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Estimating current transformer core characteristics application

Program do wyznaczania charakterystyk rdzeni przekładników prądowych

Introduction

While determining parameters of magnetic transformer circuits, a thorough understanding of magnetization and loss characteristics of sinusoidal magnetic induction is essential. This is especially important when dealing with cores composed of materials with different magnetic characteristics, as in axially or radially assembled cores.

Most specifications available from manufacturers of magnetic materials are incomplete and unsatisfactory, revealing only partial characteristics at specific points. The alternative, technical method might become useful for the magnetization characteristics of sinusoidal magnetic induction only; it is not suitable for evaluation of loss characteristics.

The following paper summarizes the process of elaboration and realization of the individual algorithm for evaluation of magnetization and loss characteristics of ring-shaped ferromagnetic material samples. The method bases on analysis of current errors and phase displacement for current transformers with magnetic cores made of analyzed materials [1]. The evident advantage of this method is the fact that the samples are being investigated while working in their appropriate working conditions.

The method of estimating characteristics of magnetic materials based on accuracy of current transformers

The key concept behind the method of estimating characteristics of magnetic materials based on accuracy of current transformers is the experimental analysis of current transformer with ring-shaped ferromagnetic core made of the investigated material. The main subject of analysis is the current error and phase displacement of the test circuit. The measurements should be conducted for a selection of primary currents and secondary loads. On analytic dependencies described in [2], one can estimate the measures for magnetization and loss characteristics of the investigated materials.

It can be deducted from the dependencies described in [2] that the following data about magnetic sample winding (current transformer) are necessary to evaluate the characteristics of the material under test:

- core cross section S_{Fe}
- average flux path length l_{Fe}
- sample weight m_{Fe}
- secondary winding resistance R_s
- number of coils in secondary winding w_s
- nominal primary current I_p
- load impedance parameters Z_b, φ_b

Additionally, the following specifications are needed:

- relative primary current k_i
- current error Δi
- phase displacement δi

The designed application is capable of evaluating the magnetic material characteristics: $B_{1m}=f(H_{1m})$ and $\delta p_{Fe}=f(B_{1m})$, B_{1m} and H_{1m} being respectively the first harmonic amplitudes for magnetic induction and magnetic field strength.

These characteristics can be presented in graphical and tabular form.

Application description

The application starts with the welcome screen presented in figure 1.

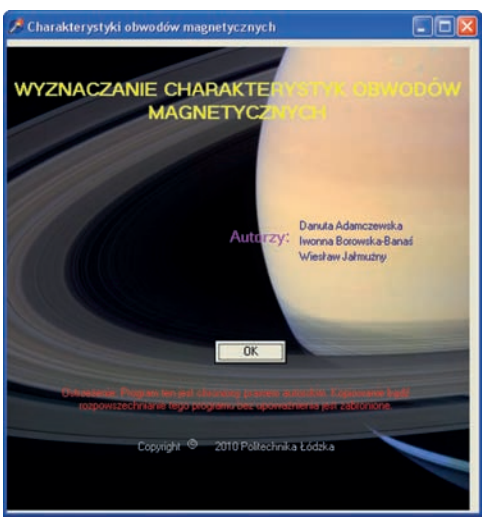

Fig.1. Welcome screen

Fig. 2. Nominal data

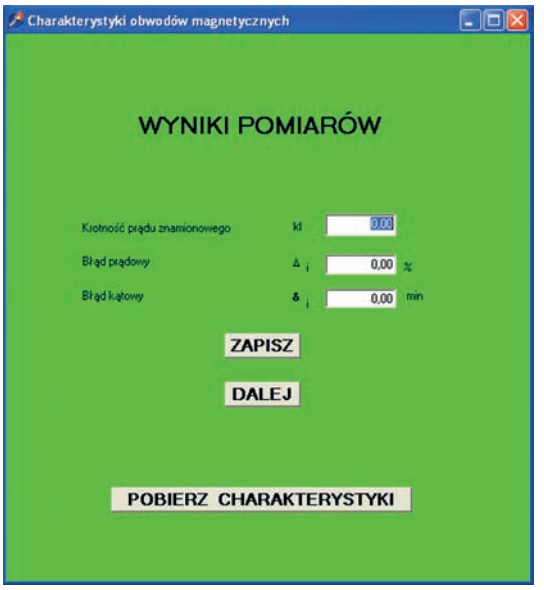

Fig. 3. Entering measurement results

The screen in figure 2 is used to enter nominal data of the current transformer with core made of the material under analysis.

