WAYS TO ACHIEVE ENERGY SAVINGS THROUGH REACTIVE POWER COVERAGE

D.B. Kodirov
National Research University TIIAME, Head of Department
J.O. Izzatillaev
National Research University TIIAME, Associate professor (izzatillaev.jurabek@gmail.com)
D.G. Yulchiev
National Research University TIIAME, Assistant
D.Hasanov
National Research University TIIAME, graduate student

https://doi.org/10.5281/zenodo.7372978

Abstract.*The article deals with the efficient use of energy in enterprises by reactive power compensation. Performed parametric analysis of the effect on the characteristics of the active load balancing device, mounted on tires of low voltage traction substations, depending on the location of the load between the power source and the load itself. Implementation of measures for reactive power compensation results in a saving of active power and energy.*

Keywords: *reactive power, power consumption, power networks, compensation, nominal value, power factor, voltage drop, capacitor.*

СПОСОБЫ ДОСТИЖЕНИЯ ЭКОНОМИИ ЭНЕРГИИ ЗА СЧЕТ ПОКРЫТИЯ РЕАКТИВНОЙ МОЩНОСТИ

Аннотация. *В статье рассматривается эффективное использование энергии на предприятиях путем компенсации реактивной мощности. Выполнен параметрический анализ влияния на характеристики активного устройства балансировки нагрузки, установленного на шинах низковольтных тяговых подстанций, в зависимости от расположения нагрузки между источником питания и самой нагрузкой. Реализация мер по компенсации реактивной мощности приводит к экономии активной мощности и энергозатрат.*

Ключевые слова: *реактивная мощность, энергопотребление, электрические сети, компенсация, номинальное значение, коэффициент мощности, падение напряжения, конденсатор.*

РЕАКТИВ ҚУВВАТНИ КОМПЕНСАЦИЯЛАШ ОРҚАЛИ ЭНЕРГИЯ ТЕЖАМКОРЛИККА ЭРИШИШ ЙЎЛЛАРИ

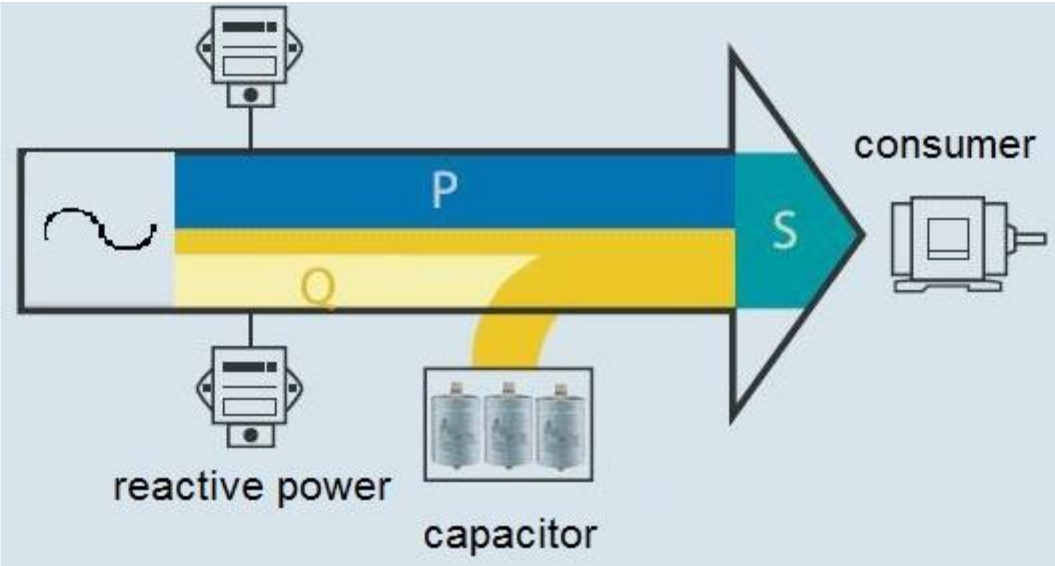
Аннотация. *Мақолада реактив қувватни қомпенсациялаш орқали корхоналарда энергиядан самарали фойдаланиш ҳақида сўз боради. Қувват манбаи ва юкламанинг ўзи ўртасидаги юкламанинг жойлашишига қараб, паст кучланишли тортувчи нимстанцияларининг шиналарига ўрнатилган фаол юкламаларни мувозанатлаш мосламасининг хусусиятларига таъсирини параметрик таҳлил этилган. Реактив қувватни қоплаш бўйича чора-тадбирларни амалга ошириш актив қувват ва энергияни тежашга олиб келади.*

