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DESIGN OF A TWO-SPEED ENGINE USING THE ANSYS ELECTRONICS

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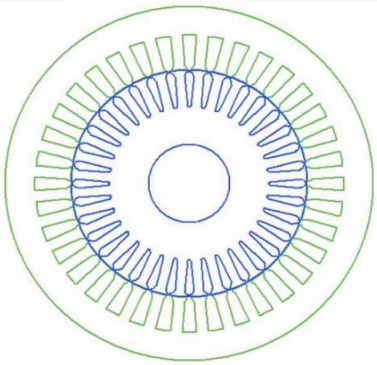
Abstract:
This article presents experimental studies of a two-speed motor, static study of a new two-speed motor, determination of the performance of a new two-speed motor using Ansoft Maxwell simulation tool.
ANSOFT Maxwell is one of the leading electromagnetic field modeling software and is used to create and research projects of two-and three-dimensional models of electric motors, transformers, as well as various electrical and electromechanical devices [1, 2]. The Maxwell program is based on the method of finite elements (Finite Element Method - FEM) and calculates static, electromagnetic and electric field harmonics, as well as, moreover, transient processes with very high accuracy [3, 4, 5]. With this in mind, instead of real experiments, it is possible to use computer models that are cost-effective.
Rotational Machine Expert (RMxprt) - it is a program that speeds up the processes of design and optimization of electrical machines. The calculation of the working characteristics of RMxprt electric machines uses classical analytical theories and equivalent methods of magnetic circuits. The following starting data of the electric motor are entered into the program: the type of windings and the connection scheme, the characteristics of the stator and rotor materials, geometric parameters, power supply, load, etc.k. Thus, this software tool allows you to significantly speed up the process of manufacturing an electric machine with a standard configuration[6, 7, 8].
As an object of study, let's consider an asynchronous electric motor with a short-circuit rotor of type 4A132M4. Figure 1 shows the basic dimensions of the asynchronous electric motor 4A132M4 using the Ansys Maxwell RMxprt software module



D_{Ext} = 225 mm
D_{in}= 145 mm
l_{st} = 180 mm
Z_1 = 36
Z_2 = 34
D_{Ext} = 144,2 mm
D_{in} = 50 mm

Figure 1. The main dimensions of the electric motor 4A132M4

Figure 2, a) and b) in the Ansys Maxwell RMxprt software, the geometric dimensions of The Shape of the stator and rotor pases of the two-speed 4A132M4 type asynchronous motor are presented.

The RMxprt set function allows you to set only the main geometric dimensions and parameters of the slots, give the task and get sample solutions.

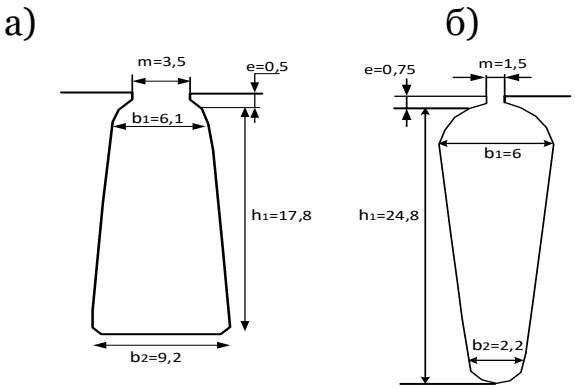


Figure 2. Current slot form of an asynchronous motor: a) stator; b) rotor

It allows us to draw conclusions about the correctness of the modeled results obtained using Ansys Maxwell and the feasibility of further application of this set of programs. Using the RMxprt tool, 2D and 3D Build modes can be used. In these modes, it is possible to consider the distribution of the field forces in the magnetic system of the stator and rotor, the temperature in individual parts of the electric motor, currents in the stator exhaust phases and other parameters [9, 10, 11]. Figure 3 shows the form of magnetic induction distribution for p=2and p=3 polar sides.

