



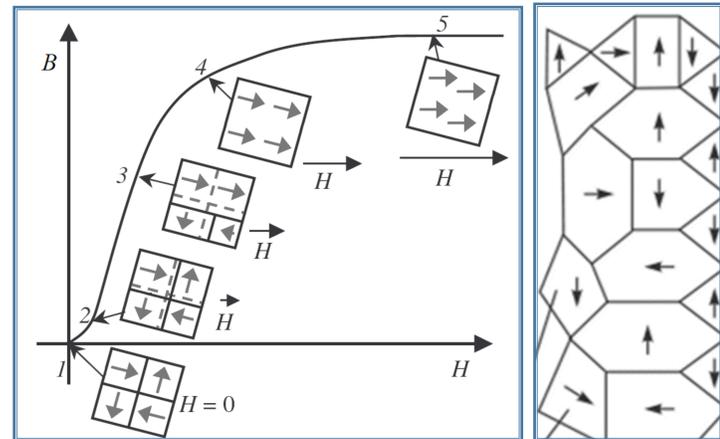
THE RESEARCH OF INFLUENCE OF SATURATION MODE ON PARAMETERS AND CHARACTERISTICS OF LINED FERROMAGNETIC MATERIALS AND DEVICES BASED ON THEM

The topic of this research is relevant because lined ferromagnets are widely used in electrical engineering and require more accurate determination of their parameters in saturation mode. The saturation phenomenon has a row of different processes occurring in them. Also, lined ferromagnets can be aged under temperature and frequent changes of current direction. Also, faulty transformer can be diagnosed and subsequently repaired thanks to the developed complex in a short time. It is much cheaper than buying a new one and saves the planet's resources.

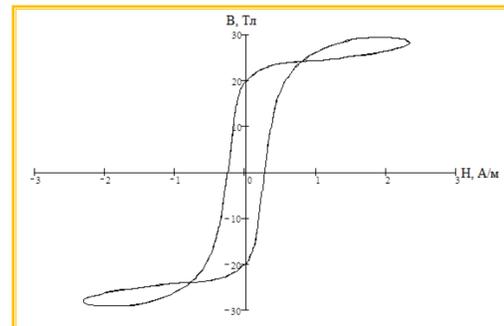
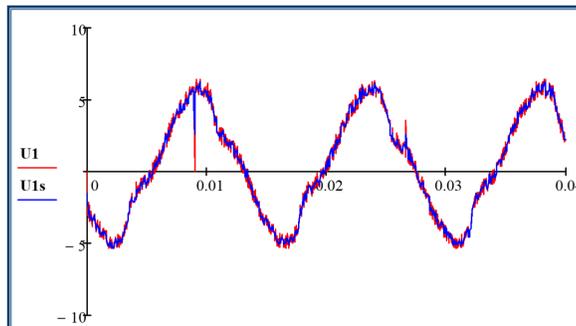
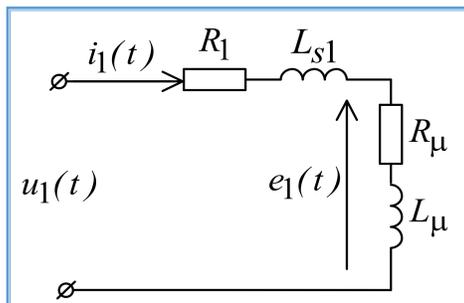
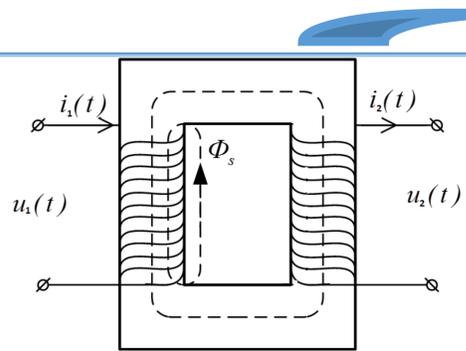
Purpose: substantiation and experimental testing of methods for calculating the magnetic and electrical properties of lined ferromagnets and parameters of electrical devices based on them, taking into account the nonlinearity of the parameters of the magnetization circuit.

Objectives of the research:

1. Investigate the adequacy of the calculated ratios to determine the parameters of ferromagnetic materials and the circuit with the lined ferromagnet in the saturation mode.
2. Test the method of determining the parameters of a circuit with a charged ferromagnet by modeling the system of calculation equations in the Mathcad package.
3. Analyze the processes occurring in the lined ferromagnets at different degrees of saturation of the magnetic system to take them into account when calculating the parameters of the circuit.
4. Experimentally test the general method of calculating the electromagnetic and energy parameters of the circuit, taking into account the processes occurring in the lined ferromagnet in the saturation mode, and compare the results of calculations with experimental data.



