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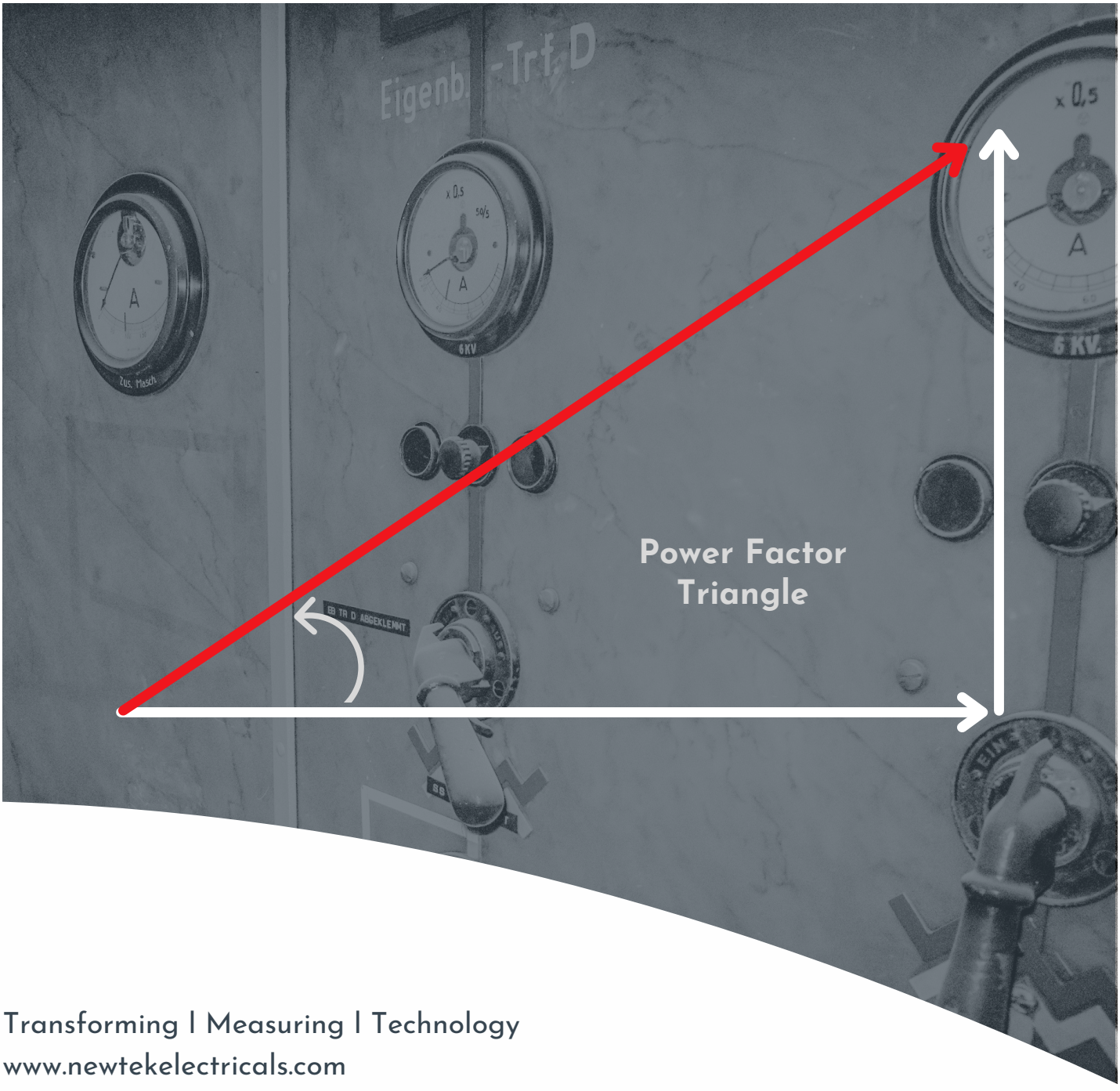
What is Phase Angle and Power Factor in AC Circuits?



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What is Phase Angle and Power Factor in AC Circuits?

