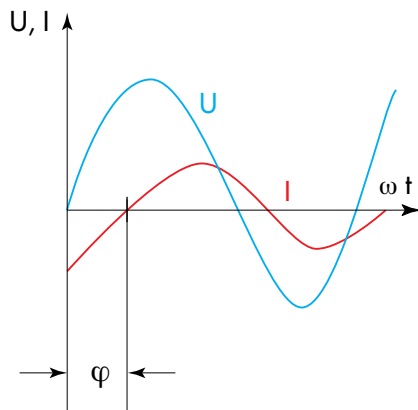


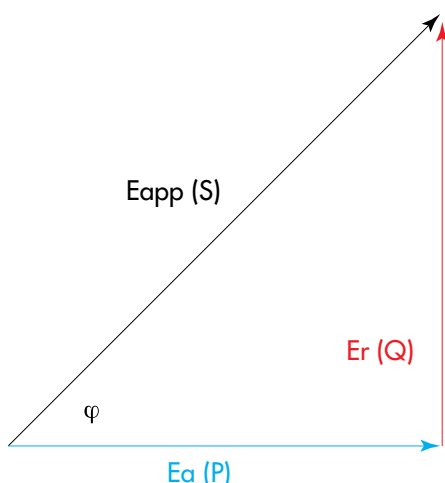


I - DEFINITIONS

1) PHASE SHIFT - ENERGIES - POWERS



■ Phase shift between current and voltage (angle φ)



An alternating current electrical installation, including receivers such as transformers, motors, welding machines, power electronics, etc., and in particular any receiver for which the current is out-of-phase in relation to the voltage, absorbs a total energy called the apparent energy (E_{app}).

This energy, which is generally expressed in kilovolt-ampere-hours (kVAh), corresponds to the apparent power S (kVA) and can be broken down as follows:

■ Active energy (E_a) : expressed in kilowatt hours (kWh). It can be used, after being transformed by the receiver, in the form of work or heat. This energy corresponds to the active power P (kW).

■ Energies

$$\vec{E}_{app} = \vec{E}_a + \vec{E}_r$$

$$E_{app} = \sqrt{(E_a)^2 + (E_r)^2}$$

■ Powers

$$\vec{S} = \vec{P} + \vec{Q}$$

$$S = \sqrt{(P)^2 + (Q)^2}$$

• for three-phase supply :

$$S = \sqrt{3} UI$$

$$P = \sqrt{3} UI \cos \varphi$$

$$Q = \sqrt{3} UI \sin \varphi$$

* for a single-phase supply, the term $\sqrt{3}$ disappears.



2) POWER FACTOR

$$\cos \varphi = \frac{P(\text{kW})}{S(\text{kVA})}$$

$$\text{tg } \varphi = \frac{E_r(\text{kvarh})}{E_a(\text{kWh})}$$

By definition, the power factor, or the $\cos \varphi$, of an electrical device is equal to the ratio of the active power P (kW) over the apparent power S (kVA) and can vary from 0 to 1.

It can thus be used to identify the level of reactive energy consumption of devices easily.

■ a power factor equal to 1 will result in a zero reactive energy consumption (pure resistance).

■ a power factor less than 1 will result in reactive energy consumption which increases as it approaches 0 (pure inductance).

In an electrical installation, the power factor may be different from one workshop to another depending on the devices installed and the way in which they are used (off-load, full-load operation, etc.).

Since energy metering devices measure the active and reactive energy consumptions more easily, EDF, the French electricity supply board, has chosen to use the term $\text{tg } \varphi$ on the electricity bills of its customers.

$\text{Tg } \varphi$ is the quotient between the reactive energy E_r (kvarh) and the active energy E_a (kWh) used during the same period.

Unlike $\cos \varphi$, it is easy to see that the value of $\text{tg } \varphi$ must be as low as possible in order to have the minimum reactive energy consumption.

The relationship between $\cos \varphi$ and $\text{tg } \varphi$ is given by the following equation:

$$\cos \varphi = \frac{1}{\sqrt{1 + (\text{tg } \varphi)^2}}$$

but a simpler method consists of referring to a conversion table (see section VII).