After submitting this form, the screen from figure 3 is presented, where measurement results should be entered (current error, phase displacement and the corresponding relative current value).

Its operational algorithm is presented in figure 4.

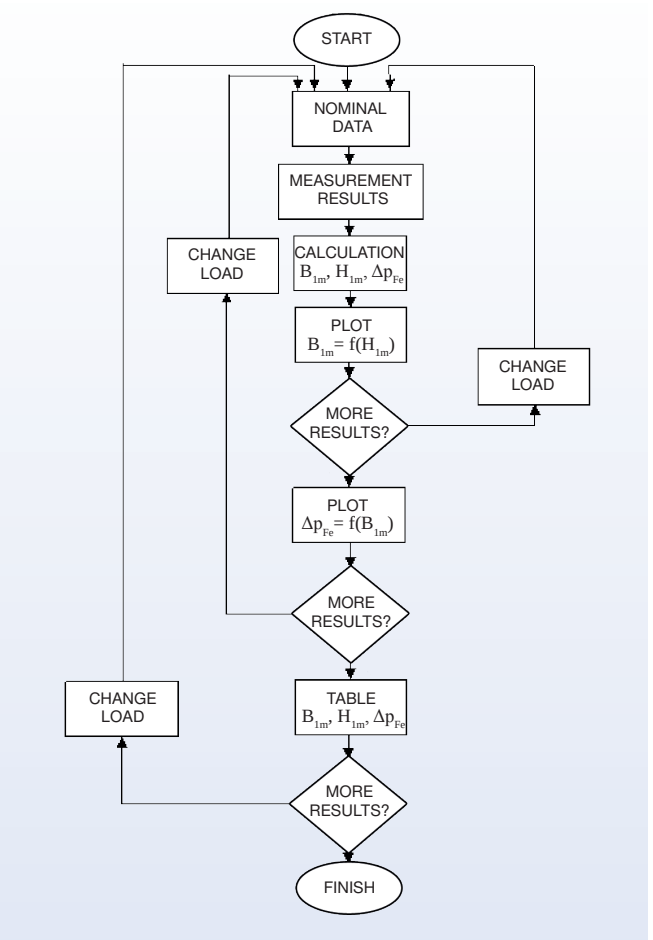

Fig. 4. Algorithm for estimating of magnetic materials characteristics

After submission, the application performs calculations and displays results as in figure 5.

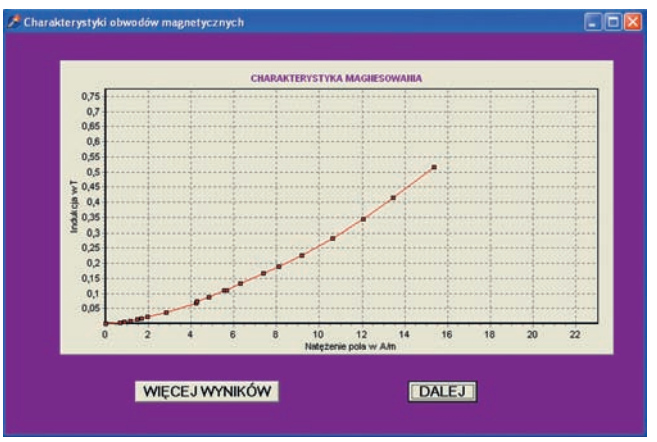

Fig. 5. Magnetization characteristic

The presented graph in figure 5 one can see the magnetization characteristic $B_{1m}=f(H_{1m})$ of the analyzed material. User can accept the number of measurement points and graph range or, if the result is not satisfactory, add more input data by clicking “MORE RESULTS”. This action will redirect him to “nominal data” screen (fig. 3). To increase measurement points or graph range, additional tests are necessary (for different test circuit setting, e. g. load value).

After accepting magnetization curve from figure 5, the following screen is displayed (fig. 6) where loss characteristic $\Delta p_{Fe} = f(B_{1m})$ of the investigated material are presented.

Again, user can add measurement points to increase graph accuracy and range by clicking “MORE RESULTS”.

When the results are satisfactory, user accepts the characteristics. The screen from figure 7 is presented.

Here, the measurement and calculations results are presented in a tabular form. Once again, user can click on “MORE RESULTS” to add more measurement results (hence increasing input data for calculations).

