https://www.proconference.org/index.php/usc/article/view/usc26-00-006
DOI: 10.30888/2709-2267.2024-26-00-006

УДК 621.313.175.32

DETERMINATION OF DEVIATIONS OF THE PARAMETERS OF THE MAGNET WIRES OF ELECTRIC MACHINES

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Annotation. *The paper considers the principles and conditions of modeling the cores of electric machines with damage. The feasibility of using the finite element method in the analysis of electromagnetic processes and fields of electric machines is justified and the advantages are given*
Keywords*: DC motor, core, current, magnetic field, magnetizing characteristics.*

Introduction.

During long-term operation and repair of electric machines (EM), the parameters of the magnetic system change, which causes the machine's performance to deteriorate. The most informative approach to assessing these changes is a study of the electromagnetic field [1]. Determination of the effect of the state of the core of the electric machine on the electromagnetic field is a complex engineering and scientific problem. Taking into account the influence of the nonlinearity of the magnetic permeability depending on the degree of saturation of the core material, as well as the unevenness of its distribution both in the axial and radial directions, the complexity of the geometry of the studied area is possible only when applying numerical methods [2-4]. According to the results of the analysis, the possibility of determining the main parameters and characteristics of EM in the process of modeling electric machines by building circle-field models based on the finite element method (FEM) is substantiated.

The purpose of the work. Determining the features of modeling the cores of electric machines with damages obtained as a result of a significant time of failure and major repairs.

Material and research results. The main constituent parts of the magnetic system of any electromechanical converter (EMF) are the stator and rotor cores. The damages that occur during the aging of an electric machine are loosening of the edge parts of the toothed area, shortening of sheets of electrical steel, general weakening of the pressing of the core [5-6]. The change in the state of the core has a greater effect on the change in magnetic permeability in the axial direction. For a rational choice of the type of model to be created, it is necessary to conduct an analysis of the type of damage. In the case of a uniform change in the relative magnetic permeability along the length of the EM core, the two-dimensional circle-field model of the cross section of the EM active zone will provide sufficient accuracy of the analysis results. A uniform change in the axial direction is caused by damage along the entire length of the core (weakening of pressing, shortening of the tooth along its length). Fig. 1 shows a simplified model of a DC motor showing the distribution of magnetic induction and lines of force [7].

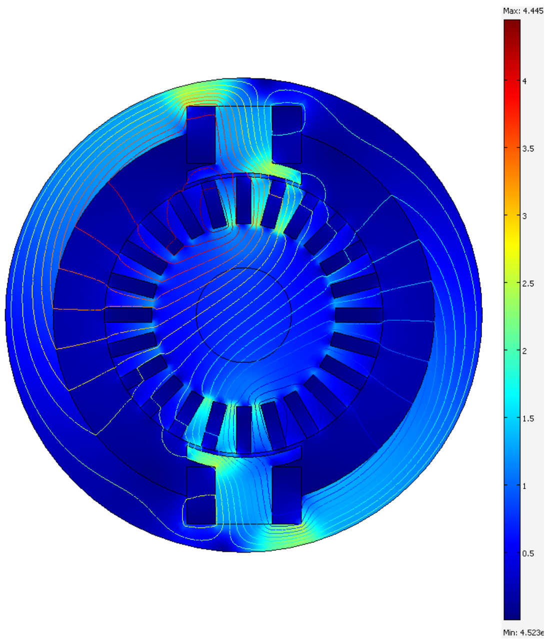

Fig. 1 – Two-dimensional circle-field model of a DC motor

Modeling was carried out on the basis of Maxwell's equations, which are supplemented by equations relating to the properties of the material, which describe the behavior of the material in the electromagnetic field [8] . The simplified form of the connection equations has the form:

$$\delta_{np} = \gamma E, \tag{1}$$

where $\delta_{ïð}$ is the conductivity current density, γ is the specific electrical conductivity of the material, E is the electric field intensity vector.

$$H = v_a (B - B_r) + q_1 \frac{\partial}{\partial t}(B - B_r) - q_2 \frac{\partial^2}{\partial t^2}(B - B_r) \tag{2}$$

where H is the magnetic field strength vector, v_a is the velocity vector field, B is the magnetic induction vector, B_r is the residual magnetic induction vector, q_1, q_2 are the dynamic indicators of the electrophysical parameters of the charged material, which are based on the relations

$$q_1 = \frac{1}{12} \cdot d^2 \cdot \gamma_{пл}, \tag{3}$$

$$q_2 = \frac{1}{720} \cdot d^4 \cdot \mu_{апл} \cdot \gamma_{пл}^2. \tag{4}$$

where d is the thickness of the sheet in the core, $\mu_{апл}$ is the absolute magnetic permeability of the sheet, $\gamma_{пл}$ and is the specific electrical conductivity of the sheet material.

The impact of damage unevenly distributed along the length of the machine can be estimated by constructing a plane-parallel circle-field model only without taking into account the mutual influence of electromagnetic fields induced in areas with local damage. The full picture and distribution of electromagnetic field parameters makes it possible to take into account the three-dimensional EM model. This is due to the possibility of calculating all the component characteristics of the electromagnetic field in space.

If there is a significant discrepancy between the magnetization curves of the given regions, the analysis of the two-dimensional circle-field model will have an increased calculation error. The use of circle-field models for the analysis of damaged cores should be accompanied by a preliminary determination of the local values of the magnetic conductivities of individual zones of the active part of EM. The proposed method of analysis of electric machines allows obtaining the main parameters in the operating and starting modes and assessing the degree of damage impact on their characteristics.

Conclusions.

The paper analyzes the features of modeling damaged EM cores that have a significant failure time and have undergone a number of major repairs. The expediency of using different types of circle-field models depending on the presence of the main types of damage to the magnetic system has been analyzed and substantiated

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