Novel Hybrid Excited Machine with Flux Barriers in Rotor Structure

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***Abstract*—Permanent magnets (PM) electrical machines are becoming one of the most popular type of the machines used in electrical vehicle drive applications. The main drawback of PM machines, despite obvious advantages, is associated with the flux control capability which is limited at high rotor speeds of the machine. This paper presents a new arrangement of PMs and flux barriers in the rotor structure to improve the field weakening control of hybrid excited machines. The field weakening characteristics, back-*emf* waveforms and efficiency maps of this novel machine have been reported.**

***Index Terms*—Electric machines, Electric vehicles, Hybrid excitation machine, Permanent magnets.**

I. INTRODUCTION

Control of the air gap flux in the machine with permanent magnets can be generally obtained in two ways: by a suitable control method, or by appropriate modification of the machine topology. Conventional machines with permanent magnets have non-controllable flux excitation. This limits the possibilities of the drive and range of U/f = const. control strategy, due to the limited power supply voltage and limited voltage strength of the winding insulation. Thus, for the higher rotational speed the weakening of excitation flux is required, in order to reduce the back-*emf*. The most common method to reduce the *emf* value is the field weakening by the *d*-axis current. This strategy generates increased losses in supply system and creates the risk of permanent demagnetization, consequently decreases the resultant torque of the machine [1].

II. MACHINE TOPOLOGY AND PRELIMINARY RESULTS

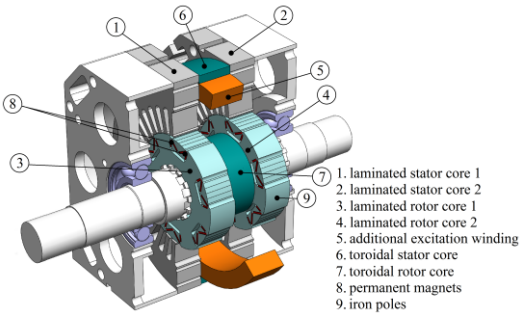

Figure 1: Structure of the ECPMS-machine.

The purpose of the paper is to explore a novel, optimized rotor structure of the modified Electric Controlled Permanent Magnet Synchronous machine (ECPMS-machine) which is shown in Fig.1. The previous version of this machine has been described, widely tested and reported in earlier published papers [2-5].

For the presented design the influence of magnets and flux barriers arrangement on controlling field excitation, has been performed by using 3-D FEAnalysis.

3-D FEA and experimental results of the back-emf waveforms have been compared (Fig. 2). The results show that the field-weakening ratio equal to 10:1 can be effectively obtained in this structure.

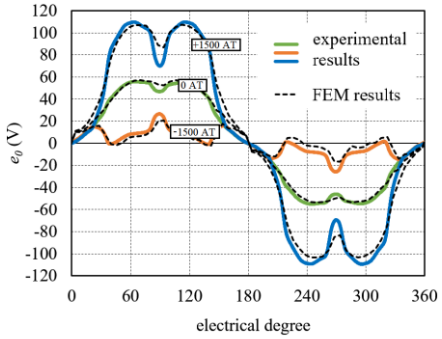

Figure 2: Back-emf under different field excitations.

III. CONCLUSION

The proposed machine topology can offer an effective flux control method allowing to extend the maximal speed at constant-power range of the ECPMS-machine.

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