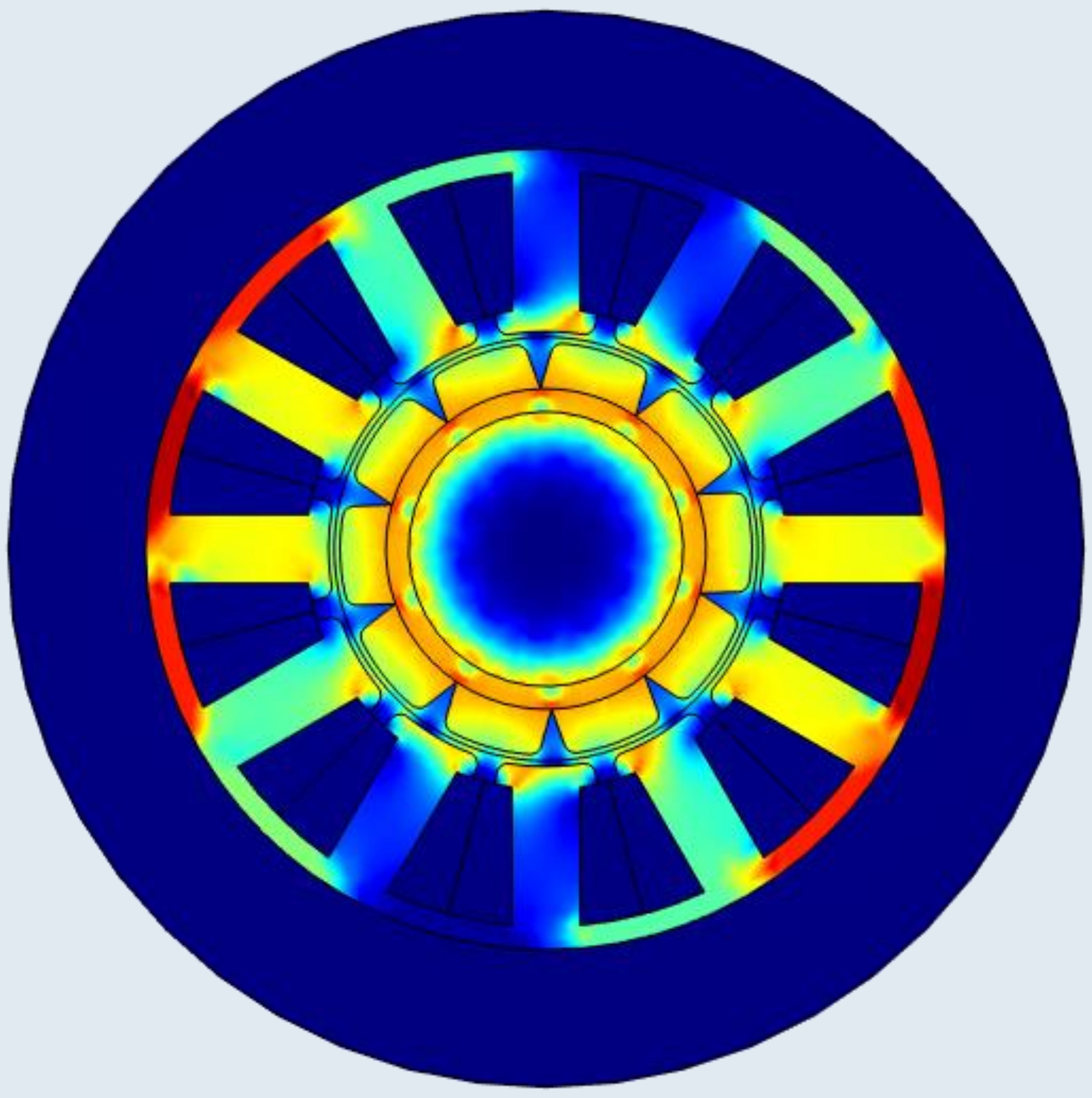

Optimizing Thermal Management of Permanent Magnet Synchronous Motors for Electric Vehicles through Integrated Cooling System

Exploring Diverse Cooling Techniques to Enhance Temperature Distribution and Boost Thermal Efficiency in PMS Motors

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Abstract

Electric motors in modern electric cars are required to be more powerful and competitive with higher torque, higher speed, and higher power density (Ref.1). The electromagnetic and thermal simulation studies are important to evaluate the efficiency of the electric motor. In that purpose we developed of a model for a PMSM used in electric vehicles, utilizing the COMSOL® software. The objective is to optimize the motor's temperature through the integration of an efficient cooling system.

