Master project, 2016-2017

Magnetic material models for high performance electrical machines in electrical mobility

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Context

Soft magnetic materials are widely employed, usually as a laminated material, for the magnetic core manufacturing of electrical machines (transformers, rotating machines …). Indeed, the electromagnetic energy conversion relies on the use of such materials as they are the vector of the energy conversion with the amplification and channeling of the magnetic flux.

In the context of electrical mobility, the energy efficiency of electrical motors is, among other aspects, intimately related to the magnetic materials properties. These properties, and in particular the magnetic behavior that exhibits a hysteresis phenomenon, are an important parameter to be accounted for in tools dedicated to electrical machine design. Also, external stresses, such as thermal and mechanical stresses, can influence the material properties. It is the case during the manufacturing process (cutting, bending, pressing …) of the motor and during its operation (mechanical stresses, thermal due to iron losses …). These effects are usually degrading for the magnetic properties.

Then, considering that the performances of the electrical motor are directly linked to the magnetic materials properties and the constraints to which they are subjected, the design process of an electrical motor requires accurate models of the magnetic materials in order to assure the accuracy and robustness of the result.

Objective and works steps

The main objective of this internship is to develop a model of magnetic material adapted for an implementation in the Finite Element (FE) calculation tool *code_Carmel*[1].

Three main steps will be considered in order to fulfill this objective:

- Bibliographic work in order to select 2 or 3 material models that can account for the anisotropy and residual mechanical stress in magnetic materials.
- Programming and testing of the models with, eventually, an adaptation/improvement of the models for an implementation in *code_Carmel*.
- Choice of the best model, according to the implementation constraint and accuracy of the model, and validation with the experiment.

Key word

Magnetic materials, energy conversion, electrical motors, modelling, anisotropy

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