- **CHEMICAL ENGINEERING DEPARTMENT**

NIT- Srinagar

Subject:-Industrial Economics and Management **Credit -3**
Semester: 7th

Suggested Books: **(1)** Peters, M.S., Timmerhaus , K. D., Plant Design and Economics for chemical Engineers , McGraw-Hill **(2)** Schwever , H.D., Process Engineering Economics, McGraw-Hill.

Syllabus:-
1. Cost Estimation: Capital investment, working capital, manufacturing cost, depreciation, insurance and taxes.
2. Decision Making: Annuities, perpetuities, capitalized costs, cash flow charts, breakeven charts.
3. PERT and CPM.
4. Organization: Structural development.
5. Production Planning and Control, inventory and quality control and time and motion study.
6. Personnel: Organization, labour relations, wages and incentives.
7. Marketing and Finance: Capital structure, fixed capital and working capital, pricing fundamentals, advertising and sales promotion

Chapter No : 5 to 9 Studying Peters, M.S., Timmerhaus

Capital Requirement

The cost of capital is what it costs a company to borrow money from all sources, such as loans, bonds, and preferred and common stock. It is an important consideration in determining a company's minimum acceptable rate of return on an investment. A company must make more than the cost of capital to pay its debts and make a profit.

From profits, a company pays dividends to the stockholders. If a company ignores the cost of capital to increase dividends to the stockholders, then management is not meeting its obligations to pay off outstanding debts. The following explanations are principal to build cost estimating of a plant.

Capital Investments

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 complete with all piping, controls, and services. In addition, it is necessary to have money available for the payment of expenses involved in the plant operation.

The capital needed to supply the necessary manufacturing and plant facilities is called the fixed capital investment, while that necessary for the operation of the plant is termed the working capital. The sum of the fixed-capital investment and the working capital is known as the total capital investment.

I. Fixed Capital Investment

About 85 to 90 percent of total capital is comprised generally of fixed capital. Fixed capital may be defined as the total cost of processing installations, buildings, auxiliary services, and engineering involved in the creation of a new plant. Several methods to obtain fixed capital investment can be described as follow.

i. Method 1

This method requires the cost factors by consider the proportional costs of each component. The cost factors presented are based on modern industrial experience. The typical variation in component costs as percentages of fixed capital investment for multiprocess grass-roots plants or large battery limit additions are summarized in table 1. A grass-roots plant is defined as a complete plant erected on a new site.

Table 1: Percentage of Fixed capital Invesment (Peters, 1990)

Typical percentages of fixed-capital investment values for direct and indirect cost segments for multipurpose plant or large additions to existing facilities	
Component :	Range, %
Direct costs	
Purchased equipment	15-40
Purchased equipment installation	6-14
Instrumentation and controls (installed)	2-8
Piping (installed)	3-20
Electrical (installed)	2-10
Buildings (including services)	3-18
Yard improvements	2-5
Service facilities (installed)	8-20
Land	1-2
Total direct costs	
Indirect costs	
Engineering and supervision	4-21
Construction expense	4-14

Contractor's fee	2-6
Contingency	5-15
Total fixed-capital investment	

ii. Method 2

This method looks like first method but, there is contained difference in the application. The used of this method requires initially that the cost of purchased process equipment. All components of direct cost are then estimated individually as equivalent to precentages of the equipment cost.

iii. Method 3

A simple technique to estimate the capital cost of a chemical plant is the Lang Factor method. The Lang factor method has a tendency to produce high results. The total cost is determined by multiplying the total purchased cost for all the major items of equipment by a constant. The multipliers, depending on the type of plant are given in table 2[10].

Table 2: Lang factor

Type of chemical plant	Lang factor, F_{lang}
Solid processing	3.10
Solid – fluid processing	3.63
Fluid processing	4.74

The capital cost calculation is determined using Equation 1.

$$C_T = F_{Lang} \sum_{i=1}^{n} C_{p,i} \qquad \text{Eq (1)}$$

Where,

C_T = Capital cost of the plant

$C_{p,i}$ = Purchased cost for the major equipment units

n = Total number of individual units

F_{Lang} = Lang Factor

II. Working Capital

Working capital is the amount of capital required to start up the plant and finance ordinarily amounts to the production cost for 1 month of operafion before revenues from the process start. In general it will be found to be amount equal to 15 to 20% of the fixed capital investment or 25% of annual product sales value[3].

