Offene Arbeit (in English)

TECHNISCHE UNIVERSITÄT DARMSTADT

Design of a Synchronous Reluctance Machine for a Low Self-discharge Flywheel System

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Introduction

A flywheel stores kinetic energy in a rotating mass. Driven by an electrical machine, the energy can be transformed into electricity and vice versa. Many flywheels adopt permanent magnet (PM) machines due to their high efficiency. However, the use of magnets has some drawbacks: Firstly, it increases the costs. Secondly, the no-load iron losses are inevitable, which lead to a high self-discharge. This means, even when no power conversion is required, e.g. at standby mode, the stored kinetic energy will still be dissipated by these losses (as well as air friction losses) over time. This is critical for a storage device. The third drawback is the danger of demagnetization at high temperature due to the cooling difficulty in vacuum. Therefore, depending on different requirements, alternative designs without magnets are drawing attention, e.g. reluctance machines, homopolar machines, etc. for the aim of high robustness and low costs.

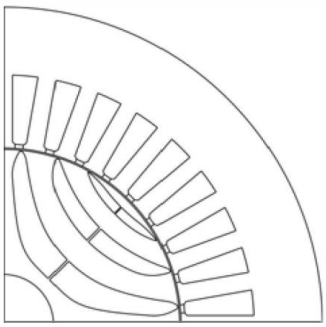

Fig.1. Sketch of a SynRM [1]

The aim of this thesis is to design and optimize a synchronous reluctance machine (SynRM) for the given speed and power requirements. The tasks include:

1. Set up an automatic simulation model in JMAG by Matlab script, including post process of the results.
2. Calculate the mechanical stress in the rotor in JMAG.
3. Analyze the electromagnetic performance of the machine.
4. Optimize the rotor geometry for higher efficiency.
5. Evaluate the costs in comparison to a PM machine.

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[1] M. Degano, M. Di Nardo, M. Galea, C. Gerada and D. Gerada, "Global design optimization strategy of a synchronous reluctance machine for light electric vehicles," *8th IET International Conference on Power Electronics, Machines and Drives (PEMD 2016)*, 2016, pp. 1-5, doi: 10.1049/cp.2016.0253.