nominal interest rates, annuities, cash flow diagram, discount factor, depreciation, inflation, and taxation.

Overview of Section 2

Topics:

4) Profitability Analysis (Chapter 8)

profitability criteria using non-discounted and discounted basis, net present value, discounted cash flow rate of return, payback period.

Overview of Chapter 5

Title: **Estimation of Capital Cost**

Topics:

1) **Classification of Capital Cost Estimate.**

2) **Estimation of Purchased Equipment Cost.**

3) **Estimation of Total Capital Cost of a Plant.**

Capital Cost

costs associated with construction of a new plant or modification to an existing plant.

Classification of Capital Cost Estimate

❶ **Order of Magnitude Estimate (Feasibility)**

❷ **Study Estimate / Major Equipment**

❸ **Preliminary Design (Scope) Estimate**

❹ **Definitive (Project Control) Estimate**

❺ **Detailed (Firm or Contractors) Estimate**

Classification of Capital Cost Estimate

❑ **Order of Magnitude Estimate (Feasibility)**

  ▪ **Data: Cost information for a complete process**

  ▪ **Diagram: BFD**

❑ **Study Estimate / Major Equipment**

  ▪ **Data: List of major equipments**

  ▪ **Diagram: PFD**

❑ **Preliminary Design (Scope) Estimate**

  ▪ **Data: Accurate equipment sizes, layout of equipment, piping, instrumentation and electrical requirements**

  ▪ **Diagram: PFD and preliminary PI&D**

Classification of Capital Cost Estimate

❑ **Definitive (Project Control) Estimate**

  ▪ **Data: specification of all equipment, utilities, instrumentation, electrical and off-sites.**

  ▪ **Diagram: Final PFD and a preliminary PI&D**

❑ **Detailed (Firm or Contractors) Estimate**

  ▪ **Data: Complete engineering of the process and all related off-sies and utilities.**

  ▪ **Diagram: Final PFD and P&ID**

Classification of Capital Cost Estimate

Table 5.2   Classification of Cost Estimates

Class of Estimate	Level of Project Definition (as % of Complete Definition)	Typical Purpose of Estimate	Methodology (Estimating Method)	Expected Accuracy Range (+/- Range Relative to Best Index of 1)	Preparation Effort (Relative to Lowest Cost Index of 1)
Class 5	0% to 2%	Screening or Feasibility	Stochastic or Judgment	4 to 20	1
Class 4	1% to 15%	Concept Study or Feasibility	Primarily Stochastic	3 to 12	2 to 4
Class 3	10% to 40%	Budget, Authorization, or Control	Mixed but Primarily Stochastic	2 to 6	3 to 10
Class 2	30% to 70%	Control or Bid/Tender	Primarily Deterministic	1 to 3	5 to 20
Class 1	50% to 100%	Check Estimate or Bid/Tender	Deterministic	1	10 to 100

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Classification of Capital Cost Estimate

Class 1 plant cost estimation accuracy:

+6 % to -4 %.

Class 5 study cost estimation accuracy:

0.015 % to 0.30 % of total plant cost.

Classification of Capital Cost Estimate

Example 5.1

The estimated capital cost from a chemical plant using the study estimate method (Class 4) was calculated to be $ 2.0 million. If the plant were to be built, over what range would you expect the actual capital investment to vary?

Classification of Capital Cost Estimate

Example 5.1/ Solution

Lowest Expected cost Range:

High Value for actual plant cost = ($ 2.0 E6)*(1+0.06*3) = $ 2.36 E6

Low Value for actual plant cost = ($ 2.0 E6)*(1-0.04*3) = $ 1.76 E6

Highest Expected cost Range:

High Value for actual plant cost = ($ 2.0 E6)*(1+0.06*12) = $ 3.44 E6

Low Value for actual plant cost = ($ 2.0 E6)*(1-0.04*12) = $ 1.04 E6

Classification of Capital Cost Estimate

Example 5.2

Compare the costs for performing an order-of-magnitude estimate and a detailed estimate for a plant that cost $\$5.0 \times 10^6$ to build.

For the order-of-magnitude estimate, the cost of the estimate is in the range of 0.015% to 0.3% of the final cost of the plant:

Highest Expected Value: $(\$5.0 \times 10^6)(0.003) = \$15,000$

Lowest Expected Value: $(\$5.0 \times 10^6)(0.00015) = \$750$

For the detailed estimate, the cost of the estimate is in the range of 10 to 100 times that of the order-of-magnitude estimate.

For the lowest expected cost range:

Highest Expected Value: $(\$5.0 \times 10^6)(0.03) = \$150,000$

Lowest Expected Value: $(\$5.0 \times 10^6)(0.0015) = \$7500$

For the highest expected cost range:

Highest Expected Value: $(\$5.0 \times 10^6)(0.3) = \$1,500,000$

Lowest Expected Value: $(\$5.0 \times 10^6)(0.015) = \$75,000$