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MODELING OF THE TEMPERATURE STATE OF TURBOGENERATORS IN THE MEDIUM OF SOLIDWORKS

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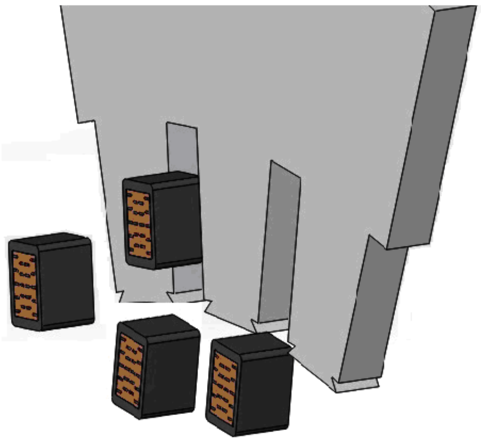
Thermal processes are of great practical importance at all stages of design, production and operation of turbogenerators (TG). In the world practice, when designing new ones and carrying out modernization of TG that are already in operation, work is underway to replace hydrogen in the TG with a power of 200-300 MW of hydrogen cooling by air. Furthermore, problems are solved in the design of new power increase TGs without changing their size (from 200 to 250 MW). However, this requires more accurate thermal calculations of the TG, and especially the most heat-loaded stator core.

In recent years, the TG designs have been significantly changed due to the use of new materials and new manufacturing technologies, which allows to improve the distribution of losses, organize more efficient ventilation, reduce temperature and vibration. To do this, it is necessary to be able to more accurately calculate the main and additional losses, take into account the temperature distribution by volume of the machine. Modern methods of experimental research, control and calculations using computers can provide a detailed picture of the dynamics of the thermal state of various TG nodes, [1,3].

The use of computers for monitoring and calculation allows solving thermal problems for determining temperature fields or calculating the temperature of individual nodes of any complexity, for example, using equivalent thermal substitution schemes (ETS), but their use encounters certain difficulties. First of all, this refers to the calculation of thermal resistances, to the correct account of the processes of heat radiation. Complex configuration of cooling surfaces, ambiguity of heat transfer coefficients, a variety of specific thermal characteristics of insulating and active materials, the complexity of determining the ways of movement of heat flows and flows of cooling liquids and gases must be taken into account. This leads to the fact that errors in the calculation of thermal resistances can be significant.

The purpose of our research is to determine the thermal state of the core and stator winding rods by modeling the temperature field, taking into account the 3D heat distribution from the circulating currents and ohmic losses, replacing the coolant with simultaneous increase of the TG power without changing its dimensions. When performing the thermal calculation of the stator core, the finite element method was used to determine the temperature distribution. This method allows modeling using SolidWorks software (Solid Works Simulation application), [1,2]. The advantage of this method is high accuracy. The 3D model of the stator core sector with the winding rods was used in the calculations, Fig. 1.



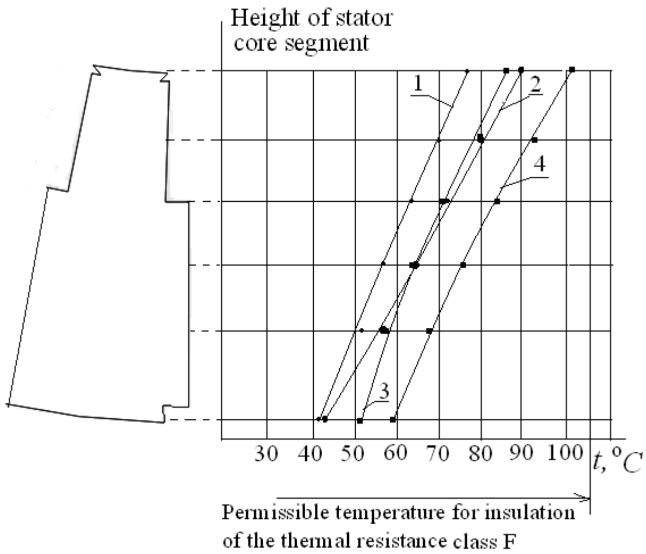


Figure 1 - 3D model of the stator core sector with winding rods

Figure 2 - Changes in the temperature of the stator core when replacing the coolant and increasing the power
1, 2 - 200 MW, cooling with hydrogen (1) and air (2); 3, 4 - 250 MW, cooling with hydrogen (3) and air (4)

The presented model allows simulating the thermal field in the stator core under hydrogen and air cooling for a TG of nominal power (200 MW) and for the same TG with a power of 250 MW, Fig. 2. It is possible to identify and prevent the emergence of an emergency overheating zone of the machine in advance and also calculate the machine thermal state. This makes it possible to exclude the appearance of the most probable overheating zones even at the design stage. It is important that such a calculation of possible places of significant overheating of TG allows us not to create additional samples for the experimental determination of the temperature values.

Literature

1. Bogan A. Yu. Experimental thermal characteristics of a new generation of turbogenerators with air cooling / A.Yu. Bogan, E.I. Gurevich, Yu.V. Pafomov and others. // S.-Petersburg: Electrosila. - Collection No. 42. - 2003. - P.p. 51-55.
2. Shevchenko V.V. Comparative estimation of mass-dimensions parameters of turbogenerators with air and hydrogen cooling systems / V.V. Shevchenko, A.N. Minko //

Kharkov: Bulletin of NTU "KhPI". Power and heat engineering processes and equipment. - 2010. - No. 3. - P.p. 108 - 112.

3. Shevchenko V.V. Ways to increase the power of turbogenerators during the work on their rehabilitation / V.V. Shevchenko // Kharkov: Kharkov Air Force University. - Information processing systems. Miscellany of scientific works. - 2012. - No. 7(105) - P.p. 152-155.