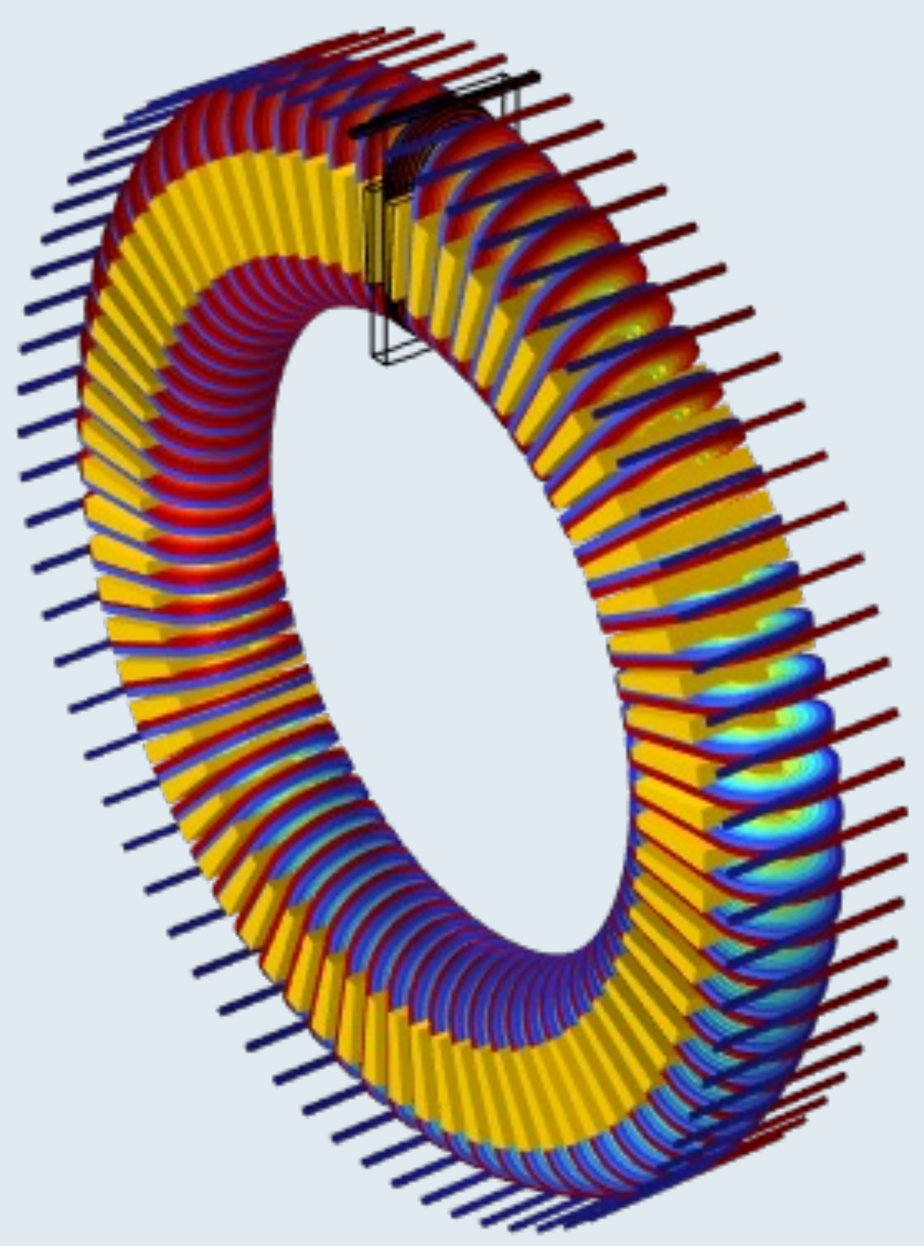

Multiphysical Simulation of Cryogenically Cooled Axial-Flux Motor

Different physics are involved in evaluating the performance of electric motors. A thermal and fluid flow simulation of internally cooled conducting coils in an axial flux motor is being modeled.

