Unit - 5

Power Plant Economics

COST OF POWER PLANT

- The cost analysis of power plant includes fixed cost and running cost.

1. Fixed cost:

(i) Land, building and equipment cost:

- Cost of land and building will depend upon the location of the plant. If the plant is situated near the cities, the land will be costlier than the case if it is located away from the cities.
- The cost of equipment or the plant investment cost is usually expressed on the basis of kW capacity installed.

(ii) Interest:

- All the enterprises need investment of money and this money may be obtained as loan, through bonds and shares, or from owners of personal funds.
- The interest on the capital investment must be considered because otherwise if the same amount was not invested in power plant, it would have earned an annual interest.
- A suitable rate of interest must be considered on the capital invested.

(iii) Depreciation cost:

- Depreciation accounts for the deterioration of the equipment and decrease in its value due to corrosion, weathering, and wear and tear with use.
- It also covers the decrease in value of equipment due to obsolescence. It is required to replace the generating plant machinery after its expiry of useful life.
- Therefore, a certain amount is kept aside every year from the income of the plant to enable the replacement of plant at the end of its useful life. This amount is called depreciation amount.
- The following methods are used to calculate the depreciation amount:
  - Straight line method
  - Sinking fund method
  - Diminishing value method

Let P = Initial cost of plant

S = Salvage value at the end of the plant life,

n = Plant life in years,

r = Annual rate of interest on the invested capital,

A = The amount to be kept aside per year as depreciation amount.

(a) Straight line method:

- According to this method, annual amount to be set aside is calculated by using following formula:

$$A = \frac{P - S}{n}$$

- In this method, the amount set aside per year as depreciation fund does not depend on the interest it may draw. The interest earned by the depreciation amount is taken as income.
- This method is commonly used because of its simplicity.

(b) Sinking Fund Method:

- In this method, the amount set aside per year consists of annual installations and the interest earned on all the installments.
  - Depreciation amount set aside at the end of first year = A,
  - Depreciation amount at the end of second year = A + interest on A
    $= A + Ar = A(1+r)$
  - Depreciation amount at the end of third year
    $= A(1+r)$ + interest on $A(1+r)$
    $= A(1+r) + A(1+r)\, r = A(1+r)(1+r) = A(1+r)^2$

$\therefore$ Amount at the end of nth year $= A(1+r)^{n-1}$

Total amount accumulated in n years =
Sum of the amounts accumulated in n years

$P - S = A + A(1+r) + A(1+r)^2 + \ldots\ldots\ldots + A(1+r)^{n-1}$

$y = A[1 + (1+r) + (1+r)^2 + (1+r)^3 + \ldots\ldots + (1+r)^{n-1}]$ ..... (1)

($\because$ Taking $P - S = y$)

Multiplying the above equation by (1+r), we get

$y(1+r) = A[(1+r) + (1+r)^2 + (1+r)^3 + \ldots\ldots + (1+r)^n]$ ……(2)

Subtracting equation (1) from equation (2), we get

$$y.r = [[(1+r)^n - 1]A$$

$$\therefore y = \left[\frac{(1+r)^n - 1}{r}\right]A$$

$$\therefore (P - S) = \left[\frac{(r+1)^n - 1}{r}\right]A$$

$$\therefore A = \left[\frac{r}{(1+r)^n - 1}\right](P-S)$$

(c) Diminishing value method:

- In this method the deterioration in value of equipment from year to year is taken into account and the amount of depreciation calculated upon actual residual value for each year. It thus, reduces for successive years.

Let x % of amount is set aside per year on the initial cost of plant at the end of each successive years.

