Vector mixed model inversation strategy for rotational hysteresis in isotropic materials

L. Stoleriu, M. Kuczmann, A. Stancu

I. INTRODUCTION

The typical scalar measurements specific to most measuring devices commonly available in the laboratories – like magnetometers and hysteresigraphs – can be simulated by the means of several scalar hysteresis models with reliable identification techniques.

Nevertheless, the magnetic processes taking place in technical applications, like the case of the processes involved in magnetization dynamics inside electromagnetic machines, are influenced by the vector character of both physical quantities involved, the magnetic field ***H*** as input and the magnetic moment ***M*** or magnetic flux density ***B*** as output. This is one of the main reasons behind the great interest in the development of more efficient vector hysteresis models [1-2].

In vector modeling the most successful approach was the micromagnetic (physical) approach. The main disadvantage of applying a micromagnetic model to a large system is that it requires great computing resources so, in this context, phenomenological vector models represent a very useful category of models which are aiming to obtain the precision achieved by the micromagnetic models in describing the vector properties of a sample as well as the rapidity and the simplicity of phenomenological models.

A peculiar aspect of some electromagnetic problems is that the measurements need reversed hysteresis models with ***B*** as input parameter and ***H*** as output [3].

In this paper we are proposing a simple technique for designing a inverse vector model for isotropic materials.

II. THE MEASUREMENT SYSTEM

The experimental data was collected with a Rotational Single Sheet Tester with round shaped disk specimen that has been developed to measure the rotational flux patterns [4]. The magnetic field inside the specimen can be generated by a special two-phase winding, and the two orthogonal components of the magnetic flux density can be controlled by two independent current generators and the waveform of the currents can be set by a program developed in LabVIEW. The two orthogonal components of ***H***(*t*) and of ***B***(*t*) inside the specimen can be measured by a sensor system. The tangential component of ***H***(*t*) can be measured by a system of four coils placed onto the surface of the specimen, and ***B***(*t*) inside the specimen can be measured by two coils slipped into holes of the specimen.

The implemented controller can be used to generate any kind of magnetic flux density pattern. Fig. 1 presents the magnetic field intensity and the magnetic flux density in the case of circular magnetic flux.

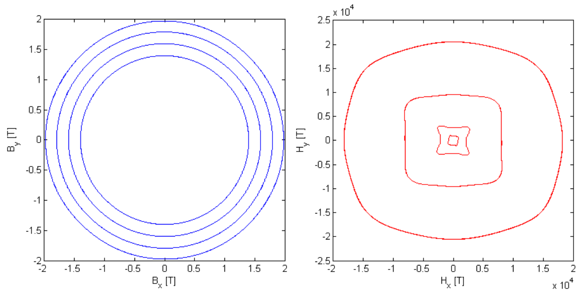

Fig. 1. Loci of the magnetic flux density (left) and the magnetic field intensity (right).

III. MODELING

In order to simulate the reversed rotational hysteresis curves we have used our vector model [5] and the interpolation technique presented in [6] to produce the inverse Everett function (Fig. 2) which, for the case of the isotropic material, is characteristic to any direction of the applied field.

The Everett function is further used as input for two perpendicular scalar models which are subject to flux densities equal with the projection of the total magnetic flux density ***B*** on their direction and which produce as outputs the components of the magnetic field ***H***.

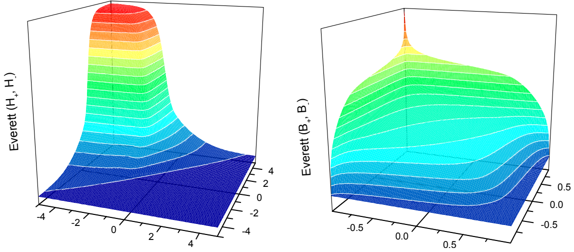

Fig. 2. Forward (left) and inverse (right) Everett functions.

ACKNOWLEDGEMENTS

This work was partially supported by Romania-Hungary FEM bilateral research grant.

REFERENCES

[1] E. Della Torre, G.Kadar, J. Appl. Phys. **63**, 3004-3006 (1988)
[2] I.D.Mayergoyz, G.Friedman, J. Appl. Phys. **61**, 4022-4024 (1987)
[3] E. Dlala, J. Saitz, A. Arkkio, IEEE Trans. Magn. **42**, 1963-1973 (2006)
[4] M. Kuczmann, Physica B, **403**, 433-436 (2008)
[5] A.Stancu, L.Stoleriu, P.Andrei, J.Magn.Magn.Mater. **316**, 309-312 (2007)
[6] L. Stoleriu, A. Stancu, IEEE Trans. Magn. **42**, 3959-3961 (2006)

L. Stoleriu and A. Stancu are with the Department of Physics, Al. I. Cuza University, Iasi, Romania, e-mail: lstoler@uaic.ro
M. Kuczmann is with the Laboratory of Electromagnetic Fields, Department of Telecommunications, Széchenyi István University, Gyor, Hungary, e-mail: kuczmann@sze.hu