Калит сўзлар: *реактив қувват, қувват сарфи, электр тармоқлари, компенсация, номинал қиймат, қувват коэффициенти, кучланишнинг пасайиши, конденсатор.*

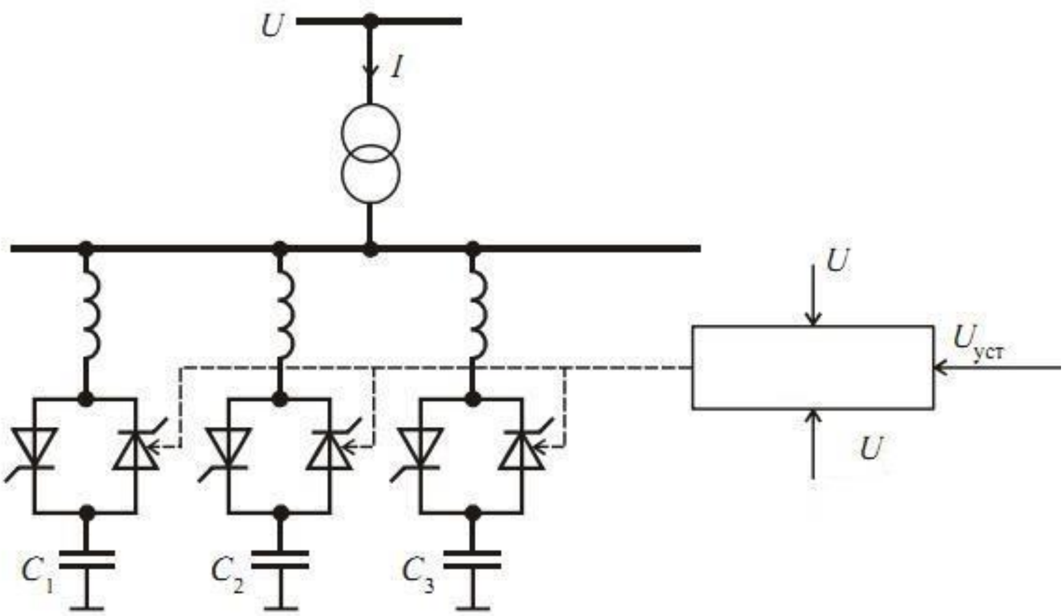
According to the regulation on the procedure for organizing work on reactive power compensation, the standard value of the power coefficient for consumers supplied from the 0.38 kV network is set at tgφm = 0,25 (or cos φ m = 0.97), but the power coefficient in industrial enterprises is at the required level it is not. Therefore, it is necessary to use energy efficiently in the enterprise by means of reactive power compensation [2].

What are the main consumers of reactive power [1]:

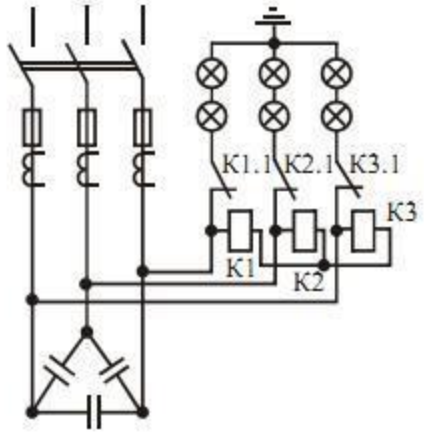
1. Asynchronous motors consume 60% of the total reactive power.



2. Power transformers consume about 20% of reactive power.



3. Controlled rectifiers, induction furnaces, discharge lamps, etc. consume about 15-20%.



If an automatic compensation device is used, what will be the economic effect [1]:

1. Losses in the power grid and transformers are reduced due to the reduction of consumption current;
2. The voltage drop in power lines is reduced;
3. The computing power of the system decreases;
4. Due to the reduction of phase currents in working objects, energy loss in cables is reduced;
5. Reactive energy payment is saved;
6. Reducing the load on power transformers leads to a decrease in the heating temperature in the coils and ultimately to an increase in the life of the transformer.

Costs per unit of time for the application of the condenser device to the enterprise are determined.