Initial cost of the plant = P

Depreciation amount at the end of first year = $P \times \frac{x}{100}$

Balance plant cost = $P - \frac{P.x}{100} = P\left(1 - \frac{x}{100}\right)$

Depreciation amount at the end of second year,

$$= P\left(1 - \frac{x}{100}\right).\frac{x}{100}$$

Balance plant cost at the end of second year

$$= P\left(1 - \frac{x}{100}\right) - P\left(1 - \frac{x}{100}\right).\frac{x}{100}$$

$$= P\left(1 - \frac{x}{100}\right)^2$$

Depreciation amount at the end of third year,

$$= P\left(1 - \frac{x}{100}\right)^2 . \left(\frac{x}{100}\right)$$

Depreciation amount at the end of n year,

$$= P\left(1 - \frac{x}{100}\right)^{n-1} . \left(\frac{x}{100}\right)$$

- This can be explained by the following example:

Say the equipment cost is 20000 Rupees. The amount set aside is 10% of the initial cost at the beginning of the year and 10% of the remaining cost with every successive year. Therefore

balance plant cost at end of first year

$= 20000 - \frac{10}{100} \times 20000 = 18000$ balance

the balance plant cost at end of second year

$= 18000 - \frac{10}{100} \times 18000 = 18000 - 1800$

$= 16200$ balance

balance plant cost at end of third year

$= 16200 - \frac{10}{100} \times 16200 = 14580$ balance.

(iv) Insurance:

The costly equipment and the buildings must be insured for the fire risks, riots etc. A fixed sum is set aside per year as insurance charges. The insurance charge depends upon the initial cost of the plant and the insurance coverage.

(v) Management cost:

This includes the salaries of management, security and administrative staff, etc. working in the plant. This must be paid whether the plant is working or not. Therefore, this is included in fixed charges of the plant.

2. Running cost:

The running cost or operating cost of the power plant includes the cost of fuel, cost of lubricating oil, direct labour cost, cooling water and number of consumable articles required. The wages required for supplying the above material are also included in the operating cost of the power plant.

(i) Fuel cost:

In a thermal power plant, fuel is the heaviest item of operating cost. The selection of the fuel and the maximum economy in its use are, therefore, very important consideration in thermal power plant design. The cost of fuel includes not only its price at the site of purchase but its transportation and handling cost also.

(ii) Oil, Grease and Water cost:

The cost of various consumables like oil, grease, etc. and water cost are also proportional to the amount of power generated. These costs increase with an increase in life of the plant as the efficiency of the power plant decreases with the age.

The total cost of power generated is the sum of fixed charges and operating charges.

IMPORTANCE OF LOAD FACTOR AND DIVERSITY FACTOR

(1) Load factor

- Load factor is the ratio of average load to maximum load on the power plant.
- The load factor will increase if the average load increases without the increase in maximum load. Thus, the total number of units of energy generated (kWh) at higher load factor would increase.
- But the annual fixed charges per unit of energy generated would reduce with the increase in load factor.
- Hence, the annual fixed charges per unit of energy generated would reduce with the increase in load factor. As a result the overall cost per unit of energy generated reduces.

(2) Diversity factor

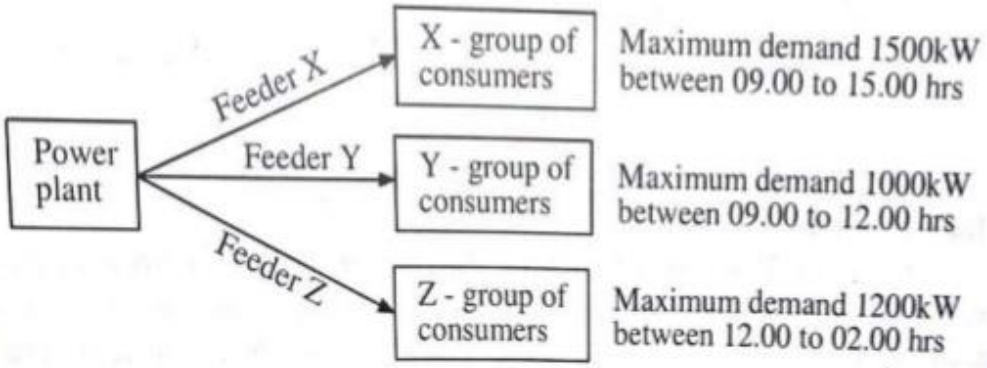

Fig. 7.8 Maximum load demand by various group of consumers