LABORATOIRE D'ELECTROTECHNIQUE ET D'ELECTRONIQUE DE PUISSANCE DE LILLE

Université de Lille — L2EP Laboratoire d'électrotechnique et d'électronique de puissance de Lille — Arts et Métiers Sciences et Technologies — MSMP Mechanics, Surfaces and Materials Processing

Master project, 2024 - 25

— Effect of shrink-fitting on magnetic properties of electrical steels —

Supervisors: A. Benabou ; O. Messal | abdelkader.benabou@univ-lille.fr ; oualid.messal@univ-lille.fr
L2EP – Univ. de Lille

Context

The performance and efficiency of electrical machines can be significantly impacted by their manufacturing processes. In particular, the magnetic circuits are highly sensitive to cutting, punching, shaping and assembly operations. From the point of view of usage properties, this impairs the magnetic properties (increase in iron losses and decrease in magnetic permeability). In this context, the aim of this master thesis is to study the effect of the shrink-fitting of magnetic circuits of electrical machines to understand the involved mechanisms. The will allows for assessing how these manufacturing process can be taken into account, or even adapted to minimize its effects right from the design stage of electrical machines.

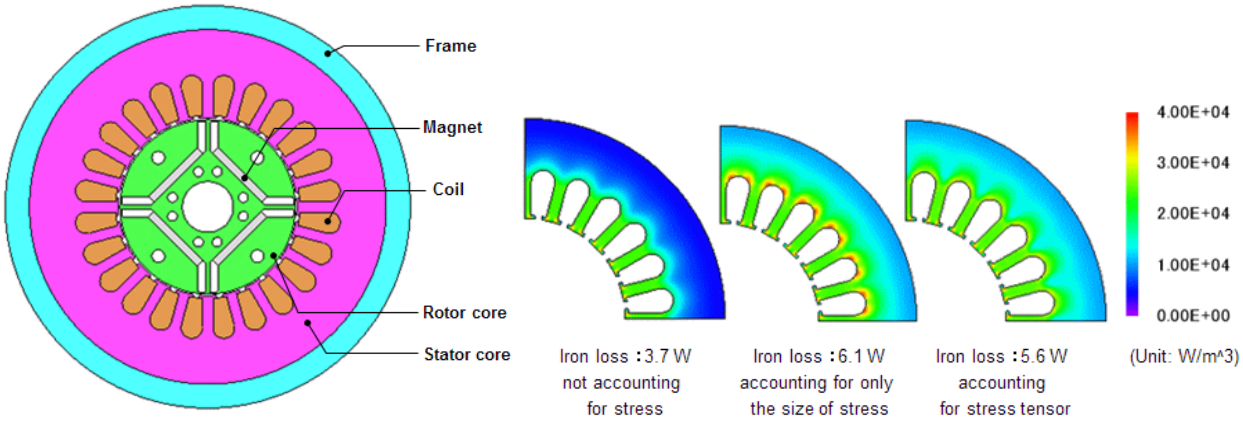

Fig 1. Effect of shrink-fitting stress on the stator iron loss density (JMAG application note JAC087).

Objective

Development of a first approach for the modelling of the shrink-fitting of a toroidal magnetic core or a stator-like case, in collaboration with MSMP lab. (A. Van Gorp).

Work steps

Bibliographic study on magnetic materials in general and electrical steels in particular, effect of mechanical stresses on the magnetic properties of electrical steels, existing research works on shrink-fitting, etc.
Numerical simulation of the shrink-fitting of a toroidal magnetic core or a stator-like to analyze the distribution of the mechanical stresses within it.
Magnetic measurements $\mathbf{B}(\mathbf{H},\sigma)$ under different mechanical stress strengths σ on electrical steel test samples by using the uniaxial single-strip tester of L2EP.
Development of a simple magneto-mechanical scalar model $\mathbf{B}(\mathbf{H},\sigma)$ based on the equivalent stress in the elastic domain.
Numerical implementation of the model in the Code_Carmel Finite Element Software in order to analyze the impact of the shrink-fitting on the magnetic properties of the test case.

Key words

Electrical steels; Magnetic properties; shrink-fitting.

References

[1] Hugo Helbling, "Etude de l'impact des procédés de fabrication des machines électriques sur les propriétés des noyaux magnétiques", Thèse de doctorat, Université de Lille, 2021.