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Introduction

Axial flux motors offer higher power density and torque-to-weight ratios but suffer from heat losses that reduce efficiency. The project K-AXFLUX aims to enhance the cooling performance of an axial-flux motor using indirect cooling with hydrogen gas as the coolant. In this concept, hydrogen gas passes through hollow, conducting copper coils in the stator, removing heat from the source. The gas exiting the coils is then sent to a fuel cell.

A multiphysics simulation in COMSOL Multiphysics® models the hydrogen flow and heat transfer in the motor.

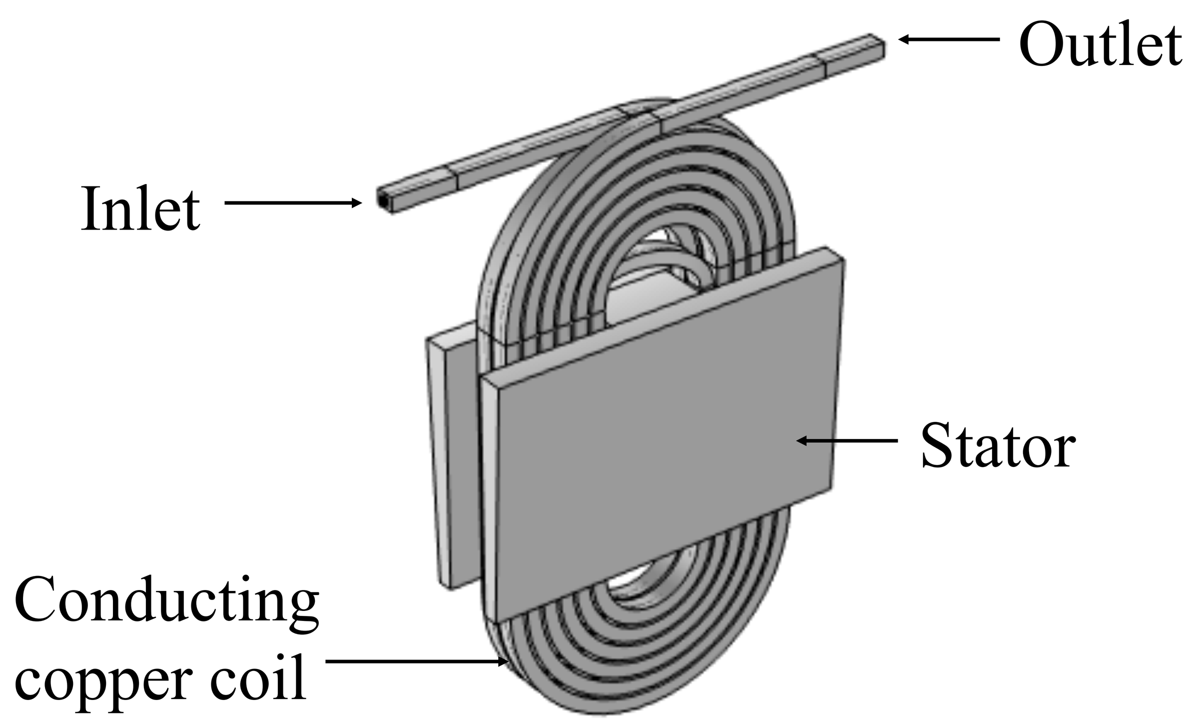

FIGURE 1. Sectoral geometry of the stator component.

Methodology

The stator geometry is periodic around its central axis; therefore, only a single sector, as shown in Figure 1, is simulated with periodic boundary conditions on either side.

K-epsilon model is used to solve the turbulent flow, and non-isothermal coupling is used to couple the heat transfer in solid and fluids with the turbulent flow model. The study is divided into multiple steps to improve the convergence of the nonlinear model.

Results

The temperature distribution of the fluid flow along its length and the stator geometry can be seen in Figure 2. The gas at the outlet reaches a temperature of 268 K, which is well below room temperature. One of the most important design conditions is to keep the stator temperature below 150 °C (423.15 K) to ensure that the insulation materials within the motor do not lose their integrity. Without any cooling, the stator would theoretically reach a maximum temperature of 3500 K.

