Flexible extension of hysteresis models for magnetic anisotropy

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Increased demands on iron-loss calculation of electrical machines require accurate models to replicate the magnetization behavior of the soft magnetic materials in any spatial direction [1,2]. Two-dimensional measurement devices are developed to characterize the vectorial properties of the material and the power losses. These two dimensional measurements reveal a variety of features and characteristics that cannot be reproduced by most of the conventional one-dimensional hysteresis models and their phenomenological two-dimensional extensions.

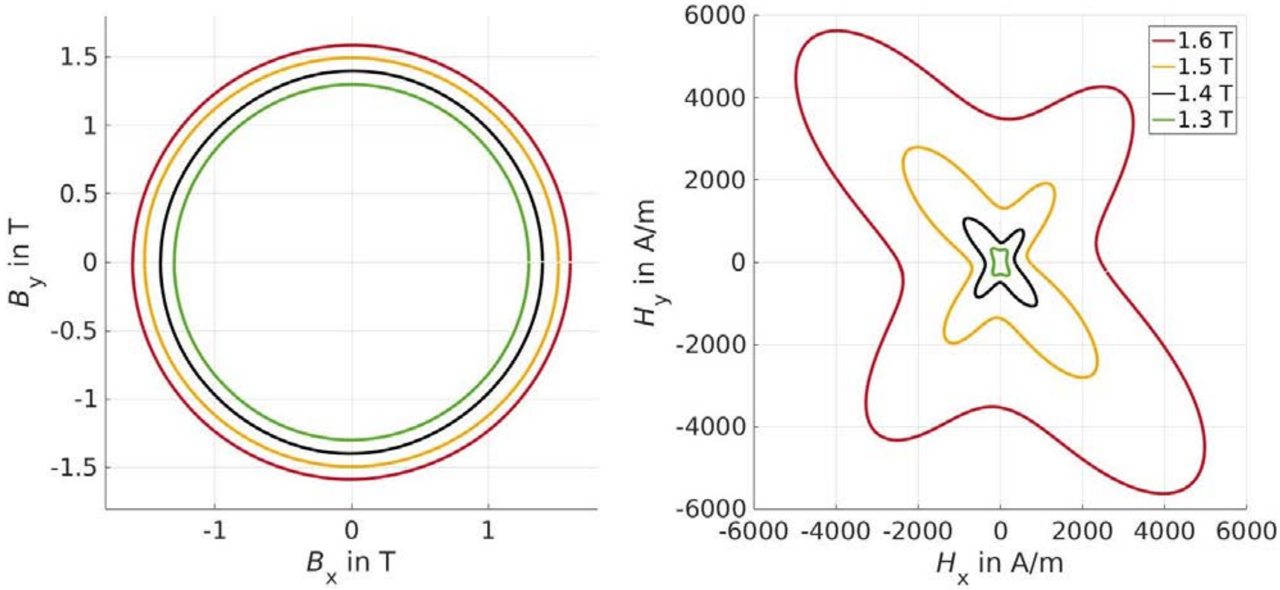

Figure 1. $\mathbf{H}$- and $\mathbf{B}$-loci for circular polarization from 1.3 up to 1.6 T at 50 Hz.

These are e.g. the phase difference between $\mathbf{H}$ and $\mathbf{B}$-vector, the influence of the magnetic hard direction as a function of the magnetic excitation and the applied field loci originating from the magneto-crystalline anisotropy [3]. This paper discusses the effect of magnetic anisotropy by using measured data obtained from a rotational power loss tester (RPT) for a set of non-oriented electrical steels, as shown in Fig. 1.

Central to the replication of the magnetic anisotropy in magnetization and hysteresis models is the description of the direction-dependent anhysteretic magnetization curve [4]. The ability of different classical hysteresis models to describe the magnetic anisotropy which is necessary to accurately predict the magnetic behavior is studied and compared. Further on, flexible modifications of the mathematical formulations of these analytical models are performed and studied with respect to the contribution for a better mapping of the observed direction-dependent magnetic behavior.

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