

UDC 621.316.71

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APPLICATION OF COMSOL MULTIPHYSICS SOFTWARE PACKAGE FOR CALCULATION OF ELECTRICAL MACHINES

Today, the issue of cost-effectiveness of development and speed of processing of solutions in the electromechanical industry is acute. For this reason, it is necessary to quickly and with minimal costs analyze the efficiency of various electromechanical systems. At the same time, manual calculation using known methods is laborious and time-consuming. A typical application of the Comsol Multiphysics software package can be automated calculation of electrical machines with given characteristics. This set of programs is designed for modeling electromagnetic fields in the design and study of models of engines, sensors, transformers and other electrical and electromechanical devices for various applications. Comsol Multiphysics is built on the basic equations of Maxwell and uses the Finite Element Method (FEM) for calculations, which allows you to calculate electromagnetic and electric fields, as well as transient processes in field problems. The software package has a large library of templates of known electrical machines. In these templates, it is enough to enter the main geometric dimensions, materials intended for use, and based on these initial data, calculate the characteristics of the electrical machine under study. There is a possibility of calculation and analysis at three different levels: accelerated analysis using equivalent circuits; calculation by the finite element method in a two-dimensional formulation of the problem; calculation by the finite element method in a three-dimensional formulation of the problem. In the last two levels of calculation, there

is a possibility of solving a magnetostatic problem, a dynamic problem, there is a possibility of connecting an electrical circuit of the system, which means that there is a possibility of analyzing the operation of an electrical machine when connecting semiconductor equipment, various loads, etc. There is also an opportunity to familiarize yourself with various oscillograms, see the magnitude of the induction, a picture of the paths of the closing of the lines of force flux, calculate magnetic, electrical losses, as well as losses caused by the generation of eddy currents in the magnetically conductive parts of the system. The data of mathematical modeling and calculations using the classical method were compared. During the verification, losses in the electric machine were calculated, the magnetic circuit was calculated, the operating characteristics and oscillograms of voltage and currents of the idealized system were constructed. All calculations performed manually confirmed the results of the calculation using the Comsol Multiphysics program. It should be noted that the software package provides some additional capabilities that cannot be obtained when calculating manually, such as voltage surges and current jumps, losses from eddy currents and electro-magnetic torque pulsations. Analyzing the results of the work performed on the calculation of the electric machine, the following conclusions can be drawn: the accuracy of the calculation of electric machines in the Comsol Multiphysics software package is not inferior to the accuracy of calculations using traditional calculation methods; to initially perform an estimated calculation of the electromechanical system and determine the main dimensions, it is advisable to use simplified estimated design methods; To analyze and verify calculations and perform optimization, modern software should be used, which should ensure high accuracy of calculations and speed of work.