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Development and Research of Algorithm for Determining the BH Curve Using a Single Primary Measuring Converter Based on the Method of Full-Scale Model Tests

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Abstract: This study presents the results of the development of the algorithm for determining the two coordinate BH magnetization curve of the material according to indications of one transmitter. The method of full-scale model tests is used to solve the problem. The algorithm is implemented as lua-script for FEMM 4.2 program. A program implemented in LabVIEW 2013 environment to control the process of determining the BH magnetization curve.

Key words: Method of full-scale model tests, flux-current characteristics, BH curve, magnetic, measurement

INTRODUCTION

Now a days magnetic materials are important components of most devices: transformers (Ovchinnikov, 2012), electric drives (Gorbatenko *et al*., 2011, 2015a, b; Shayhutdinov *et al*., 2015a), electromagnetic relays. Electrical devices in turn are important components of the various technical systems (Dubrov *et al*., 2015a, b).

Methods and approaches to determine their status separately and as part of systems being actively developed (Lankin *et al*., 2015; Shaykhutdinov *et al*., 2013, 2015a-e).

Wide spread techniques based on computational and experimental approach, including the method of full-scale model tests (Bulgakov *et al*., 2015; Shayhutdinov *et al*., 2015b; Lankin *et al*., 2015). The method of full-scale model tests involves the use of the experimental results as a model setting criteria and as the initial characteristics of the controlled object. An important problem is to minimize the number of primary devices used to implement the method of full-scale model tests.

The aim of this study is to develop a new algorithm for implementing the method of full-scale model tests. This algorithm should define two coordinate function BH characteristic of the material. The source of information should be a measure of the only one physical quantity the magnetic flux.

MATERIALS AND METHODS

The problem is solved by the using of the device for the control of electrical steel sheet, previously developed (Shaikhutdinov *et al*., 2015; Shayhutdinov *et al*., 2015c).

The result of operation of the device is the Weber-voltage characteristic of the magnetic system "magnetizing device-test sample". In the study the algorithm has been proposed in which the function is defined by the BH-characteristic varied by one coordinate the magnetic field H. Thus, the error in determining the characteristics of BH was reduced to 5%. A further reduction of the error causes difficulties due to the lack of a degree of convergence of the algorithm.

Greater efficiency showed an algorithm for determining of magnetic BH characteristics shown in Fig. 1. Software package FEMM 4.2 was chosen as the simulation environment. This package implements the most accurate of the currently existing finite element method. The algorithm (Fig. 1) as a lua-script for FEMM 4.2 environment was implemented. This lua-script controls the process of determining the magnetic characteristics. An algorithm (Fig. 1) became a piece of software for the PC. This PC is a part of information-measuring system for measuring the magnetic properties of electrical steel sheet. The software with the graphical programming language in LabVIEW 2013 environment was implemented.

The software provides a readout data of magnetic flus, electric current and the thickness of the test sample and lua-script definition of BH characteristics. The software executes lua-script with the given input data afterwards. The inverse problem of determining the magnetic characteristics of BH as measured magnetic flux interim results are displayed on the PC screen in the process of solving. An example of the results of the work of the information-measuring system for measuring the magnetic properties of electrical steel sheet is shown in Fig. 2.