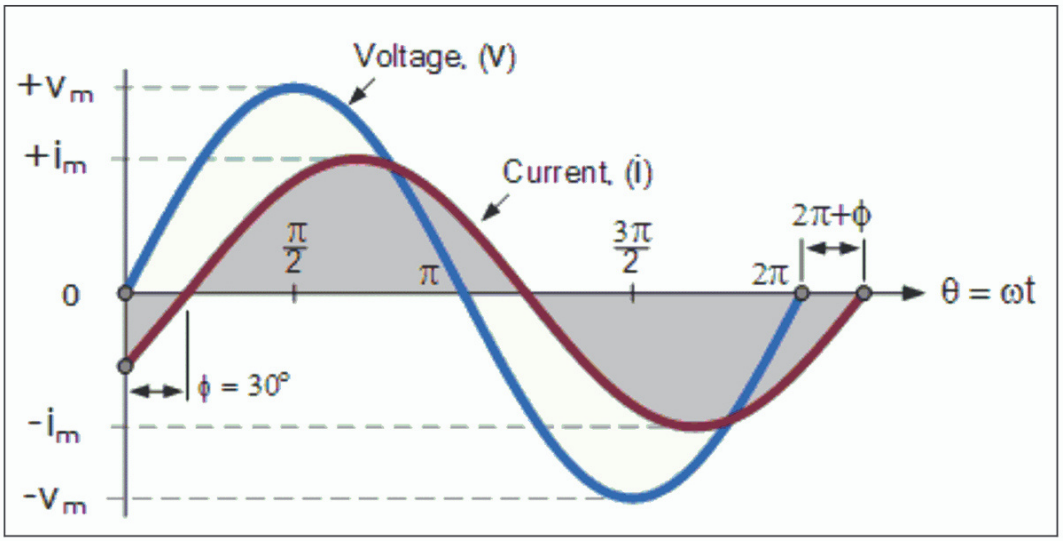
Part I

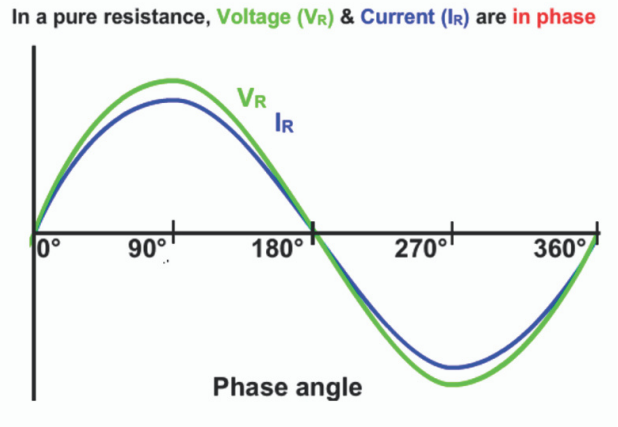
What is Phase Angle in an Electrical Network?

Phase Angle is the angle between voltage and current in an electrical circuit. When capacitors or inductors are involved in an AC circuit, current and voltage do not peak at the same time. The fraction of a period difference between the peaks expressed in degrees or radians is the phase difference or phase angle.

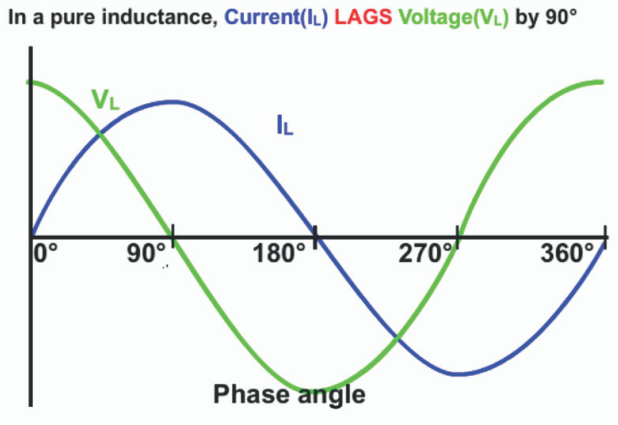
It is customary to use the angle by which the voltage leads the current. This leads to a positive phase for inductive circuits since current lags the voltage in an inductive circuit. The phase is negative for a capacitive circuit since the current leads the voltage.
The phase angle(Ø) is usually measured in degrees or radians.

The following diagram shows a phase shift or phase angle of 30 degrees between the voltage and current.

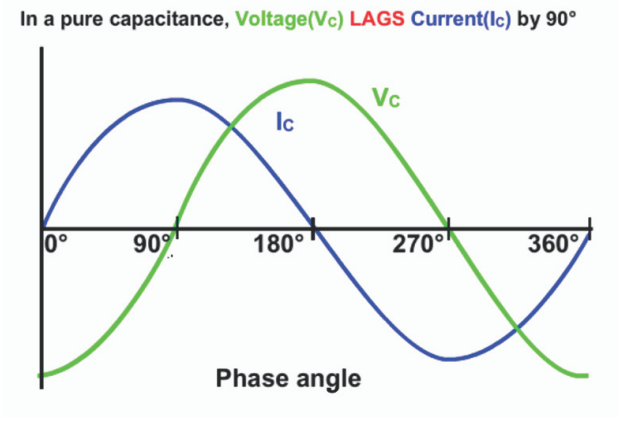




For purely resistive loads, there is no phase shift between voltage peak and current peak. Hence, phase angle (Ø) is 0 degree (360 degree)



For a purely inductive load, the current lags the voltage by phase angle (Ø) of +90 degree.



For a purely capacitive load, the current leads the voltage by 90 degees (or Voltage lags the current by 90 degrees) Hence please angle (Ø) is

Conclusion

Phase angle can stand anywhere from 0 to 360 degrees depending on the type of load and the quadrant in which the circuit is working. It is a key indicator of system stability and must be checked when two sources have to be connected to avoid inverse current.

