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

Master project, 2021-2022

— Characterization and modelling of the magnetic aging of electrical steels —

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Context

Energy efficiency of electric motors is largely based on the magnetic properties of electric steels used to manufacture the iron cores (stator and rotor). However, during the life cycle of an electrical motor, the iron cores are subjected to mechanical and thermal stresses which can lead to an irreversible degradation of their performances. Moreover, the operating conditions of modern electric motors (high compactness, high supply frequency, etc.) lead to increasingly severe thermal constraints. The consequence of such severe operating conditions is sometime observed on the iron losses that increase, in an irreversible way, leading to what is called "magnetic aging" of the electrical steels. This phenomenon, the origin of which is at the scale of the micro-structure, is mostly observed on the iron losses which increase significantly (from 15 to 40% on the hysteresis losses, see Fig. 1). Consequently, the energy efficiency of electrical motors is degraded, irreversibly and very inhomogeneously depending on the operating conditions from one motor to another.

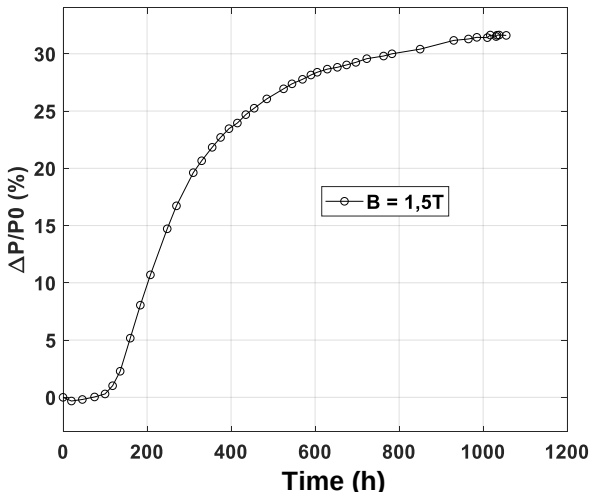

Fig 1. Evolution of iron losses (1.5T / 50Hz) with magnetic aging

Objectives of the Master Thesis

The objective of the proposed master thesis is to characterize experimentally the phenomenon of magnetic aging, in particular its effect on iron losses, for electrical steels commonly used in the motorizations of electric vehicles where severe operating constraints are likely to trigger the phenomenon of magnetic aging. Based on the experimental data, a model for predicting the evolution of iron losses during magnetic aging will be developed. This type of model is intended to be integrated into the design tools of electrical motors in order to predict the behaviour of iron losses following thermal aging during operation.

Keywords

Electrical steel, magnetic properties, magnetic aging, iron losses.