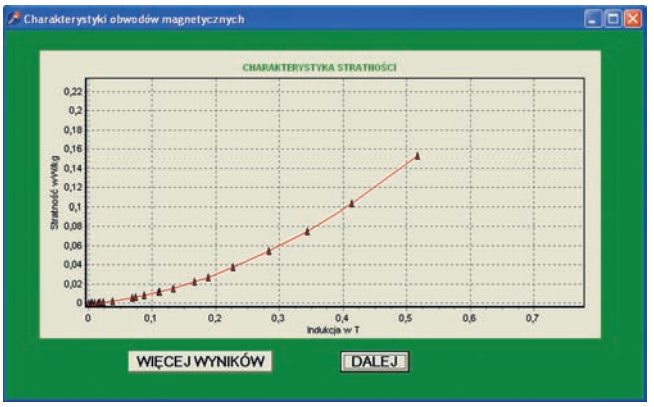

Fig. 6. Loss characteristic

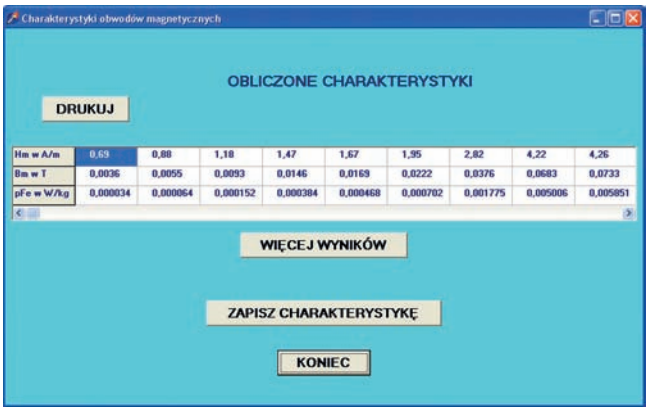

Fig. 7. Tabular form of characteristics

Application results

To verify the initial assumptions and application accuracy, the obtained characteristics have been compared to the similar measurements of the same magnetic material used in "Designing current transformers" described in [3] and [4].

The results of this comparison are presented in figures 8 and 9.

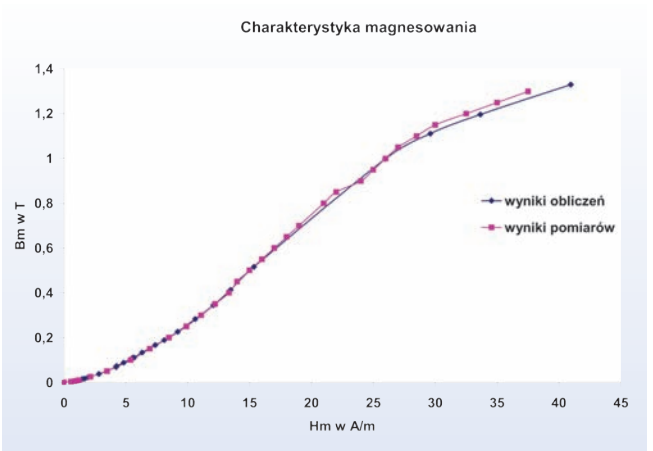

Fig. 8. Comparison results of magnetization characteristics

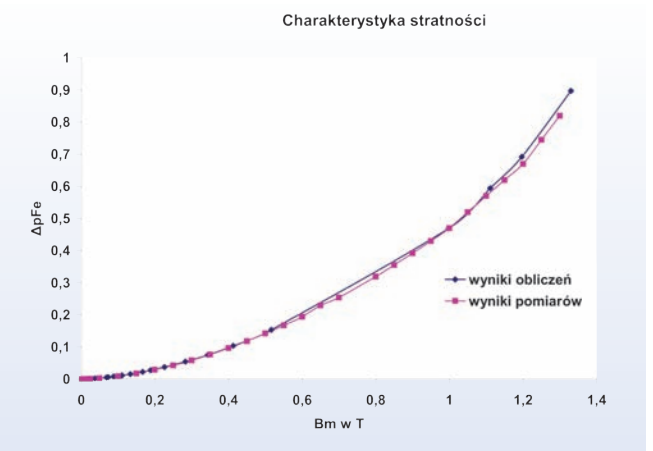

Fig. 9. Comparison results of loss characteristics

Summary

Below, the main advantages of the elaborated and realized method of estimating characteristics of magnetic materials based on precision of current transformers are listed:

- The possibility of practical reconstruction of working conditions for current transformers driven by sinusoidally alternating magnetic induction.
- Obtaining more accurate (due to the possibility of rescaling the magnetic circuit) results in comparison to the technical method.
- The possibility of tracing the magnetization and loss characteristics of the axially or radially assembled cores as well as comparing them to the results from "Designing current transformers" elaborated by the authors of this paper.

LITERATURE

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