APPLICATION OF REACTIVE POWER COMPENSATION METHODS IN ELECTRIC MOTORS

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***Annotation**: In this article, we provide information on how to calculate the power losses of asynchronous electric motors and how to save them, ie reactive power compensation.*

***Keywords**: engine, motor, jet, rectifier, coefficient.*

Reactive value compensation and $\cos\varphi$ increase are also important for all manufacturing sectors. The low power factor is due to the following reasons:

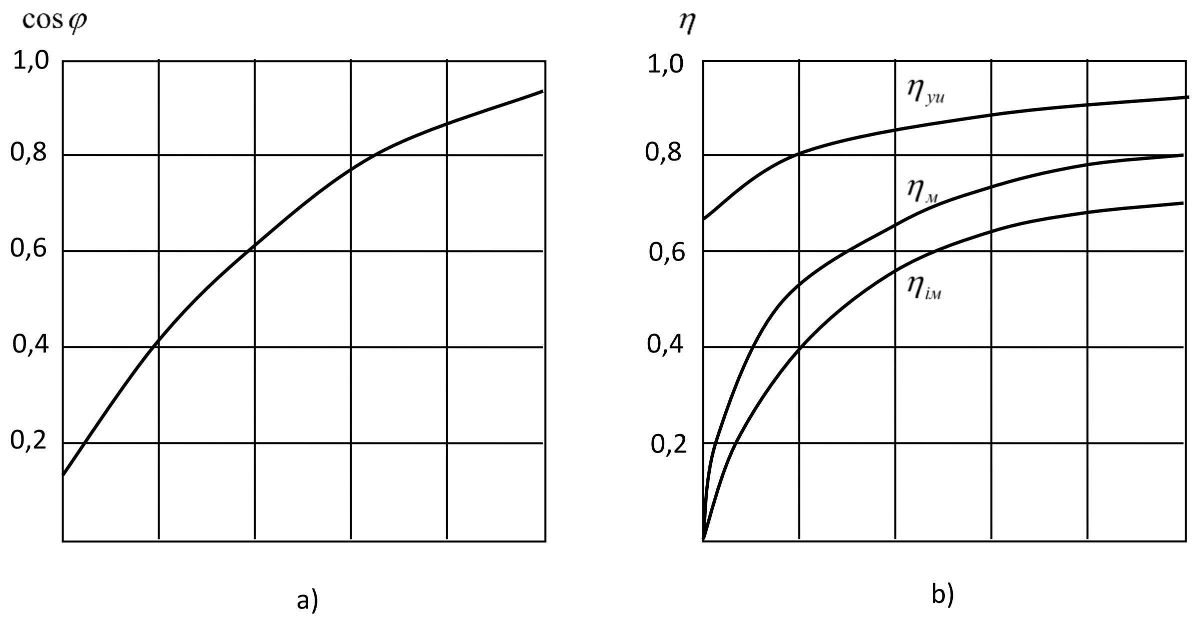
1. Incorrect selection of asynchronous motors in terms of power and operating conditions. Due to the high scattering of inductive resistance of phase rotor induction motors, the value of $\cos\varphi$ is lower than that of induction motors with short-circuited rotors. Cooling conditions in closed engines are lower than in open engines. Among motors of the same type and power, the higher the speed of one of them, the higher the value of $\cos\varphi$.
2. Incomplete and uneven loading of production mechanisms and their electrical equipment.
3. Unloaded operation of electric motors and transformers.
4. Use of high-power electric motors and transformers in low-power production facilities.
5. The use of electric motors at a power higher than the rated power increases the scattering of the magnetic flux, resulting in a decrease in $\cos\varphi$.
6. Use of faulty or badly repaired electrical equipment: for example, do not tightly compress the rotor steel cans, the number of coils of the Tatar coil is less than the initial number, etc. A 10% reduction in the number of wheels increases the engine speed by 25%, which leads to a decrease in power factor by 6-8%. A difference of 10 mm in the size of the rotor steel leads to a reduction of $\cos\varphi$ 15-30%
7. During lunch, evening shifts, when high-power machines are turned off for a long time and when operating in low load mode, a few volts increase in mains voltage leads to an increase in inductive consumer magnetic current and, consequently, a decrease in ladi. This is due to the fact that high-inductance consumers, such as welding machines, are used without reactive power compensators.

8. As a result of the presence of rectifiers and the presence of ferromagnetic core power consumers operating in the mode close to the saturation mode, the sinusoidality of the voltage in the network is violated. In asynchronous motors and transformers, an additional power drop occurs under the influence of nosinusoidal voltage, which reduces the service life of the insulation.

$$K_M = \cos\varphi_1 K_{\Pi 1}, \qquad (1.1)$$

here $\cos\varphi$ is the power coefficient of the first harmonic

$K_{\Pi} = \frac{I_1}{\sqrt{\Sigma I_i^2}}$ - correction factor; i is the harmonic organizer order number.



