Soft Magnetic Materials 21

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Conference Program And Book of Abstracts

Organised by

Wigner Research Center for Physics,

Institute for Solid State Physics and Optics

G2-02

Frequency dependency of nonlinear loss parameter for an improved iron loss prediction

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For the design process of electrical machines the prediction of the iron losses has to be as accurate as possible. The iron-loss model needs to describe the material behavior for various frequencies and flux densities (which represent the operating points of the electrical machine). Considering high frequencies and flux densities, the material behavior becomes nonlinear. With respect to this, an iron-loss formula (1) based upon a pure mathematical parameter identification has been developed to improve the accuracy in this higher frequency range [1].

$$P_{IEM,4} = d_1 \cdot B^2 \cdot f + d_2 \cdot B^2 \cdot f^2 \cdot \left(1 + d_3 \cdot B^{d_4}\right) \tag{1}$$

A semi-physical parameter identification procedure aiming at the physical interpretation of the parameters d_1 for pure hysteresis and d_2 for eddy current was presented in [2]. There, the nonlinear loss component represented by the parameters d_3 and d_4, is described by a mathematical approximation of the separated loss component for each examined frequency, which leads to the need of loss measurements for each subjected frequency.

Considering this, the frequency dependence of the parameters d_3 and d_4 in line with the nonlinear loss component for a wide frequency range is studied in this paper. This investigation is done with the intention of a mathematical description of the parameter behavior as well as the attempt to combine the behavior of the nonlinear loss component with material characteristics. The aim is to predict the nonlinear material behavior on the basis of low frequency measurements to reduce the measurement effort.

Figure 1 shows the course of the identified nonlinear loss parameters with frequency for two different materials with the thickness d = 0.35 mm. The parameter course of both materials seems to describe a $\frac{1}{f}$- course.

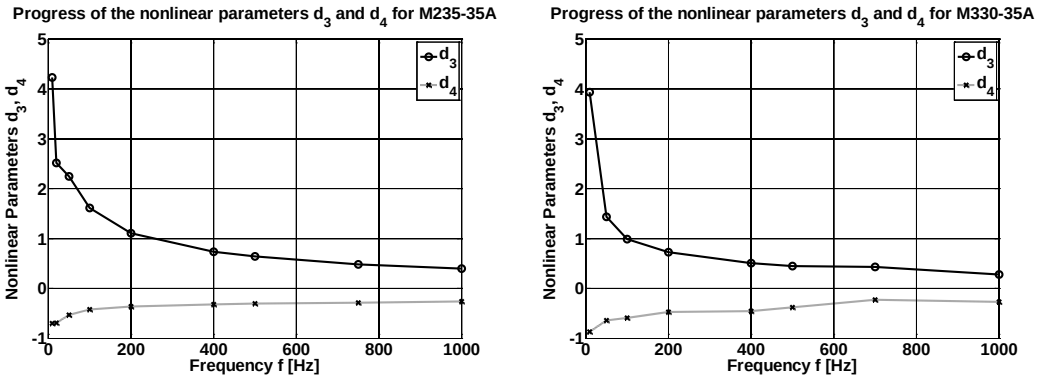

Figure1: Frequency dependent course of the nonlinear parameters d_3 and d_4 for
a) M235-35A b) M330-35A

[1] JACOBS, S. – HECTORS, D. – HENROTTE, F. – HAFNER, M. – HERRANZ GRACIA, M. – HAMEYER, K. – GOES, P.: World Electric Vehicle Journal, volume 3, ISSN 2032-6653, 2009.
[2] EGGERS, D. − STEENTJES, S – HAMEYER, K.: IEEE Transactions on Magnetics, volume 48, number 11, pages 3021-3024, ISSN 0018-9464, 2012.

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