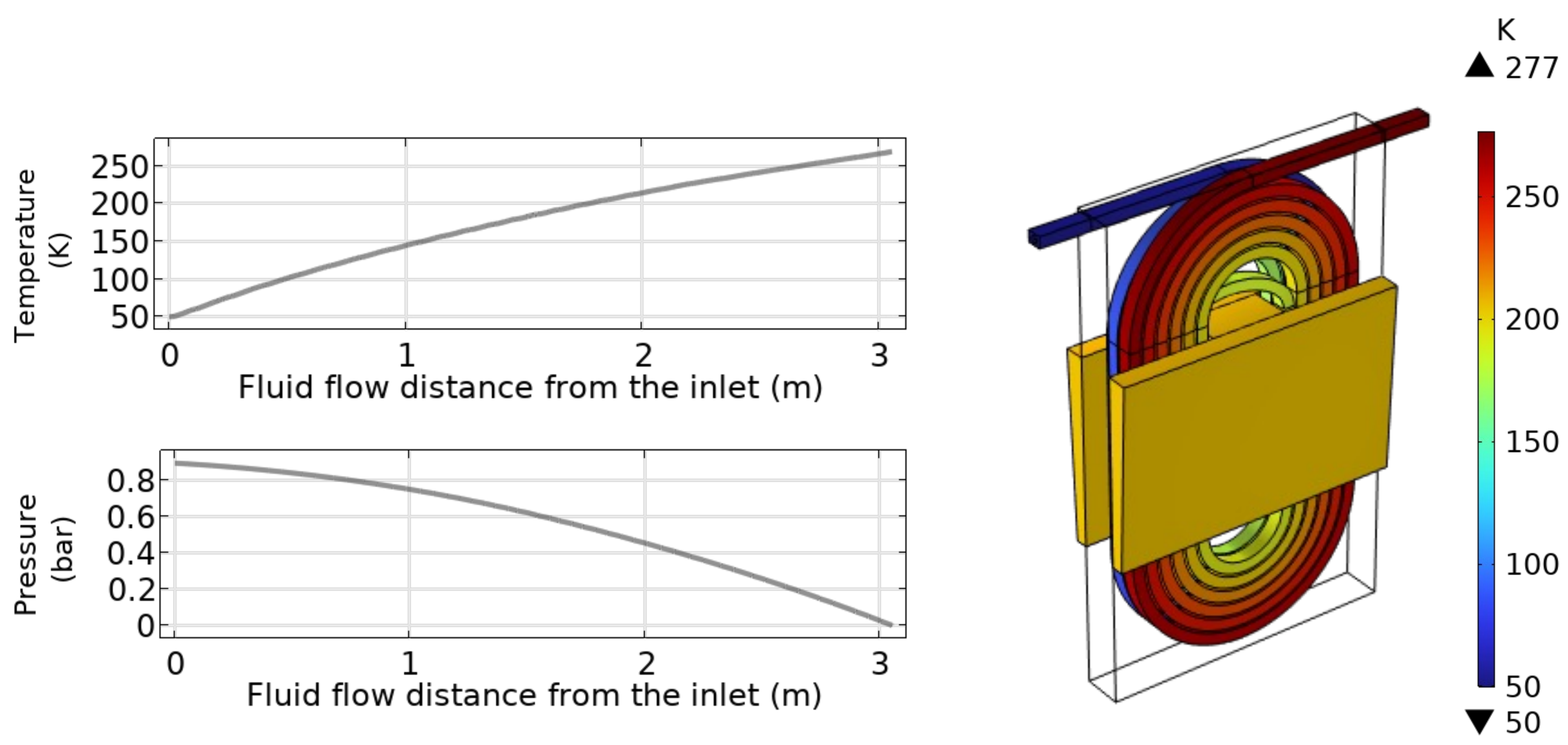

FIGURE 2. Left: Temperature and pressure drop along the fluid flow path, Right: Temperature profile of the stator.

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