TEMPERATURE GRADIENT IN STATOR ELEMENTS OF INDUCTION MOTOR ATD-5000 IN THE CHANGE OF LOAD

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Introduction. One of the main constituents of induction motor (IM) is a stator winding. In the course of prolonged operation, particularly powerful IMs, stator winding damages can occur, especially due to overheating of the winding conductors. Such injuries at significant volumes can lead to an emergency stop of IM with significant economic losses. Therefore, the study of the causes of the stator winding damage to prevent emergencies is an urgent task. The causes of the primary damage of the stator winding are usually associated with: IM overloading, the disadvantages of the technological processes of manufacturing a specific IM, or using low-quality insulating materials. The study of the temperature gradient in electric machines was carried out in [1].

The purpose of the work. The purpose of this article is to study the methods of mathematical modeling of the temperature gradient distribution features in the stator winding insulation, which arise during the overload of the IM.

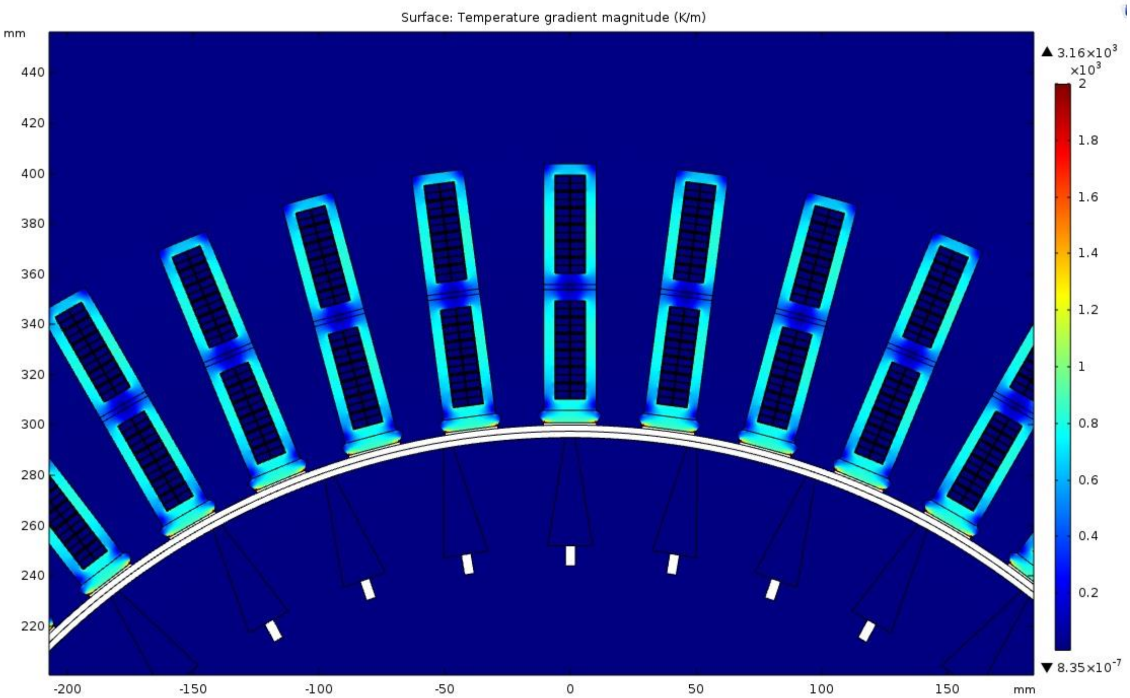
Material and results of the research. The research was carried out on the example of IM type ATD, whose parameters are: nominal power - 2500 kW, power factor - 0,905, efficiency - 0,964, rotational speed - 2980 rpm, rated stator voltage - 6 kV, nominal stator current - 280 A, stator diameter - 1115 mm, air gap - 5 mm, number of stator grooves - 48, scheme of connection of phases of stator winding - triangle, diameter of rotor cutting - 590 mm, number of rotor rods - 38, class of insulation resistance of stator winding - B. Under each groove of the rotor are located axial ventilation canal.

In the article, the values of the temperature gradient (temperature difference) in stator elements of the IM were investigated, which influence the magnitudes of thermomechanical stresses in these elements and, therefore, is an important characteristic of the temperature field of the machine.

