EEE 411
Power Station Engineering

ECONOMICS OF POWER GENERATION

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Reference: Chapter- 4 (V. K. Mehta)

Introduction

For any business, the focus of the manager is to get the maximum output from his or her workers with minimum cost.

In the case of a power plant, the goal is similarly to produce electricity with minimum cost.

And to quantify that we need to get the value of “*cost per units generated*" of electricity.

Class work

We expect to _______ cost per units generated.

a) Maximize

b) Minimize

Can we get 0 (zero) as a cost per units generated?

Cost Analysis of a Power Plant

In this lecture, we are going to know about different costs associated with generation of electricity.

Any cost analysis of a power plant includes

A. Fixed Cost
B. Semi Fixed Cost
C. Running Cost

Fixed Cost

independent of maximum demand and units generated

It includes:

1. annual cost of central organization,
2. interest on capital cost of land
3. salaries of high officials

Semi Fixed Cost

independent of units generated but depends on the maximum demand

(The greater the maximum demand on a power station, the greater is its size and cost of installation.)

It includes:

1. annual interest and depreciation on capital investment of building and equipment
2. taxes, salaries of management and clerical staff

Running Cost

depends only upon the number of units generated

It includes:

1. annual cost of fuel, lubricating oil, maintenance, repairs
2. salaries of operating staff

Expression for Cost of Electrical Energy

1. Three part form:

$$Total\ Cost = Fixed\ Cost + Semi\ Fixed\ Cost + Running\ Cost$$

Here

$Fixed\ Cost = a$ (in currency units ৳, $ etc.)

$$Semi\ Fixed\ Cost = b \times Maximum\ Demand = b \times kW$$

$$Running\ Cost = c \times Units\ generated = c \times kWh$$

Expression for Cost of Electrical Energy

2. Two part form:

$$Total\ Cost = Fixed\ Cost + Running\ Cost$$

Here

$Fixed\ Cost = A \times Maximum\ Demand$

$Running\ Cost = B \times Units\ generated$

The constant A is linked to the constants a and b of the previous three part form.

Depreciation

The decrease in the monetary value of the any product due to constant use is known as depreciation.

Methods of determining depreciation charge

1. Straight line method
2. Diminishing value method
3. Sinking fund method

Straight Line Method

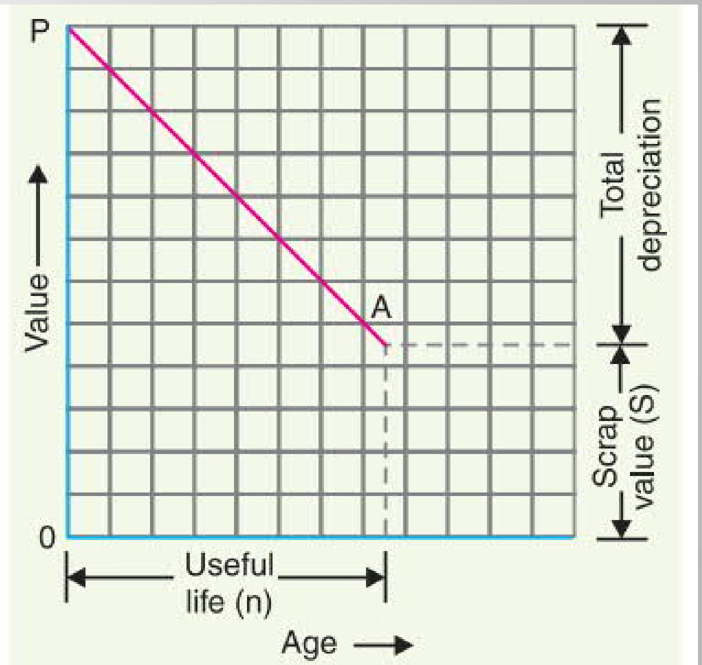
$$annual\ depreciation\ charge = \frac{P - S}{n}$$