The main contribution of this research is the creation of customized user interface using the Application Builder that allows customers to study and evaluate the performance of the PMSM under different operating conditions. By implementing various cooling solutions and analyzing their impact on temperature reduction, valuable insights were gained, aiding in the selection of optimal cooling strategies for improved motor performance.

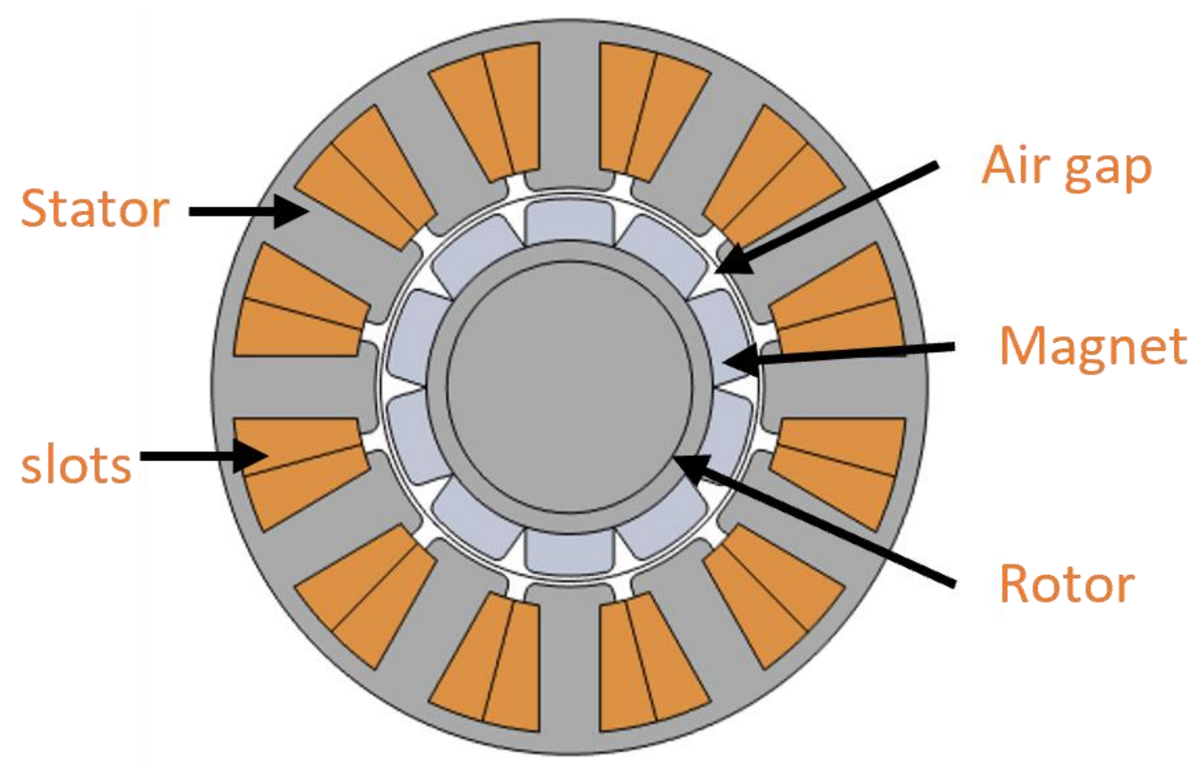

FIGURE 1. 2D schematic of the model geometry

Methodology

A permanent magnet synchronous motor was modeled. It consists of an inner rotor and outer stator, 12 slots and 10 poles.