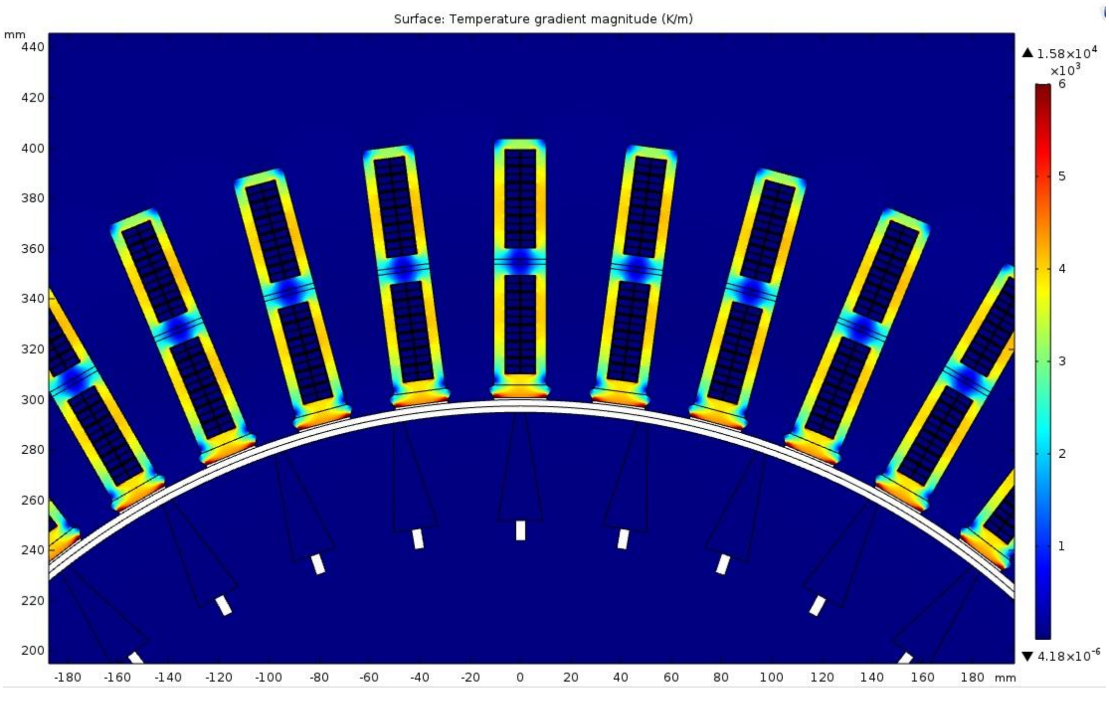
In pics. 1-3 shows the distribution of the temperature gradient in the stator grooves in the non-operating regime, at the nominal load and at the overload of the IM by 58%, respectively. From the analysis of the distribution diagrams of the temperature gradient of the IM, working at the nominal load, the following conclusions can be made:

1. The minimum value of the temperature gradient in the IM stator insulation is observed in a glass-fiber lining in the middle part of the groove (250 °C/m).
2. The maximum value of the temperature gradient is observed in the grooved isolation of the IM stator in the middle part of the stator winding layers (4000 °C/m).
3. Large values of the gradient are also observed in the groove wedges (till 7000 °C/m).
4. The smallest temperature gradient indicators are observed at idle mode, and the highest temperature gradients are observed when the IM is used for overloading.

