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ELECTRIC ANALOGIES OF THERMAL PROCESSES IN THE INSULATIONS LAYERS OF THE OIL-IMMERSED POWER TRANSFORMER WINDING

Modeling of thermal processes in an oil-immersed power transformer is used to predict the processes of the cellulose insulation thermal aging. When developing these models, electrical analogues of thermal processes are used. Known electrical equivalent circuits of these processes do not take into account the nature of the thermal interaction of horizontal layers of the winding cellulose insulation with transformer oil, which reduces the accuracy of modeling.

The purpose of the work is to improve the accuracy of modeling the thermal ageing of the winding insulation. This is achieved by including in the equivalent circuit such elements as analogues of the heat capacity of the moving oil layer and the thermal resistance of the “cellulose insulation – transformer oil” section. Thus, in the i -th layer, part of the thermal energy Q_{in} of losses from current flow in the winding goes to increase the insulation temperature, and part goes to increase the oil temperature. The oil moves to the overlying insulation layers and gives them the energy received, which increases the temperature of these layers. In the equivalent circuit of the $(i + 1)$ th layer thermal processes, this flow is represented by a heat source, which is added to the heat flow caused by the current flowing through the winding. As a result, the temperature increase in the winding layers is non-linear and decreases for the upper layers.

Using the proposed model of thermal processes, a computer program has been developed to predict the dynamics of temperature changes in the horizontal layers of the transformer winding insulation in the non-stationary load mode. The program is implemented in the Simulink environment of the Matlab system.

The temperature values of cellulose insulation layers obtained using the program are used to calculate the absolute humidity of this insulation and calculate the instantaneous values of its relative wear rates. The simulation results confirmed the possibility of accelerated wear of insulation in layers with a lower temperature than the temperature of the most heated layer. Based on this, it was concluded that

it is necessary to monitor the relative wear rates of the cellulose insulation of the windings during the operation of the transformer layer by layer. This will improve the accuracy of the simulation.