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CALCULATION OF POWER WASTE IN ELECTRICAL NETWORKS

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A B S T R A C T	K E Y W O R D S
The quality of electricity in the territory of our republic mainly depends on current and narguz, taking into account the interaction of magnetic currents used in the control and management of currents of electric power supply networks, frequency, voltage, currents. In winter, we can use it to improve the quality of electricity. Today, the demand for electricity is increasing. On this scale, we can use it for the purpose of reducing the length of the line in order not to increase the power loss in the overhead line. If we increase the tension, we eliminate it, we need to choose the cross section of the wire in the line. the results of the study are presented.	electric energy, currents, power dissipation, control, voltage, magnetic flux, element, Rogovsky belt - stem, retort, probability of working state, model, reliability indicators, work ability.

INTRODUCTION

The loss of active and reactive power in three-phase alternating current lines, if we do not take into account the conductivities of the line (V=0, G=0), is calculated according to the following formulas:[1]

$$\Delta P = 3I^2 r = 3(I_a^2 + I_p^2)r \qquad (1)$$

$$\Delta Q = 3I^2 x = 3(I_{à}^2 + I_{ð}^2)x \qquad (2)$$

Here r and x are active and inductive resistances of the line; I_a and I_R are the active and reactive components of the full load current I.It is known that

$$Ð = \sqrt{3}UI\cos\varphi; \quad Q = \sqrt{3}UI\sin\varphi . \qquad (3)$$

Full current through its active and reactive components

$$I\cos\varphi = I_a , \quad I\sin\varphi = I_p \qquad (4)$$

we express: We put the values of I_a and I_R in (3):

$$Ð = \sqrt{3}I_a U, \quad Q = \sqrt{3}I_p U . \qquad (5)$$

From this $I_a = \frac{P}{\sqrt{3}U}$; $I_p = \frac{Q}{\sqrt{3}U}$ putting expressions (1) and (1) we get the following important expressions:

$$\Delta P = 3I^2 r = 3\left(\frac{P^2}{3U^2} + \frac{Q^2}{3U^2}\right)r = \frac{P^2 + Q^2}{U^2} r = \frac{S^2}{U^2} r. \quad (6)$$

$$\Delta Q = 3I^2 x = 3\left(\frac{P^2}{3U^2} + \frac{Q^2}{3U^2}\right)x = \frac{P^2 + Q^2}{U^2} x = \frac{S^2}{U^2} x. \quad (7)$$

Here S is full power. Based on the expressions obtained above, we make the following conclusions:

1. Active and reactive power dissipation depends on R and Q.
2. The dissipation is inversely proportional to the square of the voltage. Therefore, increasing the voltage to a small value significantly reduces power dissipation. But raising the voltage requires additional spending. [2]
3. When there are several consecutively connected loads along the line (Fig.4.1,a), the power loss in it is the sum of the power losses in each section, i.e.

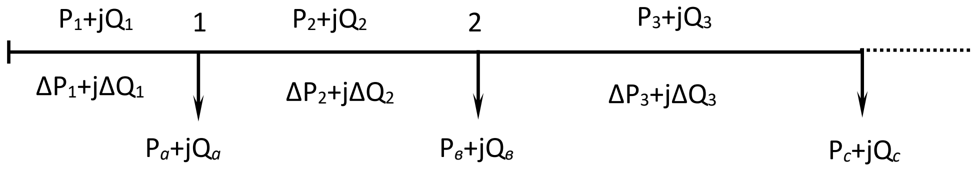
$$\Delta P_z = \Delta P_1 + \Delta P_2 + \Delta P_3 + \cdots + \Delta P_n,$$

$$\Delta Q_z = \Delta Q_1 + \Delta Q_2 + \Delta Q_3 + \cdots + \Delta Q_n.$$

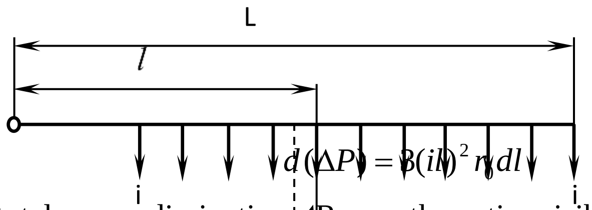
Here ΔR_1, ΔR_2, …and ΔQ_1,, ΔQ_1,,… are determined by expressions (6) and (7), respectively.

Power dissipation when the load is distributed uniformly along the length of the line. We assume that the cross-sectional surface of the conductor is uniform over the entire length of the line:

We define the loading of the line per unit length by i_0,



a)



To determine the total power dissipation ΔR over the entire visible length L line, we add the values

б)

4.1- расм.