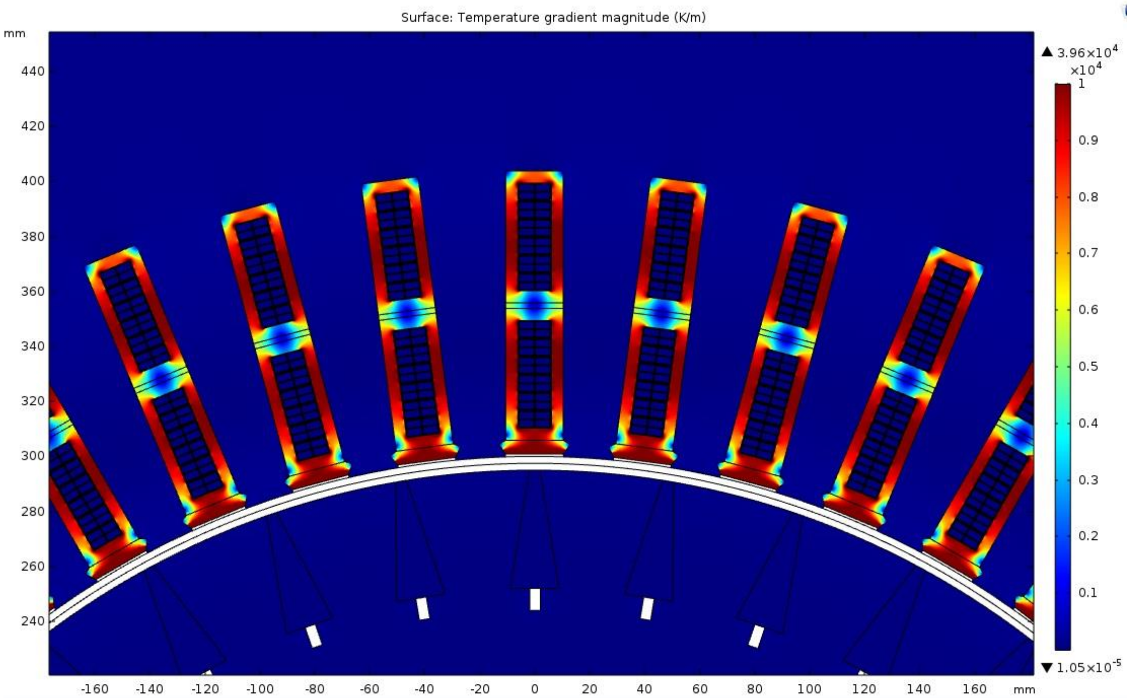
5. The temperature gradient in the IM's steel is small (from 6 till 160 °C/m) (pic. 5). Local excess of the permissible values of the temperature gradient in the IM's steel are located in the corners around the grooves and stator wedges (till 160 °C/m).



Picture 1 – Distribution of the temperature gradient in the stator winding isolation at idle speed

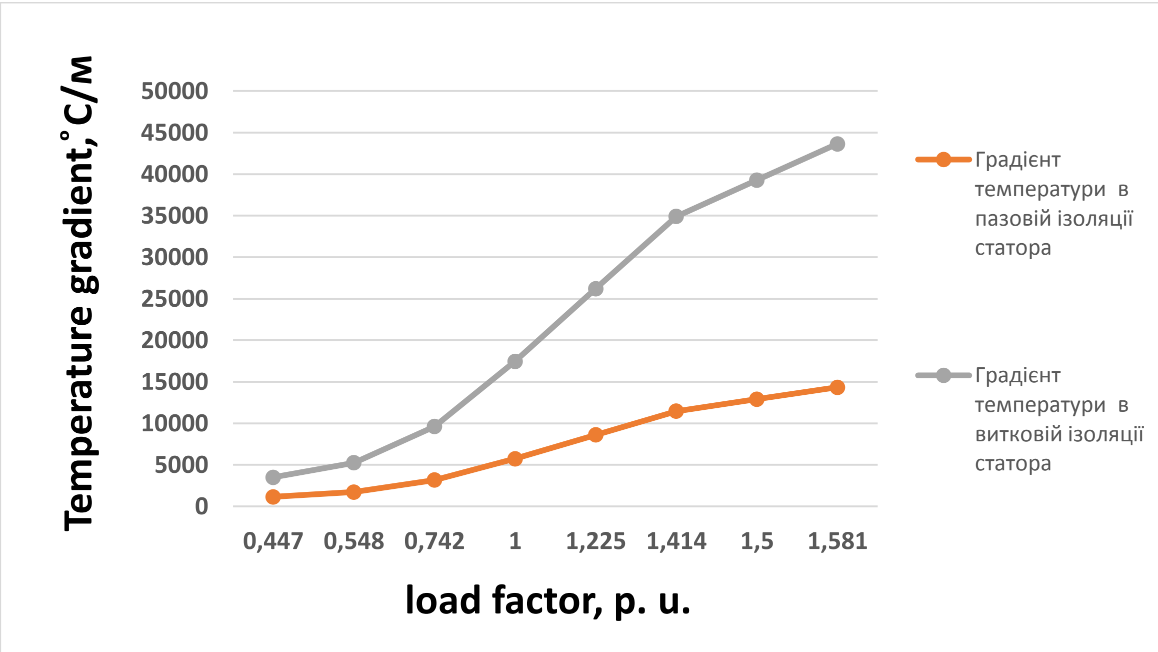


Picture 2 – Distribution of the temperature gradient in the stator winding isolation at the nominal load

