EFFECT OF ACTIVE AND REACTIVE POWER ON THE POWER SUPPLY SYSTEM

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Abstract.
In this article, the difference between the effect of active and reactive power to the power supply system and the asset power of active power and the difference between reactive power and asset. P, Q, S, changes in any section of the network in any section of the variable current chain are approved and studied.
Keywords: Active power, active resistance, intelligence, total power, amplitude, inductive and capacity.

Active, reactive and full power.
Unlike DC networks, where the expression of power is $P = U \cdot I$ and does not change with time, AC networks do not. The power in an AC circuit is also variable. It is defined as the product of instantaneous voltage and current values in any part of the circuit at any time T.
In the period with full active resistance, it is equal to:

$$p = u \cdot i$$

$$u = U_m sin\omega \cdot t \quad \text{va} \quad i = I_m sin\omega \cdot t$$

$$p = U_m \cdot I_m \cdot sin^2\omega \cdot t = \frac{U_m \cdot I_m}{2} \cdot (1 - cos^2\omega \cdot t) = U \cdot I - U \cdot I \cdot cos^2\omega \cdot t$$

Based on the above expressions, active energy consists of two parts - constant $U \cdot I$ and variable $U \cdot I \cdot cos^2\omega \cdot t$ which changes twice in frequency. Its average value is $P = U \cdot I$
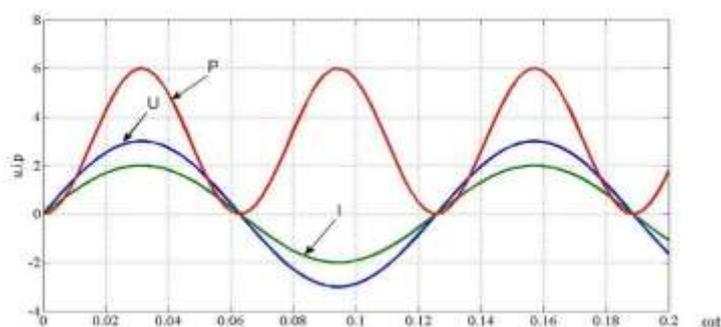

Figure 1 shows the graph of P (ωt).

Difference between reactive power and active power

In an electron with reactance (take an inductance as an example), the value of the

instantaneous force is:

$$q = u \cdot i$$

Accordingly $= U_m \sin\omega \cdot t$ va $i = I_m \sin\left(\omega \cdot t - \frac{\pi}{2}\right) = I_m \cos\omega \cdot t$

at the end we get:

$$q = U_m \cdot I_m \sin\omega \cdot t = \frac{U_m \cdot I_m}{2} \sin^2\omega \cdot t = U \cdot I \cdot \sin^2\omega \cdot t$$

This expression shows that the reactive energy contains only a variable part, it changes twice with the frequency, and its average value is zero
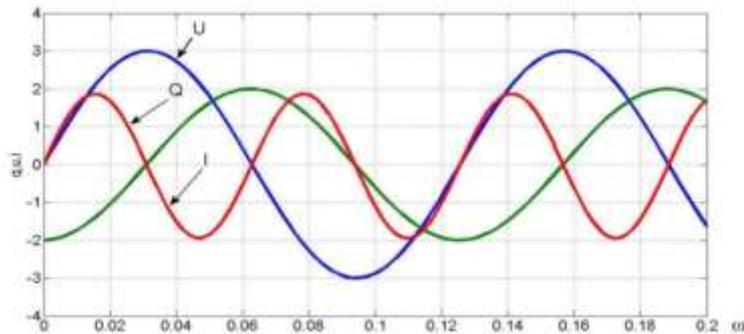

Figure 2. Graph (ωt)

If the current and voltage are sinusoidal and the network includes elements of the RL or RC type, then in such networks, in addition to converting the energy in the active element R, the energy of the electric and magnetic fields in the reactive elements L and S.

In this case, the total power of the network is equal to the sum:

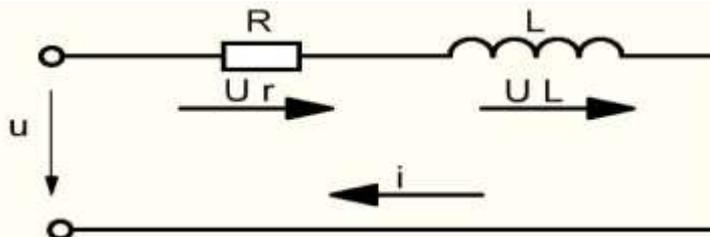$s = p + q$ What is the apparent power in the example of a simple RL circuit?