The Rotating Machinery, Magnetic interface was employed to accurately calculate losses. The thermal part was then coupled with the electromagnetic part to simulate the temperature distribution within the motor, considering the effects of heat generation and dissipation. Based on this motor model, a user interface was built using the Application Builder in COMSOL®.

Results

As illustrated in Figure 2, a comparative study of the steady-state temperature is established under different cooling conditions to determine the most appropriate cooling method for the electric motor. The simulation results for cooling using different methods – forced air convection, and water cooling.

The results of the simulation show that the cooling method has a significant impact on the temperature distribution within the motor, and that liquid cooling provides the most effective thermal management. The study demonstrates the utility of numerical simulations in optimizing the thermal management of electric motors for improved performance and reliability.

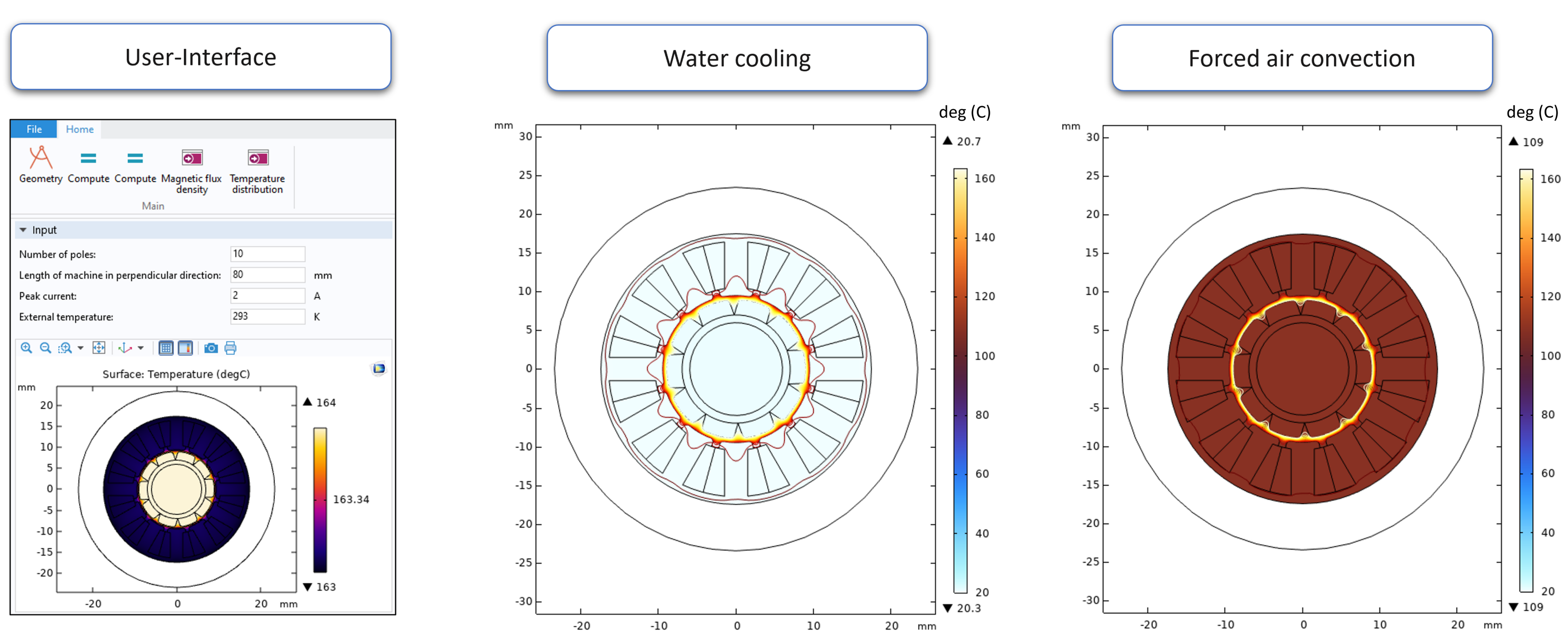

FIGURE 2. Left: User Interface for the Electromagnetic Thermal Management Model of PMSM. Right and center : 2D Temperature distribution with forced air convection and forced water cooling respectively

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