Analysis of heat transfer phenomena in Line Start Permanent Magnet

M.Sc. Eng. Szymon Lipiński

Abstract

The aim of the presented study is contribution to knowledge base about thermal phenomena in Line Start Permanent Magnet Synchronous Machines. LSPMSMs are used more commonly in wider power range. Thus providing new measures for analysis heat transfer and generation in LSPMSMs are of great importance, particularly in scope which is specific to unique characteristics of LSPMSMs. The object of study is permanent magnet machine based on the stator of squirrel cage induction motor type Sh90-L4. To prove thesis and achieve the aim of the dissertation the study was accomplish in the following scope:

1. Preparing of the electromagnetic model of the LSPMSM.
2. Preparing of the thermal model of the LSPMSM including CFD.
3. Coupled thermal and electromagnetic simulation in transient and steady state operation.
4. Measurement and verification of the numerical models on the test rig.
5. Thermal analysis in selected states and proposing solutions for risk minimization of the thermal damage.

The coupling between electromagnetic and thermal models is achieved with definition of all electromagnetic materials properties as a function of temperature and definition of all heat sources in thermal model dependent on the result electromagnetic calculation. Consecutive iterations with passing data between models provide electromechanical and thermal characteristics as a result regardless of chosen initial temperature. Boundary conditions for the thermal model are calculated using CFD with simulation of the external flow around finned frame surface forced by fan mounted on the shaft of the motor. There were simulated steady states with nominal and distorted supply voltage. Additional there were calculated curves of temperature rise during constant load operation and direct on line start. Numerical model was verified on the test rig prepared to measure simultaneously electrical, mechanical and thermal parameters.

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