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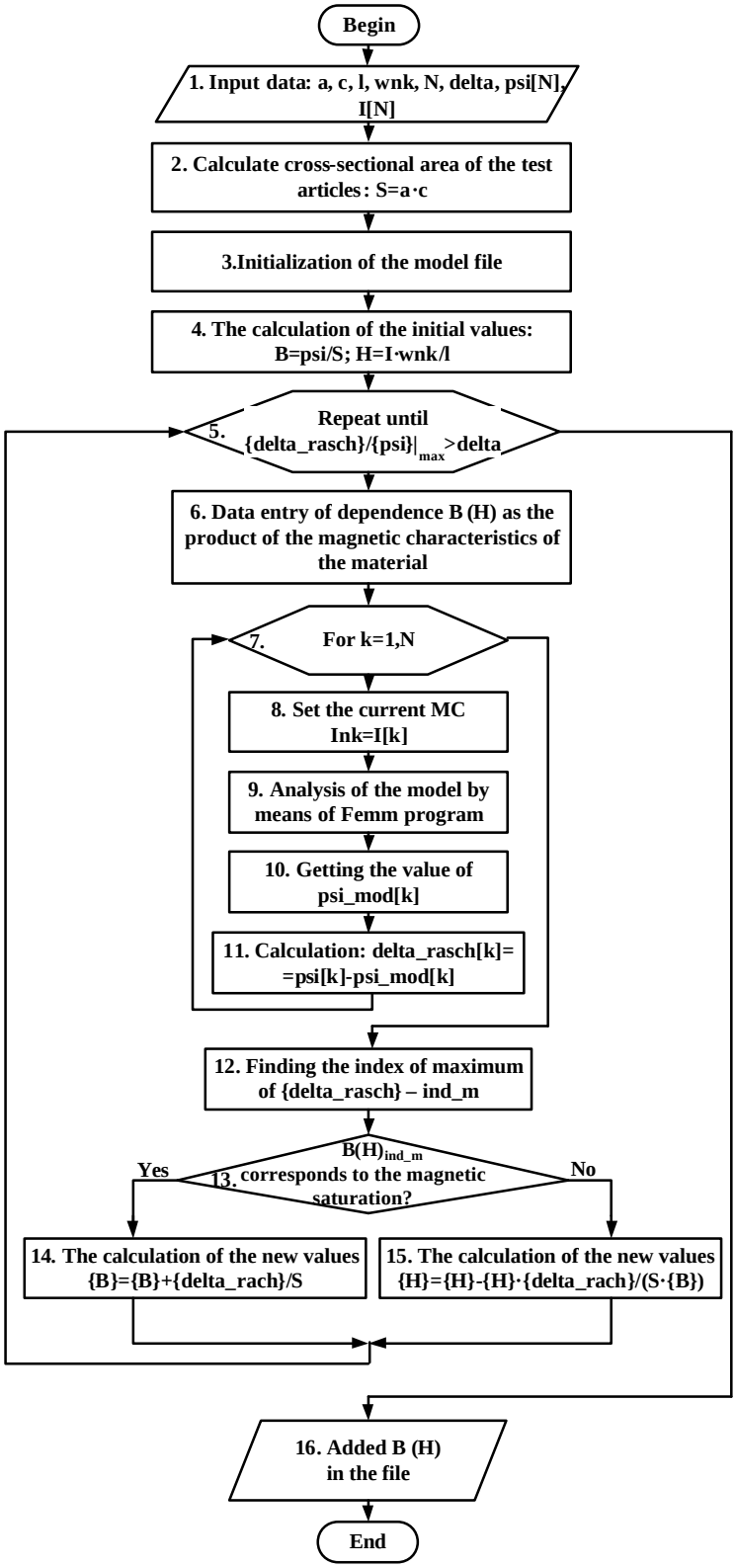

Fig. 1: The block diagram of algorithm for determining the BH curve using a single primary measuring converter based on the method of full-scale model tests

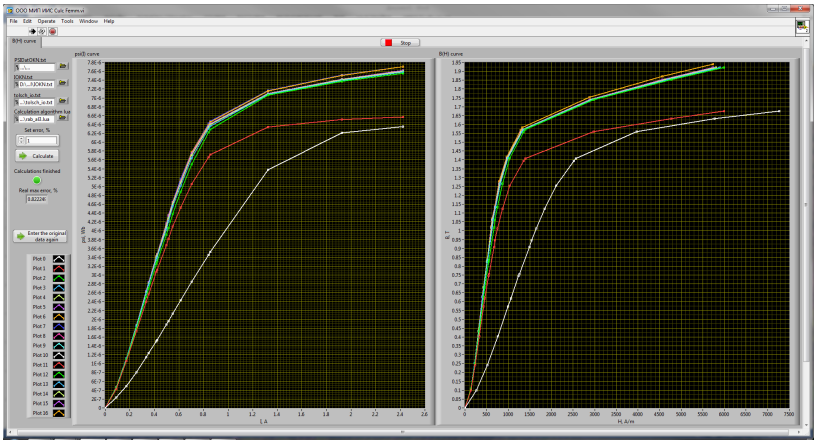

Fig. 2: An example of the implementation of the developed algorithm

RESULTS AND DISCUSSION

The algorithm for determining the 2 coordinate BH magnetization curve of the material according to indications of one transmitter is developed. The method of full-scale model tests is used to solve the problem. The algorithm is implemented as lua-script for FEMM 4.2 program. A program implemented in LabVIEW 2013 environment to control the process of determining the BH magnetization curve.

The developed algorithm for determining the BH curve using a single primary measuring converter based on the method of full-scale model tests provides a definition of magnetic characteristics with high level of the convergence and accuracy (error is no >3%).

Thus, it becomes possible to implement the algorithm in devices for measuring of magnetic characteristics of various ferromagnetic materials.

CONCLUSION

In the study developed and approved the algorithm and program for determining the magnetic characteristic based on computational and experimental approach. The algorithm is different from the others in that it is allow to configure an adequate model of testing object by using only one measurement parameter magnetic flux.

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