What is Phase Angle and Power Factor in AC circuits?

Part II

What is Power Factor in an electrical network?

Power Factor (PF) is the cosine of phase angle between voltage and current in an electrical circuit.

PF = cosine (phase angle)

Alternatively, PF is also defined as the ratio of Total Real Power to Total Apparent Power as shown in the Fig 1.

$$\text{Power Factor} = \frac{\text{Real Power (kW)}}{\text{Apparent Power (kVA)}} = \frac{\text{kW}}{\sqrt{(\text{kW})^2 + (\text{kVAr})^2}}$$

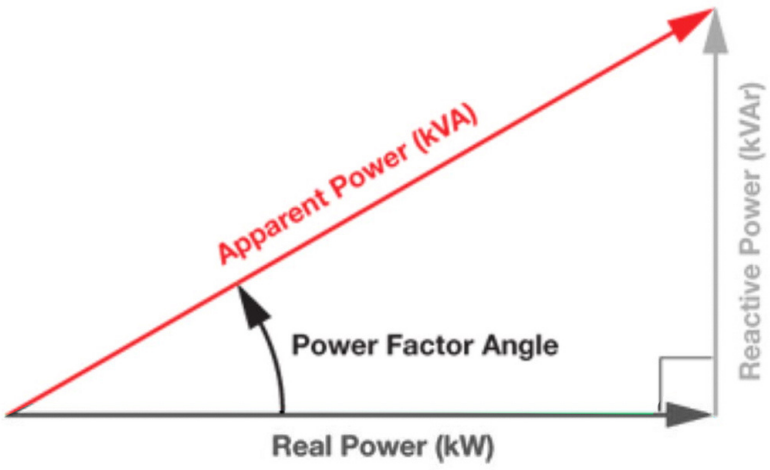


Fig 1 Power Factor Triangle

Importance of Power Factor in an electrical network

In an AC circuit, power is used most efficiently when the current is aligned with the voltage. (Phase angle = 0 PF = cos (0) = 1.0). (Refer Fig 2.)

Hence PF is desired to be closed to unity (1.0)

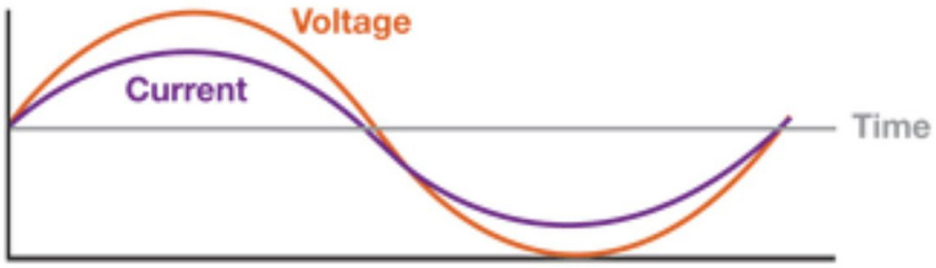


Fig 2

However, most equipment tends to draw current with a delay (phase angle), misaligning it with the voltage. What this means is that more current is being drawn to deliver the necessary amount of power to run the equipment.

The more an equipment draws current with a delay, the less efficient the equipment is.

Refer Fig 3

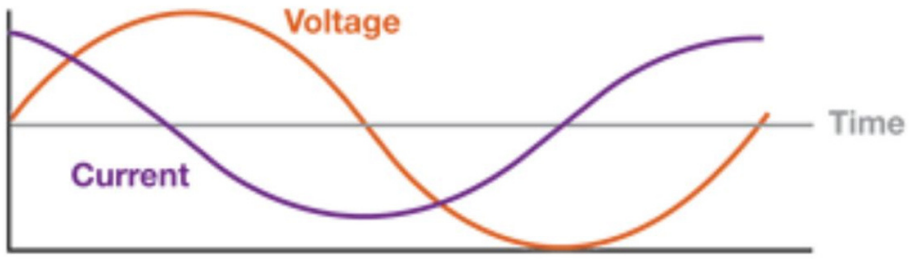


Fig 3

Power factor is a way of measuring how efficiently electrical power is being used within a facility's electrical system.
When Real (Active) Power = Apparent Power, and PF = 1.0 it indicates a 100% efficient system. When Active power = 0, then PF = 0.0/1.0 = 0.0.This indicates a 0% efficient system.

Conclusion

Tied to efficient use of power, PF has a direct impact on your electrical bill. For most efficient use of power, PF should be close to unity.

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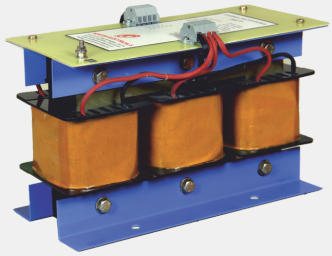

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