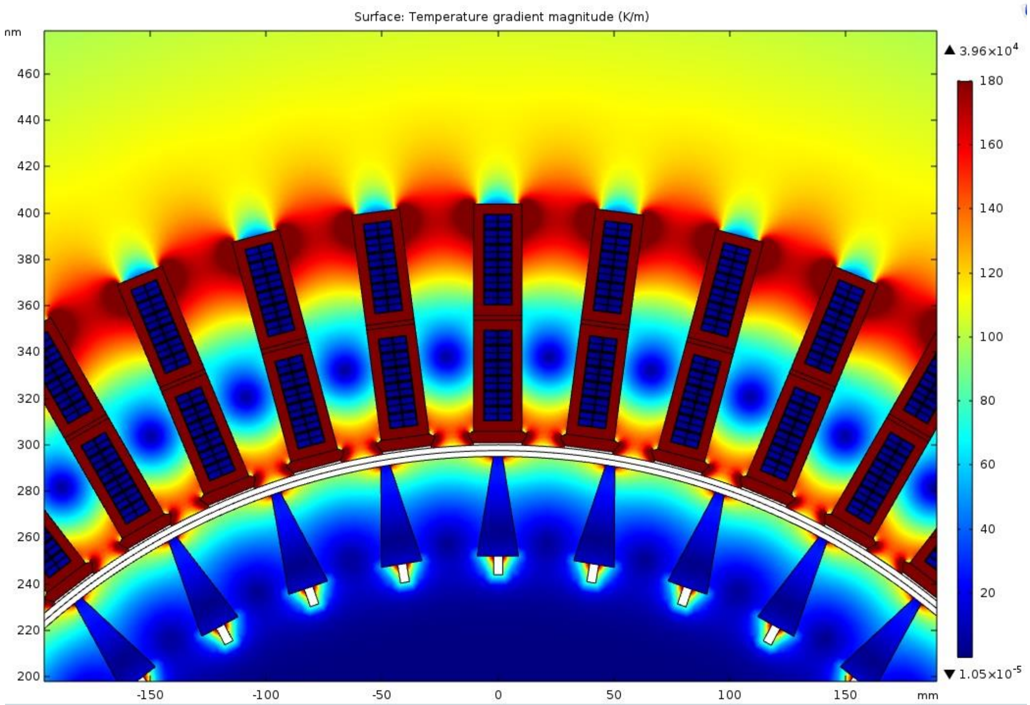


Picture 3 – Distribution of the temperature gradient in the stator winding isolation at the overload

Picture 4 shows the dependence of the temperature gradient on load factor during the operation of the IM from the mode of idling to the mode of overload of IM by 58%. When overloading the IM by 58% in comparison with the nominal loading mode, the temperature gradient in the stator insulation increases by 2,5 times.



Picture 4 – Dependence of the temperature gradient on the load factor in slot isolation (lower line) and in turn isolation (upper line)



Picture 5 – Distribution of temperature gradient in IM's steel

Conclusions. In the article, the methods of mathematical modeling have investigated the features of the temperature gradient distribution in the elements of the IM in the change of load. According to the results of the research, the following recommendations can be given:

1) insulating linings under the wedge must be made of materials with a minimum coefficient of temperature expansion;

2) it is recommended to use a modern isolation of the type *Micadur*, which has a thermal conductivity in 2 times higher than the coefficient of thermal conductivity in the mica insulation [2]. This may allow to increase the nominal power of the IM without changing its design, and reduce the temperature heating of its elements;

3) temperature sensors should be installed around the middle conductors in each layer of conductors, rather than at the bottom of the groove, as some firms establish in the manufacture of IM, because the conductors in the middle layers are the hottest;

4) when changing the load of the IM from the nominal value, you can change the cooling intensity depending on the value of the load factor;

5) in addition to temperature sensors, it is recommended that a thermostat should be installed, which, in case of overheating, will disable it from the power supply.

References

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