Non-uniform Grid in Preisach Model for Soft Magnetic Materials

Jakub Eichler, Miroslav Novák, Miloslav Košek
Technical University of Liberec
jakub.eichler@tul.cz, miroslav.novak@tul.cz, miloslav.kosek@tul.cz

Abstract

Very efficient hysteresis modeling by Preisach model in discrete presentation uses two-dimensional grid with ideal dipoles (hysterons) in its nodes [1]. The complete description of material magnetic properties is given by dipole momentums that form the weighting function, defined at the grid triangular upper part. The hysteresis loop is derived from the weighting function by different manner for excitation field increase and decrease. Strictly, increasing excitation switches other dipoles and in different order than the decreasing field. The experimental derivation of the weighting function requires extended experiment that usually uses the first order reversal curve (FORC). Measurement that starts at negative saturation level and measures individual hysteresis loops for increasing excitation amplitude up to symmetric positive saturation. Then their decreasing reversal parts are processed by partial derivations by both the field strengths. Usually the uniform grid is used for the weighting function and the linear excitation amplitude increase for the measurement. However, examined grain oriented steel has weighting function with very sharp maximum and long saturation regions. In the case of uniform grid these regions contribute to the results by small, but no negligible amount. The better solution should be the use of no-uniform grid [2]. In order to analyze the errors due to the problem simplification, the simplest no regular grid with only two lattice constants was used. The simple analytical weighting function of probability density type was selected and harmonic excitation applied. The weighting function maximum is close to the main diagonal of Preisach's triangle. All the practical differences due to the grid reduction were very small. The comparison in time response near saturation region shows, that only differences are the coarser steps on the magnetic flux waveform, but the shape and position of the curve is not affected. The use of no uniform grid is important for experiments; since the measurement time is shorten several times. The same value of computation speed is valid for calculations, when the simplest robust algorithm in MATLAB is used. If a very sophisticated algorithm is invented, the calculation speed increases about thousand times. The efficient no uniform grid is the grid with the same flux density steps, for instance. The extended work in this field is now in progress.

References

1. G. Bertotti and I. Mayergoyz and . "The science of hysteresis" Vol. 1, 2 and 3. 1st ed.. Elsevier, 2006. ISBN 978-0–2-369431-7, Chapter 3..
2. P. Postolache and M. Cerchez and L. Stoleriu and A. Stancu. "Experimental evaluation of the Preisach distribution for magnetic recording media". IEEE Transactions on Magnetics, vol. 39, no. 5, pp. 2531-2533, Sept. 2003.