Electrical Power Engineering

Load Curves and Factors

Variable Load on Power Station:

A power station is designed to meet the load requirements of the consumer. An ideal load on the station would be one of constant magnitude and study duration. However, such a steady load is never realized in actual practice. The load demand of any consumer at any time may be different from that of the other. Some of the important effects of variable load on a power system are:

1. Need of additional equipment.
2. Increase of production cost.

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Load curves:

The curve showing the variation of load on the power station with respect to time is known as a load curve.

There are three types of load curve:

1. ***Daily load curve:*** the load variations during the day (24 hours) are recorded half-hourly or hourly and are plotted against time.

2- Monthly load curve: can be obtained from the daily load curves of the month. Average values of power a month at different times of the day are calculated and then plotted on the graph. It is generally used to fix the rate of energy.

3- Yearly load curve: is obtained by considering the monthly load curves of that particular year and it is used to determine the annual load factor.

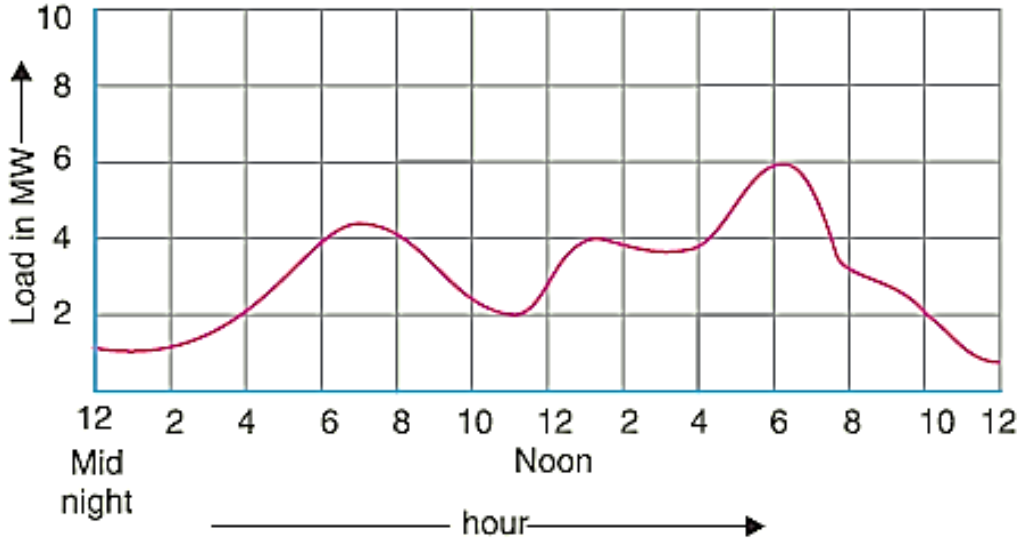

Figure (10), Load Curve

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Importance. The daily load curves have attained a great importance in generation as they supply the following information readily :

(*i*) The daily load curve shows the variations of load on the power station during different hours of the day.

(*ii*) The area under the daily load curve gives the number of units generated in the day.
Units generated/day = Area (in kWh) under daily load curve.

(*iii*) The highest point on the daily load curve represents the maximum demand on the station on that day.

(*iv*) The area under the daily load curve divided by the total number of hours gives the average load on the station in the day.

$$\text{Average load} = \frac{\text{Area (in kWh) under daily load curve}}{\text{24 hours}}$$

(*v*) The ratio of the area under the load curve to the total area of rectangle in which it is contained gives the load factor.

$$\text{Load factor} = \frac{\text{Average load}}{\text{Max. demand}} = \frac{\text{Average load} \times 24}{\text{Max. demand} \times 24}$$

$$= \frac{\text{Area (in kWh) under daily load curve}}{\text{Total area of rectangle in which the load curve is contained}}$$

(*vi*) The load curve helps in selecting* the size and number of generating units.

(*vii*) The load curve helps in preparing the operation schedule** of the station.

