

Master project, 2022 – 2023

Magnetic ageing of electrical steels subjected to thermal operating conditions encountered in electrical mobility applications

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Context

In electrical machines, ferromagnetic materials are key components for the efficiency and performance of the energy conversion process. However, in modern applications, severe operating conditions, such as thermal constraints, influence their usage properties and may induce the so-called magnetic ageing. Thus, the electrical machine performances may be significantly impacted, especially in terms of efficiency. Indeed, during the electromechanical conversion, the different sources of losses (iron losses, Joule losses) may lead to an overheating of the machine. In some applications, the temperature increases significantly reaching up to 200 °C in some locations of the machine. Combined with the time factor, this variation of the temperature can activate the ageing physical mechanisms that will modify irreversibly the magnetic properties of the electrical steel. This process is usually defined as the magnetic ageing. Therefore, to predict accurately the electrical machine performances during their lifetime, it is necessary to investigate the magnetic ageing in electrical steels, starting by characterizing and modelling its impact on the usage properties.

Methodology

- Bibliographic study of the magnetic ageing in electrical steels.
- Experimental characterization of steel samples under thermal ageing condition (isothermal and non-isothermal).
- Modelling of the iron loss evolution under thermal ageing condition.

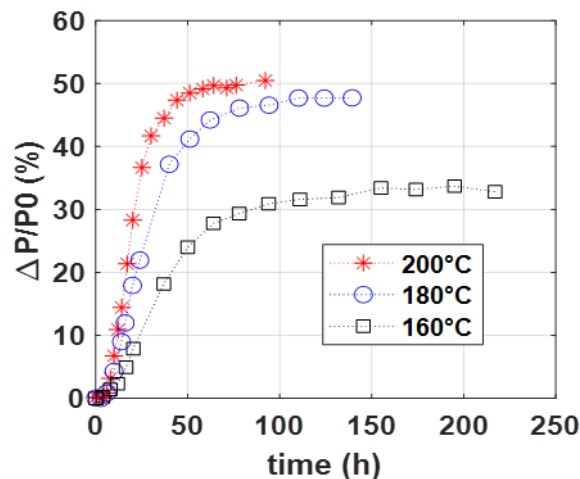


Fig.1. Relative increase of the iron losses for an electrical steel subjected to different ageing temperatures (from H. Helbling PhD thesis, L2EP, 2021).

Objectives

- Characterize the magnetic ageing of electrical steels.
- Model the ageing kinetic in order to predict the iron loss evolution.

Key words

Electrical steel, magnetic ageing, iron losses, experimental characterization, modelling.