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Ways to Reduce Losses in Power Transformers

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Annotation: Research in the field of transformer engineering has led to the creation of transformers with reduced no-load losses, which makes it possible to reduce the overall level of losses in distribution networks.

Key words: transformer, calculating electricity losses, the efficiency, transformer engineering

At present, a significant part of power transformers in the power systems of the Republic of Uzbekistan is operated beyond the limits of the standard service life, and many of them underwent major repairs with the dismantling of the magnetic circuit. According to the results of diagnostic tests, the actual power losses in the magnetic wires of these transformers differ significantly from their passport values [1]. At the same time, in the current methods for calculating electricity losses in networks, the life of the transformer and the presence of a major overhaul with the dismantling of the magnetic circuit are not taken into account. This circumstance leads to a significant error in the calculation of electricity losses in the magnetic circuits of transformers and affects the efficiency of energy saving measures taken.

In modern conditions, the importance of the task of reducing electricity losses in networks has increased significantly due to the fact that the cost of standard losses is one of the components of the electricity tariff. Excess electricity losses not included in the tariff are direct losses for power grid companies, the savings from the reduction of which can be used to reconstruct networks, improve the organization of transmission and distribution of electricity, improve the reliability and quality of power supply to consumers, increase staff salaries, and reduce electricity tariffs. In this regard, improving the accuracy of calculating losses in transformers is a particularly urgent task.

In the idle mode, the active power consumed by the transformer is consumed only to cover the losses in the steel of the magnetic circuit and in the primary winding from the no-load current ($I^2_0 \cdot r_1$). The losses arising in this case in the magnetic circuit are called magnetic and are denoted $P_м$. A and the total losses in the idle mode (at the nominal primary voltage and frequency) are called no-load losses and are denoted by P_0: $P_0 = P_м + I^2_0 \cdot r_1$, where r_1 is the active resistance of the primary winding. A feature of no-load losses is their constancy and independence from the load mode of the transformer. Indeed, the no-load current I_0 is determined by the geometric sum of the magnetizing and active components. The current I_μ creates the main flow Φ_0, and the active component I_a is determined only by the losses in the steel from hysteresis and eddy currents. The magnetic flux Φ_0 remains constant, no matter how the load mode (currents I_1 and I_2) of the transformer changes. Therefore, the current I_μ will remain unchanged under any load. The active component depends only on magnetic losses, and for a given magnetic circuit made of a certain steel grade (at nominal primary voltage and frequency), it is also unchanged. Naturally, the losses in the primary winding from the flow of current I_0 will remain unchanged. Thus, at rated primary voltage and frequency, noload losses P_0 are constant and do not depend on the load of the transformer.

When the load is switched on, electromagnetic power is transferred from the primary winding to the secondary; current I_2 appears in the secondary winding; at the same time, a current I_1 appears in the primary winding, which is directly dependent on the load, i.e., on the current I_2. In this case, power is lost in the windings, proportional to the squares of the currents and the resistances of the primary and secondary windings: $P_{нагр} = I^2_1 \cdot r_1 + I^2_2 \cdot r_2$, where I_1 and I_2 are the load currents; r_1 and r_2 are the resistances of the

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corresponding windings. Naturally, the losses $P_{нагр}$ directly depend on the amount of power required by the consumer. If we take into account that the need for energy during the day is not the same, then significant fluctuations in the load losses in the windings are obvious, i.e. these losses are not constant and depend on the load mode.

Research in the field of transformer engineering has led to the creation of transformers with reduced no-load losses, which makes it possible to reduce the overall level of losses in distribution networks. It should be noted that the use of transformers with an amorphous steel core gives the greatest energy savings [1-3].

Thus, the above circumstances indicate the need to analyze the effectiveness of replacing transformers with significant service life and increased no-load losses with more modern ones.

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