Important Terms and Factors:

The variable load problem has introduced the following terms and factors in power plant engineering:

1- Connected Load: is the sum of continuous ratings of all equipment connected to supply system.
2- Maximum Demand: it is the greatest demand of load on the power station during a given period. It is very important as it helps to in determining the installed capacity of the station.
3- Demand Factor: it is the ratio of the maximum demand on a power station to its connected load.

$$\text{Demand factor} = \frac{\text{Maximum demand}}{\text{Connected load}} < 1$$

Its value usually is ***less than 1***, its value is important to determine the capacity of the plant equipment.

4- Average Load: the average of loads occurring in the power station in a given period (day or month or year).

$$\text{Daily average load} = \frac{\text{No. of units (kWh) generated in a day}}{\text{24 hours}}$$

$$\text{Monthly average load} = \frac{\text{No. of units (kWh) generated in a month}}{\text{Number of hours in a month}}$$

$$\text{Yearly average load} = \frac{\text{No. of units (kWh) generated in a year}}{\text{8760 hours}}$$

5. Load Factor: the ratio between the average loads to the maximum demand during a given period.

$$\text{Load factor} = \frac{\text{Average load}}{\text{Max. demand}}$$

If the plant is in operation for T hours,

$$\text{Load factor} = \frac{\text{Average load} \times \text{T}}{\text{Max. demand} \times \text{T}}$$

$$= \frac{\text{Units generated in T hours}}{\text{Max. demand} \times \text{T hours}}$$

The load factor may be daily load factor, monthly load factor or annual load factor if the time period considered is a day or month or year. Load factor is always less than 1 because average load is smaller than the maximum demand. The load factor plays key role in determining the overall cost per unit generated. Higher the load factor of the power station, lesser* will be the cost per unit generated.

6. Diversity Factor: is the ratio of the sum of individual maximum demands to the maximum demand on the power station.

$$\text{Diversity factor} = \frac{\text{Sum of individual max. demands}}{\text{Max. demand on power station}}$$

The maximum demand on power station is always less than the sum of maximum demands, therefore, the Diversity factor > 1. The greater the diversity factor the lesser on the cost of generation of power.

7. *Plant Capacity Factor:* it is the ratio of the actual energy produced to the maximum possible energy that could have been produced during a given period.

$$\text{Plant capacity factor} = \frac{\text{Actual energy produced}}{\text{Max. energy that could have been produced}}$$

$$= \frac{\text{Average demand} \times \text{T}}{\text{Plant capacity} \times \text{T}} \quad **$$

$$= \frac{\text{Average demand}}{\text{Plant capacity}}$$

Thus if the considered period is one year,

$$\text{Annual plant capacity factor} = \frac{\text{Annual kWh output}}{\text{Plant capacity} \times 8760}$$

The plant capacity factor is an indication of the reserve capacity of the plant. A power station is so designed that it has some reserve capacity for meeting the increased load demand in future. Therefore, the installed capacity of the plant is always somewhat greater than the maximum demand on the plant.

$$\text{Reserve capacity} = \text{Plant capacity} - \text{Max. demand}$$

It is interesting to note that difference between load factor and plant capacity factor is an indication of reserve capacity. If the maximum demand on the plant is equal to the plant capacity, then load factor and plant capacity factor will have the same value. In such a case, the plant will have no reserve capacity.

8. Plant use Factor: it is the ratio of the kWh generated to the product of the plant capacity and the number of hours for which the plant was in operation.

$$\text{Plant use factor} = \frac{\text{Station output in kWh}}{\text{Plant capacity} \times \text{Hours of use}}$$

For example, a plant has installed capacity of 20 MW produces an annual output of 7.35 $X10^6$ kWh and remains in operation for 2190 hour in a year to end the plant use factor.

$$\text{Plant use factor} = \frac{7{\cdot}35 \times 10^6}{\left(20 \times 10^3\right) \times 2190} = 0{\cdot}167 = 16{\cdot}7\%$$

Thanks