The working capital for an industrial plant consists of the total amount of money invested in raw materials and supplies carried in stock, finished products in stock and semifinished products in the process of being manufactured, accounts receivable, cash kept on hand for monthly payment of operating expenses, such as salaries, wages, and raw-material purchases, accounts payable, and taxes payable[7].

Total Production Cost

Important part of a complete cost estimate besides capital investment is the estimation of costs for operating the plant and selling the products. Capital expenditures occur once during the life of a project but operating expenses are recurring expenses and, as such, significantly affect the cash flow and profitability of a venture. These costs can be grouped under total production cost. Total production cost is generally divided into the categories of manufacturing costs and general expenses.

I. Manufacturing Costs

The manufacturing expense will be interpreted to mean all expenses required to make a product and to ready it for shipment. These expenses, as considered here, are divided into three classifications as follows: direct production costs, fixed charges, and plant-overhead cost.

II. General Expenses

In addition to the manufacturing costs, other general expenses are involved in any company's operations. These general expenses may be classified as administrative expenses, distribution and marketing expenses, research and development expenses, and financing expenses.

Estimating Procedure

Committees within the firm are formed to plan for the future and prepare capital budgets. The economic evaluation of a process proceeds in several steps. These are:

1. preparing a process flow diagram
2. calculating mass and energy flows
3. sizing major equipment
4. estimating the capital cost
5. estimating the production cost
6. forecasting the product sales price
7. estimating the return on investment

The difficulty in a process evaluation is not the computations, but the variability in the terminology that appears in the literature, which is a result of differences in company practice[8].

DEFINIT
ION

After-tax cash flow - the net profit after taxes plus depreciation.

Breakeven point the operating - condition, such as output, at which two alternatives are equal in economy.

Cost estimating - A predictive process used to quantify, cost, and price the resources required by the scope of an asset investment option, activity, or project**.**

Cost index (price index) - a number that relates the cost of an item at a specific time to the corresponding cost at some arbitrarily specified time in the past.

Direct costs - the portion of the operating costs that is generally assignable to a specific product or process area.

Escalation - the provision in actual or estimated costs for an increase in the cost of equipment, material, labor, etc., over that specified in the purchase order or contract due to continuing price level changes over time.

Indirect costs - costs not directly assignable to the end product or process, such as overhead and general purpose labor, or costs of outside operations, such as transportation and distribution.

Interest rate - the ratio of the interest payment to the principal for a given unit of time, usually expressed as a percentage of the principal.

Operating cost (or manufacturing cost) - the expenses incurred during the normal operation of a facility, or component, including labor, materials, utilities, and other related costs.

Overhead - a cost or expense inherent in the performing of an operation, plant overhead is also called factory expense.

Payout period - the time required to recover the original fixed investment from profit and depreciation.

Present value - the value of the asset in its condition at the time of valuation.

Profit – the excess of income over expenditure

Royalty - compensation for the use of a property, usually a patent, copyrighted material, or natural resource; often expressed as a percentage of receipts from using the property.

Salvage value - the market value of a capital asset at the time it is retired (often assumed to be zero in economic analysis).

Service life - the useful life of an asset.

Stockholder - an investment group or individual holding legal ownership of a business by virtue of investing equity capital and entitled to any profits generated.

Straight line (SL) depreciation - provides that an asset be depreciated in equal annual installments over its usehl (book) life or its tax life.

Taxable income - cash earnings minus cash expense minus noncash expenses for depreciation, depletion, or amortization.

Taxes - cash payments to governmental agencies, including excise taxes, property taxes, capital gains taxes, and income taxes.

Time value of money - recognizes that money shifts in purchasing power over time to reflect inflation and uncertainty in investment returns.

Time zero - a single reference point in time set by the analyst as a starting point for economic analysis.

Working capital - cash that is tied up in an operation in addition to capital invested in facilities. Includes cash cost of inventories, net accounts receivable, spare parts or supplies,