Dynamic Hysteresis Modeling in FEM

M. Kuczmann

I. Introduction

From electrical engineering point of view, measuring the hysteresis characteristics of ferromagnetic materials aims the numerical implementation and identification of hysteresis models. The realized model can be inserted into an electromagnetic field simulation procedure based on the Finite Element Method [1,2].

Unfortunately, the measured curves are sometimes noisy, and some postprocessing is needed after the measurements, which procedure may be time consuming. The aim of this work is to remove any noise automatically in the measurement stage, and generate as fine hysteresis curves as possible, i.e. to make the identification task easier. The proposed noise removal technique is based on the Fourier transform of the measured signals. A simple but efficient method is proposed to reach distorted flux pattern by controlling the excitation current. The block representation of the well-known scalar hysteresis measurement system can be seen in Fig. 1 [2].

After measurements, the static scalar Preisach model can be identified from the measured concentric minor loops (Fig. 2).

Dynamic behavior can be modeled by using an excess loss term [3]. The static Preisach model can be identified from static measurements, and the excess loss term can be identified by using the data according to the higher frequency of excitation current (Fig. 3).

This identification task will be explained in the full paper.

II. Application in FEM

The hysteresis model represents the constitutive relation between the magnetic field intensity and the magnetic flux density, which can be represented by the polarization formulation [2]. Through this formula, the hysteresis characteristics can be implemented into a Finite Element Method based algorithm, and the resulting nonlinear system of equations can be solved by using the fixed point technique, or by a modified version of the Newton-Raphson technique [4].

The aim of this work is to implement and to identify a dynamic Preisach hysteresis model, and to use it in FEM simulations and to compare measured and simulated data.

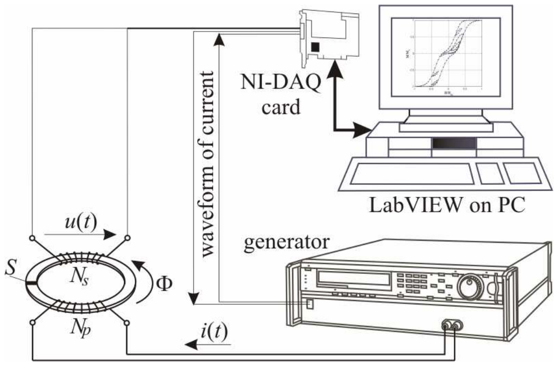

Fig. 1. The block diagram of the measurement system.

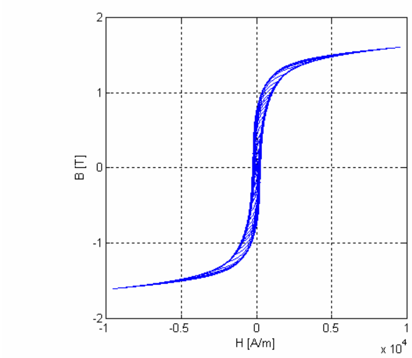

Fig. 2. Concentric minor loops.

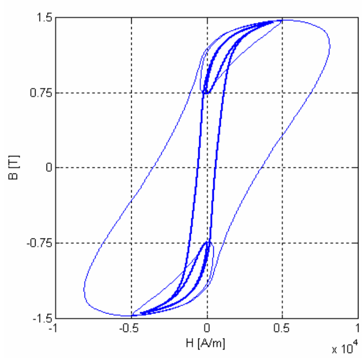

Fig. 3. Measured dynamic hysteresis curves.

References

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M. Kuczmann is with the Laboratory of Electromagnetic Fields, Department of Telecommunications, Széchenyi István University,
E-mail: kuczmann@sze.hu

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