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A Comparative Analysis of Energy Loss Mechanism of GO Electrical Steels

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Magnetic hysteresis is a physical phenomenon to characterise and classify all kinds of magnetic materials. Most of the phenomenological concepts of magnetic hysteresis are rate-dependent and can be interpreted by monitoring the dynamic hysteresis loop (DHL) [1]. This paper performs a comparative analysis of dynamic behaviour and energy loss mechanism of two types of electrical steels, CGO and HiB. The proposed approach is in line with the magnetic hysteresis and phenomenological concepts of rate-dependent and rate-independent energy loss components under time varying magnetic fields.

Keywords: Magnetic hysteresis, dynamic hysteresis loop, energy loss mechanism.

1. Methodology

Dynamic performance of GO electrical steels can be accurately analysed according to the Thin Sheet Model (TSM) which is originated from the statistical energy loss separation proposed by Bertotti [1]:

$$H(t) = H_{hys}(B(t)) + \frac{d^2}{12\rho} \frac{dB}{dt} + g(B)\delta \left| \frac{dB}{dt} \right|^\alpha \quad (1)$$

where d is the lamination thickness and ρ is resistivity. Directional parameter δ is $\delta = +1$ for $(dB/dt) > 0$, and $\delta = -1$ for $(dB/dt) < 0$. Exponent α designates the frequency dependence of excess field, and $g(B)$ is a polynomial function to control shape of the DHL.

During each magnetising cycle, magnetic materials can experience two distinct points: (B_m, H_m) where the flux density changes its direction, and (B_m, H_b) where $dB/dt = 0$. Accordingly, by magnetising the material over a continuous range of flux density, two characteristic curves can be observed [2-3].

2. Experimental Results and Discussion

Experimental works were undertaken on Epstein size laminations of 3 % SiFe with two different grades, CGO and HiB. DHLs of the materials were measured using a standard single strip tester (SST) under controlled sinusoidal induction of 50 Hz and peak flux densities of 0.1 T to 1.7 T. (B_m, H_m) and (B_m, H_b) curves were identified for each material, the results are shown in Figs 1-a and 1-b, respectively. These two curves are the basis for understanding materials behaviour, dynamic modelling and energy loss separation.

More detailed explanation on the modeling method, experimental and analytical results on static and dynamic characteristics of the material and energy loss components will be presented in the extended paper.

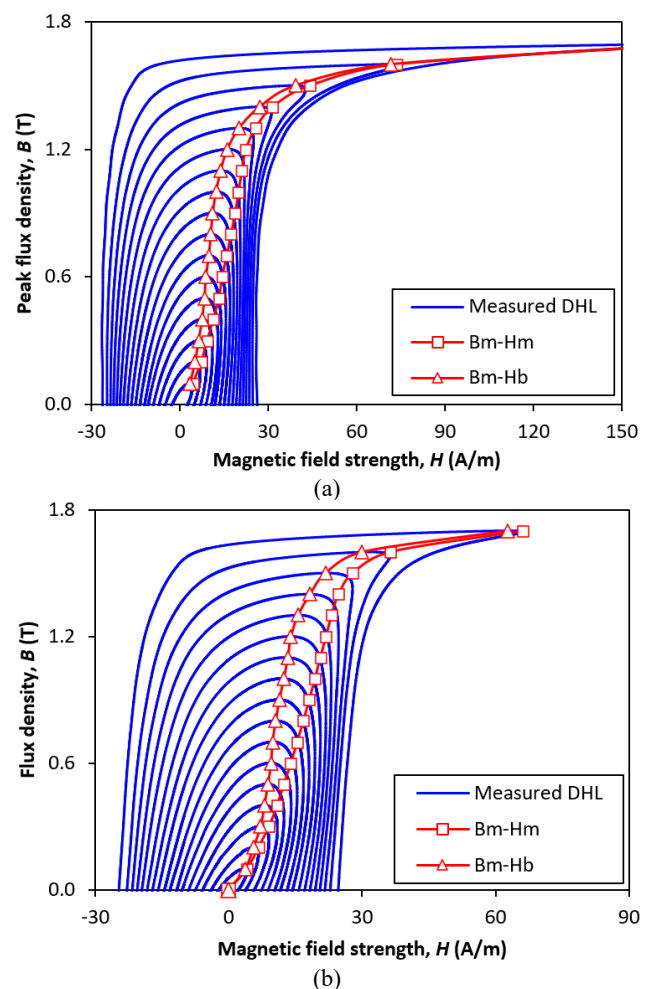


Fig 1 DHL, (B_m, H_m) and (B_m, H_b) curves for (a) CGO and (b) HiB electrical steels, at magnetising frequency of 50 Hz

References

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