3D-FEM Simulation of a Transverse Flux Machine Respecting Nonlinear and Anisotropic Materials

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Abstract

Typically a permanent excited transverse flux machine (TFPM) offers high torque density at low speed. For using it as a servo drive it must be optimized for high torque density with low torque ripple. Because of its transverse magnetic flux, a three dimensional finite element method is needed.
In this paper the model of the machine is reduced to one pole pair of one phase using sector symmetry and periodic conditions. The parametrized geometry is built in Inventor® and imported to COMSOL Multiphysics® using the LiveLink™ for Inventor®. The physics conditions are implemented with rotating machinery physics. The stator is made of soft magnetic composite (SMC) modeled with a nonlinear permeability, the rotor is a laminated electrical steel stack modeled with an anisotropic nonlinear permeability tensor. The model of one pole pair is shown in Figure 1.
To fasten the following optimization process, the meshing is done manual with smaller elements near the air gap and bigger elements in less interesting area. A stationary study using a parametric sweep over the rotor position was less time consuming than a full transient simulation. In Figure 2, the absolute value of the magnetic flux density is shown.

Figures used in the abstract

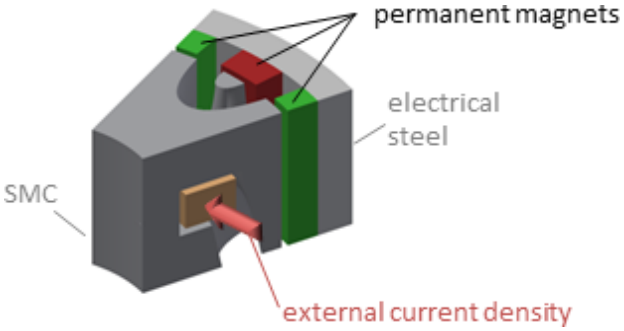

Figure 1: Model of one pole pair.

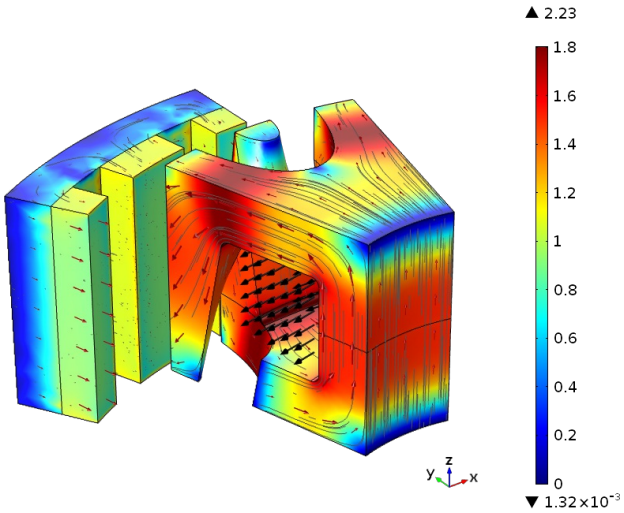

Figure 2: Magnetic flux density of one pole pair in Tesla.