) and L, i.e.:

$$\Delta Đ = \int_0^L 3(i_0 l)^2 r_0 dl = 3 i_0^2 r_0 \int_0^L l^2 dl = 3 i_0^2 r_0 \left| \frac{L^3}{3} \right|_0^L = I^2 r = \frac{P^2 + Q^2}{U^2} \cdot r. \quad (8)$$

In the above order

$$\Delta Q = I^2 x = \frac{P^2 + Q^2}{U^2} x. \quad (9)$$

Thus, when the load is uniformly distributed along the line, the power loss is three times less than when the same load is at the end of the line. We make sure of this by comparing expressions (4), (5), (8), (9). [3]

The three-phase system is very common in practice. In such a system, at a uniform power and voltage, there is less power loss than in a single-phase system. Let's compare the waste in these systems. For three-phase networks

$$S = \sqrt{3}UI_3, \qquad I_3 = \frac{S}{\sqrt{3}U}.$$

For single-phase networks

$$S = UI_1, \qquad I_1 = \frac{S}{U}\varphi.$$

Power dissipation for a three-phase network

$$\Delta P_3 = 3I_3^2 r_3, \qquad \Delta Q = 3I_3 x_3$$

Power dissipation for a single-phase network

$$\Delta P_1 = 2I_1^2 r_1, \quad \Delta Q_1 = 2I_1^2 x_1$$

Putting (10) and (11) into (12) and (13), respectively, we get: power dissipation for a three-phase network

$$\Delta P_3 = \frac{S_2}{U_2} r_3, \qquad \Delta Q_3 = \frac{S^2}{U^2} x_3$$

power dissipation for a single-phase network

$$\Delta P_1 = \frac{2S^2}{U^2} r_1, \quad \Delta Q_1 = \frac{2S^2}{U^2} x_1$$

Comparing (14) and (15), we draw the following conclusions. In fact, power loss in three-phase networks is 2 times less than in single-phase networks. However, there are two conductors in a single-phase system, and three conductors in a three-phase system. In order to homogenize metal waste, the cross-sectional area of conductors in a three-phase network should be reduced by 1.5 times compared to one-phase. In this case, the resistance increases by 1.5 times, i.e. r3=1.5r1. Substituting this value into the expression for ⊿R3, we get:

$$\Delta Đ_3 = (1{,}5S^2/U^2) r_1$$

Therefore, power loss in single-phase networks is 2/1.5=1.33 times more than in three-phase networks. [4]

Active and reactive power losses in transformers and autotransformers are divided into ⊿Rs, ⊿Qs (in conductances gt and bt) and short-circuit losses ⊿RT, ⊿QT (in circuit resistances rt and xt). When calculating power transmission lines taking into account transformers, transmittances gt and bt transmittances are taken into account in the form of a suitable load and are included in the transmitted power equation (balance).

The loss of active power due to supermagnetization and inrush currents in the steel of the transformer is defined as the loss in active conductance gt below the nominal voltage U (in normal operation) given as passport information of the transformer. In this case, the following expression for the loss in conduction gt is appropriate, since the loss of power due to the effect of pure operating current in the high voltage range is very small:

$$\Delta P_{пул} \approx \Delta P_c \approx U_н^2 g_т$$

Here, DRpul is the active power dissipated in the steel of the transformer (that is, in the core, which is usually made of steel. [5]

The reactive power spent on the magnetization of the transformer (Q is determined by the reactive conductivity bt) is found using the transformer's operating current as a percentage of the nominal current. If we assume that I_{pul}=0, since the active part of the operating current is very small, the magnetizing power is equal to:

$$\Delta Q_{пул} = \Delta Q_c = \frac{I_c \% S_н}{100} = U^2 b_т \qquad (17)$$

Active power loss in the short-circuit state, which is spent on heating the pipes (this loss is called the power loss in copper) can be found as in formula (6) as follows:

$$\Delta P_т = \frac{P^2 + Q^2}{U_н^2} r_т$$

In the same way, the loss of reactive power caused by the spread of the magnetic flux can be determined as in the formula (7):

$$\Delta Q_т = \frac{P^2 + Q^2}{U_н^2} x_т \qquad (19)$$

The voltage in expressions (18) and (19) is the nominal voltage of the considered line to which the transformer is directly connected.[6]

The expression of the loss in the winding of the transformer can be described in a different form than (18). It is known that in the short-circuit experiment, I=IN, and the active power dissipation is determined as follows:

$$\Delta P_к \approx 3 I_н^2 r_т = \frac{S_н^2}{U_н^2} r_т$$

At another value of the load current, the active power dissipation in the transformer is found as follows:

$$\Delta P_т = 3 I^2 r_т = \frac{S^2}{U_н^2} r_т \, .$$

From the relationship ⊿Rt/⊿Rk we form the following expression:

If we replace xt in expression (19) with its expression in (3.14) for ⊿Qt, we get the following formula:

$$\Delta Q_т = \frac{u_k \%}{100} \cdot \frac{S^2}{S_н} \, . \qquad (21)$$

Expressions (18) and (19) are valid for determining the power loss for two-phase and three-phase transformers and autotransformers regardless of the load on their phases. When calculating the loss in a winding of a three-winding transformer or an autotransformer, the load of the winding is replaced by the total load of the transformer in the formula, and the resistance of the corresponding winding is replaced by the resistances rt and xt. Formulas (20) and (21) are divided into low-voltage circuits, and they are also valid for losses in two-circuit transformers with homogeneous loads. [7]

Thus, the total active, reactive and total power losses in the transformer are calculated as follows:

$$\begin{aligned} \Delta P_{т\Sigma} &= \Delta P_{т} + \Delta P_{c} \\ \Delta Q_{т\Sigma} &= \Delta Q_{т} + \Delta Q_{c} \\ \Delta S_{т\Sigma} &= \sqrt{\Delta P_{т\Sigma}^2 + \Delta Q_{т\Sigma}^2} \end{aligned} \quad (22)$$

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