Graph 1. Graphs of dependence of asynchronous electric motor power factor (a), load factor $\eta_{iм}$, of electric motor $\eta_{м}$, working $\eta_{уи}$ FICs (b)

The following formula reduces the percentage of total power of the device
determined by:

The power factor used in industrial enterprises ranges from 0.2 to 0.5 (welding equipment, cranes, excavators) from 0.7 to 0.8 (fans, concrete mixers, conveyors), while the power factor is close to one. There may be consumers with dead and capacitive loads (synchronous motor compressors and pumps). However, according to the rules of operation of electrical equipment, the value of the power factor of the network should be 0.92 - 0.95.

In order to increase the power factor and reduce power losses in electrical equipment, the following measures are taken:

1. Selection of asynchronous motors with short-circuited rotors and the use of open-circuit motors that are easy to cool, depending on the capabilities and conditions.

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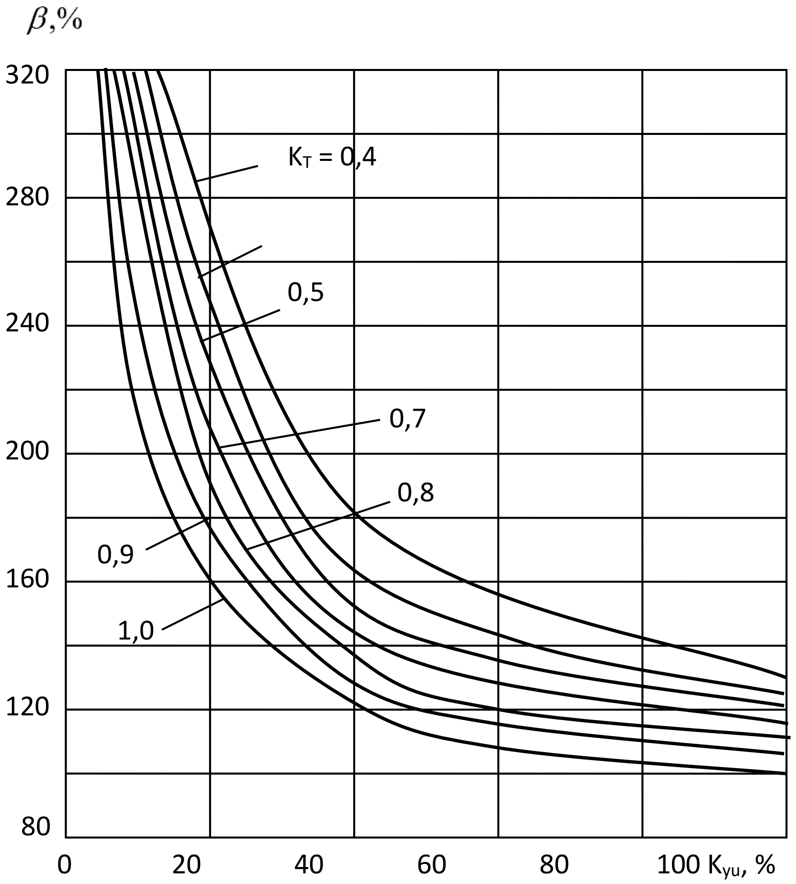

Graph 2. Graph of the specific value of electricity consumed in the working machine depending on the load factor

2. Achieving a uniform distribution of the working mechanism during the full loading and production of electrical equipment. Figure 2.2 shows the change in the load factor of the engine $\cos\varphi$ and the FIC, the working mechanism and the drive FIC depending on Kyu.

Electricity to calculate economized electricity we first calculate the specific value of energy:

$$Э_{CQ} = \frac{1}{\eta_M * \kappa_{yu}} \left[\kappa_{yu} + \frac{\alpha(1-\eta_M)}{\kappa_T} \right] \qquad (1.2)$$

Here $\eta_{\text{M}} -$ FIC when the working mechanism is fully loaded; Kyu - load factor; CT - coefficient of utilization of the working mechanism; $\alpha = 0{,}7 - 0{,}9 -$ coefficient depending on the type and design of the working mechanism.

Kyu and Kt coefficients are determined using the following formulas:

$$K_{yu} = \frac{P}{P_H}, K_T = \frac{t_M}{(t_M + t_O)}, \qquad (1.3)$$

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here Pn is the rated power of the motor, tm is the operating time of the mechanism, and t_0 is the travel time.
Since to = 0 and Kt = 1, Kyu = 1 for the maximum operating mode of the working mechanism, the specific value of electricity is the minimum:

$$Э_O = \frac{[1+\alpha(1-\eta_M)]}{\eta_M} . \qquad (1.4)$$

To calculate the energy savings as a result of increasing the load on the working mechanism, the hourly electricity savings are calculated by the following formula, taking into account the graphs in Graph 2.3 and $\beta = Э_{CQ} / Э_0$ the coefficient:

$$\Delta Э = (\beta_1 - \beta_2) * Э_O, \qquad (1.5)$$

Here $\beta_1, \beta_2 -$ electricity is applied before and after loading coefficients of relative change of specific energy.

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