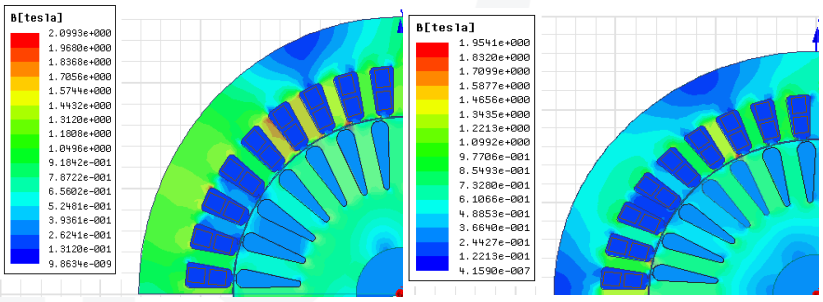


Figure 3. Induction distribution: a) p=for 2 sides, b) p=for 3 sides

The calculation of a two-speed motor is based on a single-speed motor of the 4A132M4 type. This machine has 36 stator slot, 34 rotor slot, stator outer diameter 225mm, inner diameter 145mm, shaft length 180mm, air gap δ=0.4. The two-speed motor was modeled in ANSYS Maxwell. On fig. 3 shows the distribution of induction along the

sides $p_1=2$ and $p_2=3$. It can be seen from the graph that the maximum current density is observed in the stator teeth from the side $p_1=2$.

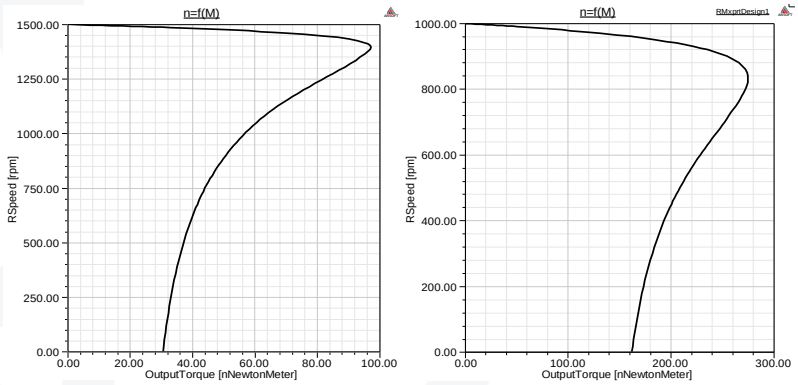
Experimental studies of the working and mechanical properties of a two-speed electric motor

As a mechanical (working) characteristic of an asynchronous motor, in a narrow sense it is understood that the speed of rotation or slip depends on the given power, and in a broad sense a number of other values important for operation, that is, such parameters as input power, current, useful working coefficient and power coefficient, are understood at the invariant value of the given voltage and [12, 13, 14, 15].

Experimental studies of the new 4A132M4/6 engine show that $p_1=2$ on the side $P_2=9$ kW, $\eta=87\%$, $\cos\varphi=0{,}87$, $I_1=18$ A, $M=58$ nM, $p_2=3$ on the side $P_2=6$ kW, $\eta=85\%$, $\cos\varphi=0.51$, $I_1=20$ A, $M=58$ nM .

In Figure 4 and 5, the working characteristics for sides $p_1=2$ and $p_2=3$ are presented.

As can be seen from Figures 6, the mechanical characteristics for both sides of the poles have sufficient rigidity (nominal slip is 2.5% and 5%) and a smooth appearance. It can be seen from the table that there are no torque curves for both sides of the poles that prevent the engine from accelerating at the moment of rated load.



а) б)

Figure 4. Mechanical characteristics of a two-speed motor:
a) p=for 2 sides, b) p=for 3 sides

Based on the analysis of the results of the experimental studies presented above, it can be concluded that the number of Poles of a new type allows the introduction of a variable-flow-based two-speed motor instead of the single-speed motors available in the transport mechanisms of cargo transportation.

A study of experimental studies of working characteristics of new motors with variable two-speed poles showed that the energy performance of these motors fully corresponds to the required values.

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