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Marcin WARDACH

West Pomeranian University of Technology, Szczecin,
Department of Power Systems and Electrical Drives

Design of hybrid excited claw pole machine with laminated rotor structure

Abstract. *The paper presents simulation research of a hybrid excited claw pole machine in which the laminated structure of the rotor was applied. This solution allows the machine to be easier to make, especially very complex structure of the rotor in which permanent magnets and an excitation coil that controls machine's flux are placed. The work analyzed the influence of excitation coil current on the most important parameters of the machine operating in the generator regime, such as the cogging torque and the induced voltage.*

Keywords: claw pole generator, hybrid excitation, permanent magnets, excitation coil.

Introduction

The subject of the research is a claw pole machine with a rotor equipped with a double excitation: permanent magnets and an excitation coil. Machines of this type are subject in many scientific researches [1-3]. They can be used in wind farms as well as in motor vehicles. In previous publications, e.g., [4-6], constructions of claw pole machines with hybrid excitation were shown in which the rotor was made of solid steel. In order to facilitate the construction of the rotor and the use of embedded permanent magnets in its poles, it is proposed to use a laminated rotor design.

Construction of the claw pole machine

Figure 1 shows the structure of the proposed machine and a simulation model made in the Ansys Maxwell program.

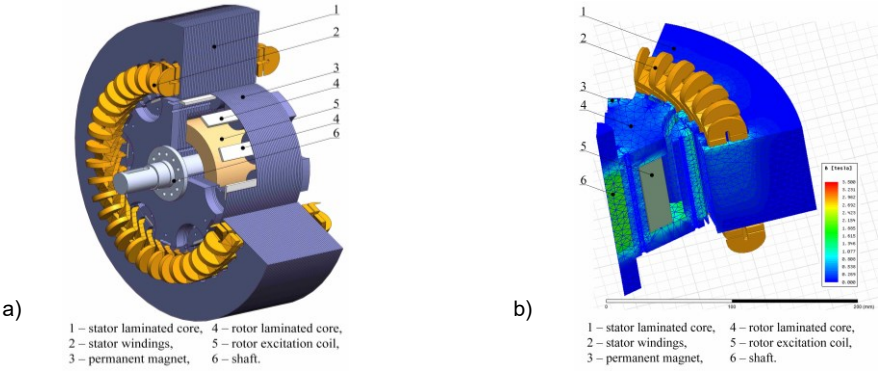

Fig.1. Design of the claw pole machine: a) visualization, b) model FEM.

Selected results of simulation tests

As a result of simulation tests, a dependence of the maximum value of the cogging torque depends on current in the excitation coil: I_{exc} = -10 A; -5 A; 0; 5 A; 10 A, has been shown. In addition, the induced voltage waveforms for the rotor rotation angle in relation

to the stator in the range from 0 to 60º are plotted, for the same mentioned above I_{exc} current values. The results are presented in Fig. 2.

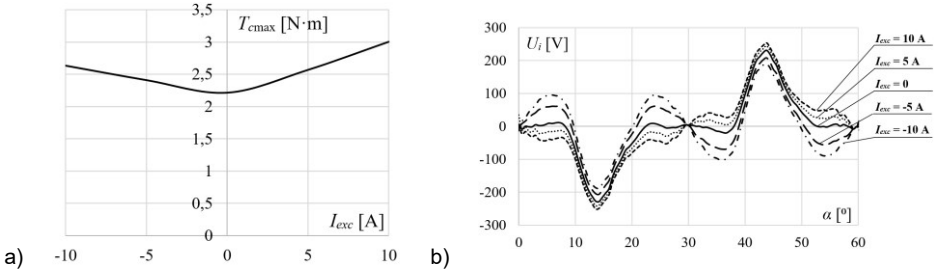

Fig.2. Test results of the machine: a) maximum cogging torque value, b) back-EMF waveforms.

Conclusion

The paper proposes a new design of a hybrid excited claw pole machine. The novelty is the use of a laminated rotor core which will significantly facilitate the machine's manufacturing process. The obtained results performed on the proposed model show that the maximum value of the cogging torque always increases with the supply of the excitation coil - regardless of whether it is a state of strengthening or weakening the field. Moreover, in the presented solution, when the coil was supplied with the current I_{exc} = 10 A, the maximum voltage value was increased by approx. 10%, while when I_{exc} = -10 A, a reduction by approx. 18% was achieved.

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***Author**: dr inż. Marcin Wardach, West Pomeranian University of Technology, Szczecin, Sikorskiego 37, 70-313 Szczecin, e-mail: marwar@zut.edu.pl.*