A Numerical Analysis of Coupled Electromagnetic and Heat Transfer Phenomena in PM BLDC Electric Motor

Bartlomiej Melka, Jacek Smolka, Zbigniew Bulinski, Arkadiusz Ryfa
Institute of Thermal Technology, Silesian University of Technology, Gliwice, Poland
bartlomiej.melka@polsl.pl, jacek.smolka@polsl.pl,
zbigniew.bulinski@polsl.pl, arkadiusz.ryfa@polsl.pl

Janusz Hetmanczyk, Dawid Makiela
Department of Power Electronics, Electrical Drives and Robotics, Silesian University of Technology, Gliwice, Poland
janusz.hetmanczyk@polsl.pl, dawid.makiela@polsl.pl

Abstract

In the study, a coupled heat, flow (CFD) and electromagnetic (EMAG) model of the permanent magnet brushless electric motor with electronic commutation was formulated and then validated. The coupling process allowed for the temperature and the power loss transfer between thermal and electromagnetic models. In addition, the anisotropic thermal conductivity was defined for the motor core and windings. The numerical model included the considered motor coupled with the generator and the surrounding air to simulate the experimental tests. Then the developed model was validated using the velocity and temperature experimental data. The horizontal velocity component of the air above the motor, coupling and generator was measured at sixteen points using constant temperature anemometers. Inside the motor, the velocity measurements were conducted using Laser Doppler Anemometry in two axes. For the temperature field, over forty calibrated thermocouples were located in the rear part of motor where velocity measurements were conducted, on the machine housing walls, in the surrounding air and in the region of the stator winding which is usually of the highest temperature. The temperature field on the motor housing was also measured by the IR camera. The measurements were compared with the coupled CFD and EMAG model results for three rotational speeds and four different loads showing a satisfactory agreement.

References

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