DEVELOPMENT OF ASYNCHRONOUS MOTOR BASED ON THE USE OF RARE-EARTH-FREE PERMANENT MAGNETS

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Traditional permanent magnet motors and generators have favored rare-earth magnets (REMs), such as Nd-Fe-B, due to their high residual flux density. However, because of unpredictable cost, uncertainty of the supply chain of these magnets in a long run and Chinese monopoly on rare-earth materials, investigation of rare-earth free electrical machines becomes an urgent issue. In some point of view, it has even become a question of national security for some countries.

In this work instead of costly and rear Nd-Fe-B PMs, the affordable and widely available ferrite magnets (FMs) were proposed in place of magnetic excitation.

Ferrite-based permanent magnet (PM) machines have low cost, good efficiency, and availability. Of course, the residual flux density of the rare-earth magnets is twice bigger the FMs, however, the main advantages of ferrite magnets are the higher demagnetization temperature, significantly lower cost (especially if produced in large volumes), resistance to corrosion and to very low -30 C and very high temperature +250 C.

Nowadays there are good potential of ferrite magnets application in electrical machines due to improvement and increasing their magnetic strength and residual flux density. For instance, such FMs as Y30BH or Y33 has a residual flux density 0,43 T and some research samples already reach the value up to 0.6 T. Therefore, in case of redesign the magnetic core of the rotor and use magnets properly in electrical machines, FMs can magnetize each other in a core and increase their magnetization, thus it can increase the energetic parameters of electrical machines with or without electromagnetic excitation. To summarize, the knowledge on the existing electrical machines with ferrite magnets is still inconsistent. And the question to what extent these machines can be developed has not been answered yet. Therefor the topic of this research on rare-earth-free electrical machines is relevant.

The main aim of the work was to improve the energy parameters of the given 1.1 kW squirrel-cage asynchronous motor, without a significant increase in its cost, by replacing the short-circuit rotor with a rotor with affordable ferrite magnets.

According to a variety of 2D simulations, that were carried out using the Ansys Maxwell software [1], we can make the conclusion about the obtained improvements in the investigated 1.1 kW motor: the maximum torque is increased by 7 %; the nominal current is decreased by 13 % and the efficiency value is increased by 6 % for nominal power, and increased by 10 % for the overload mode, which are very important in the general usage of this machine in the Energetic Sector.

List of references:

1. Ansys Maxwell 3D v.15 – Electromagnetic and Electromechanical Analysis: user's guide / Ansys Inc. – Pittsburgh, 2012. – 1006 p. [Електрон. ресурс]. – Режим доступу: https://www.ansys.com/.