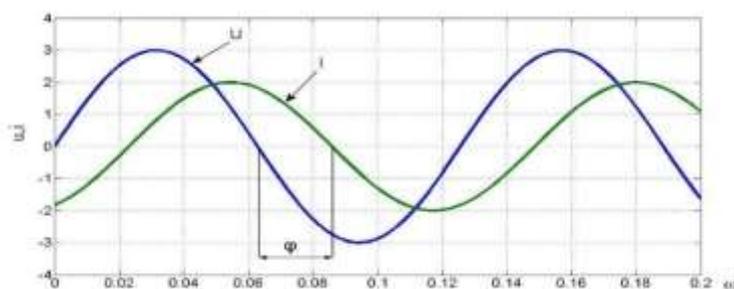**Figure 3. Graphs of changes in instantaneous values u, i:**

Figure 4. Graphs of changes in instantaneous values u, i:

φ - is the difference between current and voltage

the equation for S has the following form

And this $= u \cdot i = U_m \cdot I_m \cdot \sin\omega \cdot t \cdot \sin(\omega \cdot t \cdot \varphi)$

$\sin(\omega \cdot t - \varphi) = \sin\omega \cdot t \cdot \cos\varphi - \cos\omega \cdot t \cdot \sin\varphi$ and replace the amplitude values with the efficiency:

$$s = U \cdot I \cdot \cos\varphi - U \cdot I \cdot \cos\varphi \cdot \cos^2 \cdot \omega \cdot t - U \cdot l \cdot \sin\varphi \cdot \sin^2 \cdot \omega \cdot t$$

The value of S is considered as the sum of two quantities $s = p + q$ where

$$p = U \cdot I \cdot \cos\varphi - U \cdot I \cdot \cos^2\omega \cdot \cos\varphi ; \quad q = -U \cdot I \cdot \sin\varphi \cdot \sin^2 \cdot \omega \cdot t$$

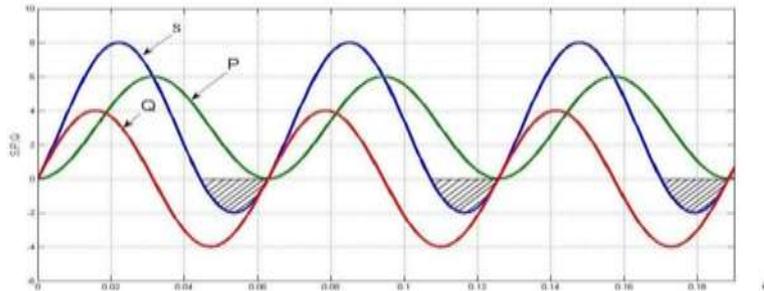and - instantaneous active and reactive power in RL sections.

Figure 5. P, Q, S graphs:

As can be seen from the graph, the presence of the inductive component led to the appearance of a negative part in the total power (the shaded part of the graph), which reduces its average value. It depends on the variation of the changes, for a certain time the current and voltage are in antiphase, so the negative value of S. appears. For effective values:

$$P = U \cdot I \cdot \cos\varphi$$
$$Q = U \cdot I \cdot \sin\varphi$$

The active component of the network is expressed in watts (W), and the reactive component is expressed in reactive volt-amperes (var). The total power of the network S is determined by the nominal data of the generator. For a generator, this is expressed as:

$$S = U \cdot I$$

For the normal operation of the generator, the current in the slip and the voltage at the terminals should not exceed the nominal values I n , U n . For a generator, the values of P and S are the same, however, in practice, S is expressed in volt-amperes (VA). Also, the network energy can be expressed separately through each component:

$$S = U \cdot I^2$$
$$Q = U \cdot I^2$$
$$P = R \cdot I^2$$

Here P, Q, S are the active, reactive and fiber power of the network, respectively. They form a triangle of power:
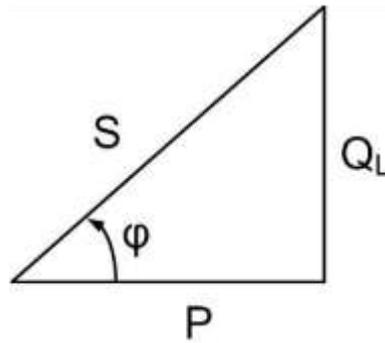
Figure 6 is a triangle of power

