

Modeling the hysteresis loss of soft magnetic materials in low magnetizing fields

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Measurement and modeling of the magnetic hysteresis power loss is crucial in development of inductive components based on magnetic cores made of soft magnetic materials. Considering the modern trends of energy saving it might be expected that most of this components are intended to work with relatively low currents. Therefore the magnetic cores of such components would work within the region of low magnetizing fields, so-called Rayleigh region, rather than in the near-saturation fields. This creates a need of power loss modeling in this specific region.

In previous work [1], the effectiveness of the Rayleigh model of hysteresis and the Steinmetz law was compared in modeling power loss of soft magnetic materials in low magnetizing fields. The Steinmetz law seemed to be a bit more accurate description. However only the basic forms of both models were taken into consideration. The purpose of the following work is to investigate the effectiveness of more developed Steinmetz law versions, such as Modified Steinmetz Law, Generalized Steinmetz Law or Improved Generalized Steinmetz Law, as well as Rayleigh model with modified exponent, as it was previously proposed in [2]. Four soft magnetic materials were taken into consideration, representing both ferromagnetic and ferrimagnetic type of magnetic ordering. The power losses of the materials were investigated with a hysteresisgraph in relatively low magnetizing fields, approximately up to the point of maximum magnetic permeability. All considered models were applied to the obtained measurement results. The effectiveness of the models was compared by the means of determination coefficient and normalized root-mean-square deviation. The obtained results indicates that the Steinmetz Law and its derivatives a bit more accurately describe the character of the power loss in the considered region of magnetizing fields.

References:

- [1] M. Kachniarz, *Acta Physica Polonica A* 146 (2024) 64.
- [2] J.A. Baldwin, J. Revol and F. Milstein, *Physical Review B* 15 (1977) 426.