Basic Electrical Engineering (TEE 101)

Lecture 25: Power Factor

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Content

This lecture covers:

- **Power Factor and its significance**
- **Low Power Factor and its cause**
- **Limitations of low power factor**

Power Factor

Power factor: It is defined as the ratio of true power (active power) to the apparent power (Volt-amperes). It is mathematically expressed as:

$$\text{Power factor} = \frac{V\,I\cos\phi}{V\,I} = \frac{\text{True power}}{\text{Apparent power}}$$

$$\text{Power factor} = \cos\phi$$

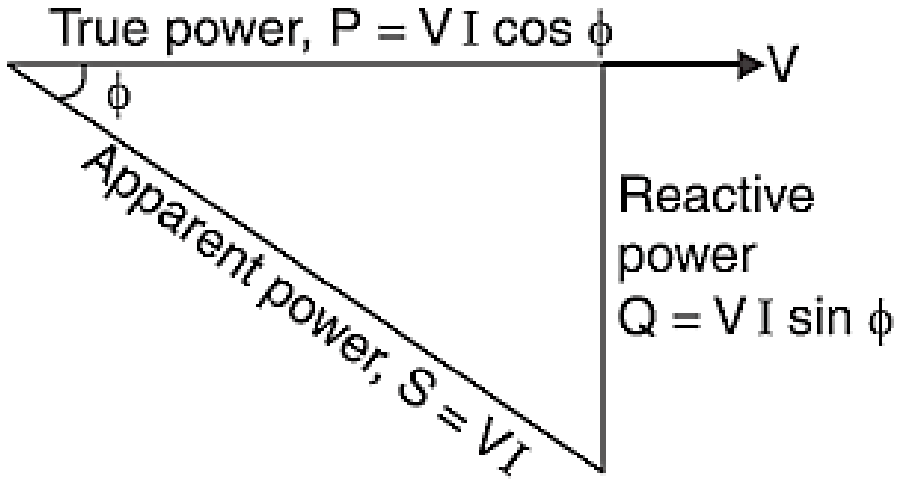

Figure 1: Power Triangle

The active power is the real power which is absorbed in an AC circuit, whereas volt-amperes is the apparent power which is produced in the circuit when the waves of voltage or current are not in phase.

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Significance of Power Factor

The apparent power drawn by a circuit has two components *viz*. (*i*) true power and (*ii*) reactive power.

True power component should be as large as possible because it is this component which does useful work in the circuit. This is possible only if the reactive power component is small.

As seen from the power triangle in Fig. 1, the smaller the phase angle φ (*i.e*. greater the p.f. cosφ), the smaller is the reactive power component.

Thus when φ = 0° (i.e. cos φ = 1), the reactive power component is zero and the true power is equal to the apparent power.

That means the whole of apparent power drawn by the circuit is being utilised by it.

Thus power factor of a circuit is a measure of its effectiveness in utilizing the apparent power drawn by it.

The greater the power factor of a circuit, the greater is its ability to utilise the apparent power.

Thus 0·5 p.f. (*i.e*. 50% p.f.) of a circuit means that it will utilize only 50% of the apparent power whereas 0·8 p.f. would mean 80% utilization of apparent power.

For this reason, we wish that the power factor of the circuit to be as near to 1 as possible.

Low Power Factor and it's causes

Power factor is a way to find out **how effectively you are using your electrical power**.

A high-power factor indicates effective utilization of electrical power, whereas low power factor signifies inefficient use of electrical power.

The device is considered to be very efficient if the power factor is close to 1.

If the reactive power increases beyond a threshold, the system becomes unstable and tends to draw more current from the source, or essentially a low power factor.

Reasons for low power factor

- Inductive loading
- Variations in power loading
- Harmonic currents
- Transformers

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Disadvantages of Low Power Factor

The undesirable effect of operating a low load at a low power factor is due to the large current required for a low power factor.

The important disadvantages of low power factor are:

- **Higher current is required by the equipment**, due to which the economic cost of the equipment is increased.
- At **low power factor**, the current is high which gives rise to **high copper losses** in the system and therefore the efficiency of the system is reduced.
- **Higher current produced** a large voltage drop in the apparatus. This results in the poor voltage regulation.

Since both the capital and running cost are increased, the operation of the system at low power factor (whether it is lagging or leading) is uneconomical from the supplier's point of view.

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Thank You