Basically a power triangle with an inductive load, if you remember the Pifagor theorem, from a right triangle you can get the following expression:

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

The reactive component in the triangle is positive (Q_L) when the current lags behind the voltage, and negative (Q_C):
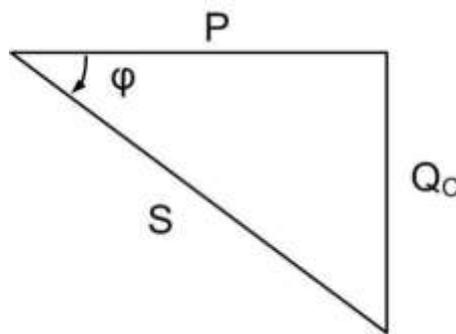

Figure 7. Power triangle with basically capacitive load

The algebraic expression for the reactive component of the network is valid:

$$Q = Q_L - Q_C$$

So, inductive and capacitive energy are interchangeable. That is, if you want to reduce the effect of the inductive part of the circuit, you need to add capacitance and vice versa. Below is an example of this scheme:
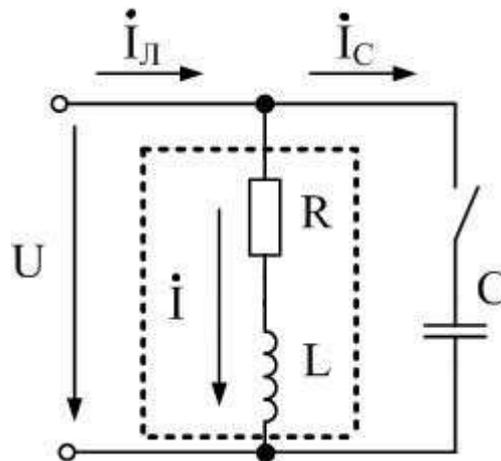

Figure 8. Reactive component compensation circuit

The vector diagram shows the effect of the capacitor on the $\cos\varphi$. As you can see, when the capacitor is turned on, $\cos\varphi_2 > \cos\varphi_1$ and $I_1 < I$.
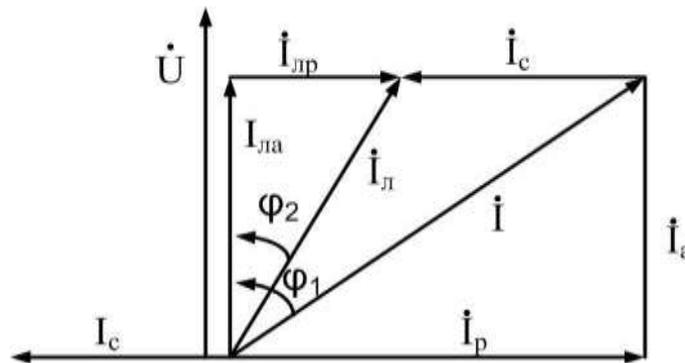

Figure 9. Vector diagram

The relationship between total and reactive energy is expressed as follows:

$$P = S \cdot \cos\varphi = U \cdot I \cdot \cos\varphi$$
$$\cos\varphi = P/(U \cdot I)$$

$\cos\varphi$ is the power factor, which indicates what part of the total energy is active energy. The closer it is to 1, the more useful energy is consumed from the network.

Conclusion

During the preparation of this article, I can conclude that the effect of active and reactive power on the power supply system, what does active power mean, and the difference between reactive power and active power. Unlike DC circuits, AC voltage circuits have three types of power - active, reactive, full. Active energy does useful work, as in constant current cycles. Reactive - does not perform useful work, but only reduces the efficiency of the network, heats the wires, loads the generator. Total - the sum of active and reactive, which is equal to the power of the network. The inductive component of reactive power can be compensated by capacitance. In practice, in industry, this is done and installed through capacitor batteries.

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