Unit time include the prices of the automatic capacitor unit E_k and the measuring current transformer, as well as additional costs such as the delivery and installation of the capacitor unit, and the cost of the cable used to connect the capacitor unit.

Remote control of the condenser device is provided, then the total consumption per unit time the price of the remote control device is also included.

In general, we assume that all additional costs are 10% of the cost of the condenser unit, and calculate the following formula [1]:

$$E_K = (C_{y1} + C_{y2} + ... + C_{yn}) \cdot K_d + C_d \quad (1)$$

where: S u1 is the price of the capacitor device; n- the number of condenser devices;

K_d = 1.1- coefficient of additional expenses;

C_d- the price of remote communication equipment.

In series, the resulting reductions in reactive power costs and reductions in conductor losses are identified.

The annual savings from reactive power payments are [1]:

$$E_{gr} = C_{G1} - C_{G2} = (P_{p1} + P_{p2}) \cdot 12T_p \quad (2)$$

where: C_{G1}- the payment for reactive energy before the installation of the condensing unit; C_{G2}-payment for reactive energy after installation of the capacitor unit; P_{p1} - payment for reactive energy in the month before installation of the condensing unit; P_{p2}- the payment for reactive energy in one month after the installation of the condensing unit; T_p- definition of reactive energy.

If there are no directly measured values when calculating the loss caused by the reduction of losses in the wires, then it is determined through the rectifier capacitor.

We assume that the coefficient of wastage K_p = 12%

Conductor are proportional to the square of the current passing through it.

Let's take a look at this constructor on the example of a working object.

Coefficient before installing the automatic capacitor device: $\cos\varphi_1$ =0.8.

Coefficient after installing the automatic capacitor device: $\cos\varphi_2$ =0.97.

Assume that the relative asset forming current is equal to 1.

The relative full current before compensation is:

$$I_1 = \frac{1}{\cos\varphi_1} = \frac{1}{0{,}8} = 1.25 \qquad (3)$$

Relative full current after compensation:

$$I_2 = \frac{1}{\cos\varphi_2} = \frac{1}{0{,}97} = 1.03 \qquad (4)$$

Reduction of active energy:

$$W_C = W_1 \cdot \left[\frac{I_1^2 - I_2^2}{I_1^2} \cdot K_п \right] = W_1 \cdot 0{,}038 \qquad (5)$$

That is, in this example, active energy consumption decreased by 3.8%. When cosφ increase from 0.8 to 0.97, active energy consumption decreases by 1.7%.

In general, the reduction of active energy consumption of a working facility in one year as a result of an increase in cosφ is determined by the following formula:

$$W_c = W_1 \cdot \left[\left(\frac{1 - \cos^2\varphi_1}{\cos^2\varphi_2} \right) \cdot k_n \right] \qquad (6)$$

where: cosφ 1 is cosφ before compensation, $\cos\varphi_2$ is the cosph after compensation, k_n=0.12 - wastage coefficient; W_1 - annual energy consumption for compensation.

Savings from the annual energy bill and calculating the amount of reactive energy compensation, the amount saved from electricity after the installation of a compensating device at the enterprise is equal to the following,:

$E = E_a + E_r$ (7)

here: E_a - active energy , E_r - reactive energy.

Find the economic payback period of the compensation device:

$$T = \frac{E_K}{E}, \qquad (8)$$

where: E_K- the price of the compensation device.

Economic efficiency calculations show that reactive power compensation in electrical installations provides savings on electricity bills and capital reductions are covered in the short term.

It was analyzed the use of the device and the technical voice, which allows to ensure the quality multiplier and to reduce the loss in the compact voltage tap with non-symmetrical load. In this case, the automatic power switch with automatic power saver is the best technical tool to reduce battery consumption.

REFERENCES

1. Criteria for the existence of established modes of power systems . Davirov A. , Tursunov O., Kodirov D., Baratov D., Tursunov, A., IOP Conference Series: Earth and Environmental Science , 2020, 614(1), 012039

2. Study on the increase in power supply reliability for the consumers of electricity. Rakhmatov A. IOP Conference Series: Earth and Environmental Science, 2021, 939(1), 012011

3. Khoshimov F.A., Lecture text on the science of energy saving, 2010, pp. 38-40.

4. Regulation on the procedure for organizing work on reactive power compensation - 2008. 1864 y.

5. Clause 131 of the 2009 Electricity Use Regulations of the Cabinet of Ministers – 2009.