Exploring New Solutions for Temperature Dependent Hysteresis Models

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Maria Roberta Longhitano*, Fabien Sixdenier†, Riccardo Scorretti†, Laurent Krähenbühl*

* Université de Lyon, Ecole Centrale de Lyon, CNRS, Ampère, F-69130, Ecully, France
† Université de Lyon, Université Claude Bernard Lyon 1, CNRS, Ampère, F-69621, Villeurbanne, France
E-mail: maria-roberta.longhitano@ec-lyon.fr

***Abstract*—In order to predict the behaviour of soft magnetic materials in electrical devices, it is very important to take into account temperature in magnetic material modeling. This paper focuses on the Energy-based hysteresis model and the possibility of studying the thermal behaviour through its parameters. The identification process of material parameters is carried out from DC measurements. The variation of the parameters is assumed from specific assumptions.**

***Index Terms*—Energy-based model, Identification, Static hysteresis, Temperature.**

I. Introduction

Electrical engineering systems have to work increasingly with sever constraints, as high temperature. Designing and optimizing devices, composed of soft ferromagnetic materials, require an accurate hysteresis model considering temperature. Conventional hysteresis models, Preisach [1] or Jiles-Atherton [2], have not taken into account temperature. Among the existing material models, the Energy-based model has many desiderable properties: it is intrinsically vectorial and built on a thermodynamic representation of the hysteresis, proposed in [3].

II. Identification of Material Parameters

We identified different Energy-based models corresponding to a 3C90 ferrite material. The experimental datasets have been measured from 223 K up to 448 K. For identification we used the procedure detailed in [4]. We obtained different distributions of pinning fields depending on temperature, Fig.1. Finally, we discretized the continous distribution by partitioning the magnetic field range into $N = 3$ cells and we obtained discrete parameters (ω_k, χ^k).

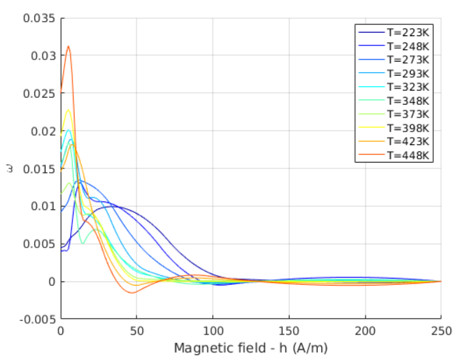

Fig. 1. Identified pinning field distribution $\omega(h)$ for different temperatures

III. Temperature Dependent Extension

We assumed that the variation of the product between the parameters of the model (ω_k, χ^k) with temperature are the same as the macroscopic coercive field h_c (1), Fig. 2. T_0 is a reference temperature, in this case we imposed $T_0 = 223$ K.

$$\frac{\omega_k \chi^k(T)}{\omega_k \chi^k(T_0)} = \frac{h_c(T)}{h_c(T_0)} \tag{1}$$

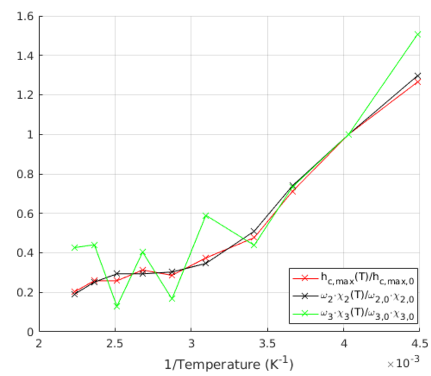

Fig. 2. Variation law of parameters with temperature

IV. Conclusion

Interestingly, we found a variation law which links the parameters with temperature. More details will be provided in the full paper.

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