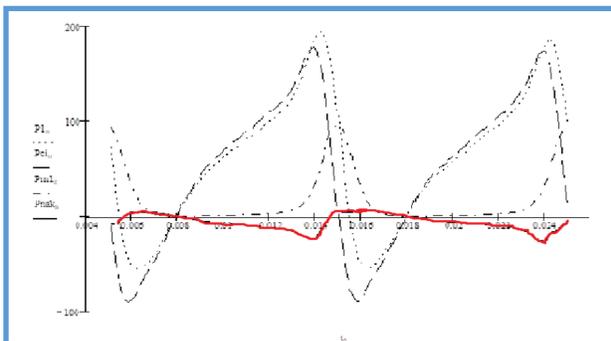
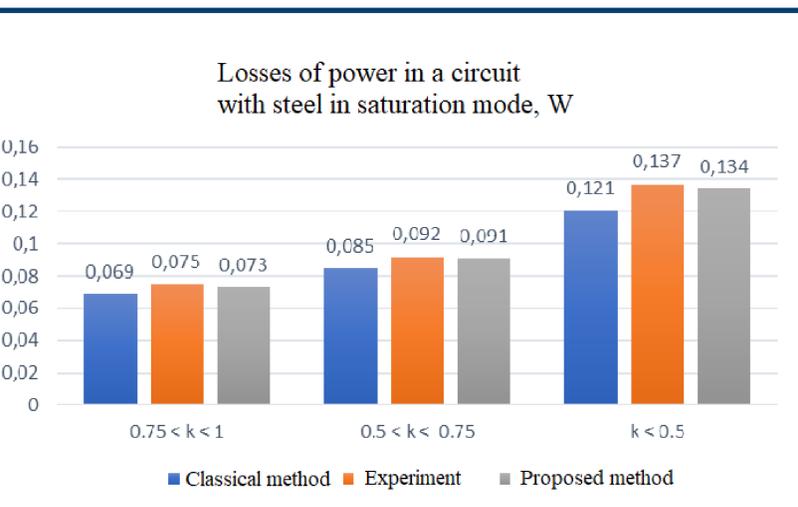
The magnetization curve and conditional image of the domain structure of the metal. (Pictures from the Internet)



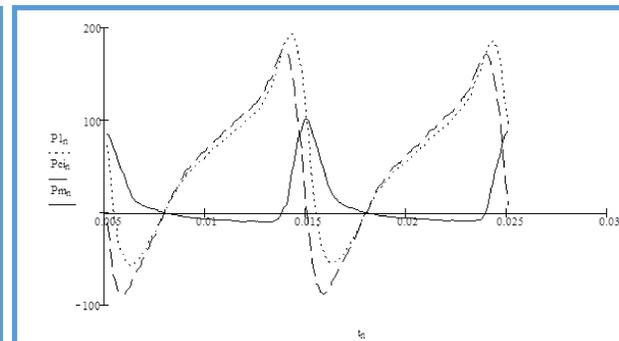
Equivalent load circuit in the form of an inductor with a ferromagnetic core and its electrical replacement circuit. Second winding is considered to be only for data collection and to decrease error in calculation. (Pictures from journal article)

Due to the incorrect shape of the studied signals, it became necessary to decompose them into a Fourier series for future studies in the Mathcad package.

Deviation from the classical form of the hysteresis loop of the magnetic material is the main reason for obtaining an additional component of losses.



We used promising methods such as a transition from mean and root mean square values of signals to instantaneous values. As a result, we noticed missed component of losses from the classical point of view. This is highlighted by a red line.



Losses in a saturated circuit with steel from the classical point of view. They were obtained by separating the losses in the copper of the primary winding based on their known quadratic dependence on current.

CONCLUSION:

1. The unsuitability of the existing methods of calculating the parameters of electrical devices for the saturation mode of the magnetic system is proved because the energy processes are not fully taken into account.
2. The method of measurement and the algorithm of processing of the experimental data allowing to define necessary electric and magnetic parameters of investigated samples at any degree of saturation taking into account the arbitrary spectral structure of the measured signals are proved and tested.
3. It is proved that the energy method used in the work to determine the parameters of electrical devices on alternating current is applicable at high saturation of the magnetic material and is characterized by an error in determining the parameters in the medium saturation mode of 3-5%, and in the high saturation mode - about 7-9%. 3-8 times less than when using the basic method of calculation.
4. The proposed calculated relations provide an adequate mathematical description as a function of the time of the main electromagnetic and energy processes in the transformer windings in the saturation mode.

RESULTS:

1. The unsuitability of the existing methods of calculating the parameters of electrical devices for the saturation mode of the magnetic system is proved because the energy processes are not fully taken into account.
2. Comparison of experimental data reveals a correlation between the losses in the lined ferromagnet and the change in the shape of the hysteresis loop in the mode of high saturation degree. The results of experimental studies show that the magnitude of losses during remagnetization of ferromagnets can be largely related to the dynamics of the motion of domain structures.



QR-code to Google Drive with file and collected data



The Mathcad logo, that was used in this research.

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