Here,

$n = useful\ life\ in\ years$

$P = initial\ cost\ for\ the\ product$

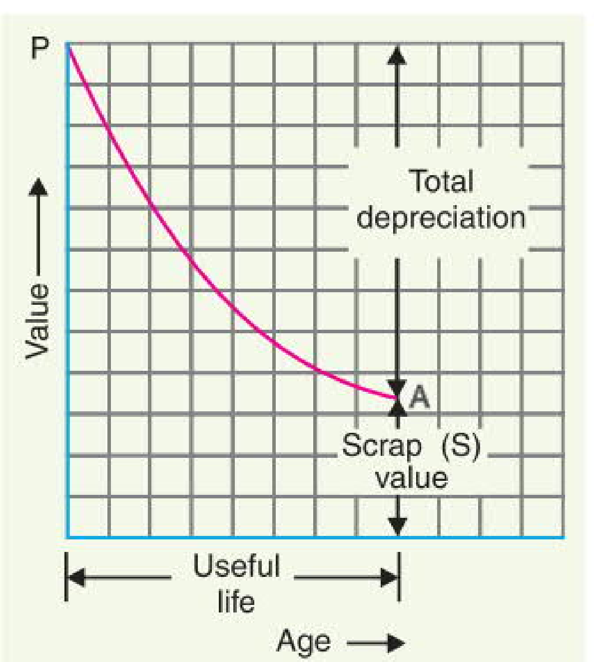
$S = scrap\ value$



At the end Year:	Product's Monetary value	Depreciation Cost (annual charge 1000)
0 (product is just bought)	10000	0
1	9000 (10000- 1000)	1000
2	8000 (9000 - 1000)	1000
3	?	1000

Diminishing Value Method

At the end Year:	Product's Monetary value	Depreciation Cost (10% annual rate)
0 (product is just bought)	10000	0
1	9000 (10000- 1000)	1000
2	8100 (9000 - 900)	900
3	?	810



Annual depreciation rate, $x = 1 - \left(\frac{S}{P}\right)^{\frac{1}{n}}$

Effect of High Load Factor

i) Reduces cost per unit generated

It is because higher load factor means that for a given maximum demand, the number of units generated is more.

(We will see this in the next numerical example.)

ii) Reduces variable load problems

A higher load factor means comparatively less variations in the load demands at various times. This avoids the frequent use of regulating devices installed to meet the variable load on the station.

Numerical Example 1 (Example 4.6)

A generating plant has a maximum capacity of 100 kW and costs Rs 1,60,000. The annual fixed charges are 12% consisting of 5% interest, 5% depreciation and 2% taxes.

Find the fixed charges per kWh if the load factor is (i) 100% and (ii) 50%.

Numerical Example 2 (Example 4.3)

The equipment in a power station costs Rs 15,60,000 and has a salvage value of Rs 60,000 at the end of 25 years. Determine the depreciated value of the equipment at the end of 20 years on the following methods :

(i) Straight line method

(ii) Diminishing value method

Numerical Example 3 (Example 4.10)

The annual working cost of a power station is represented by the formula Rs (a+ b kW + c kWh) where the various terms have their usual meaning. Determine the values of a, b and c for a 60 MW station operating at annual load factor of 50% from the following data :

(i) capital cost of building and equipment is Rs $\mathbf{5 \times 10^6}$

(ii) the annual cost of fuel, oil, taxation and wages of operating staff is Rs 9,00,000

(iii) the interest and depreciation on building and equipment are 10% per annum

(iv) annual cost of organisation and interest on cost of site etc. is Rs 5,00,000

Numerical Example 4 (Example 4.12)

Compare the annual cost of supplying a factory load having a maximum demand of 1 MW and a load factor of 50% by energy obtained from (i) a private oil engine generating plant and (ii) public supply.

(i) Private oil engine generating unit :

Capital cost = Rs $\mathbf{12 \times 10^5}$; Cost of repair and maintenance = Rs $\mathbf{0.005}$ per kWh generated; Cost of fuel = Rs 1600 per 1000 kg ; Interest and depreciation = 10% per annum

Fuel consumption = $\mathbf{0.3}$ kg/kWh generated ; Wages = Rs 50,000 per annum

(ii) Public supply company :

Rs 150 per kW of maximum demand plus 15 paise per kWh