IMPROVED MEASUREMENT WITH 2D ROTATING FLUXES CONSIDERING EFFECT OF MAGNETIZATION

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Introduction

A phenomenon that the magnetic field strength **H** loci, corresponding to the circularly rotating flux density vectors **B** in the clockwise and anti-clockwise directions are asymmetric, has been observed [1,2] using the field metric method in single sheet tester (SST). And there is a large discrepancy of rotational core losses between the opposite directions. This has not yet been fully understood. This paper presents an analysis of the effect of internal field $\mathbf{H_i}$ on the measurement and evaluation of misalignment angles of **H** surface sensing coils. Since the internal field $\mathbf{H_i}$ that relates to the interaction field and demagnetization field, is the function of magnetization, denoted as $\mathbf{H_i}=f(\mathbf{M})$, the mentioned phenomena are directly attributed to the effect of magnetization. In addition, a method to eliminate its effect is derived and employed in the paper.

Effect of Magnetization on Measurement

If the axes of the **H** sensing coils are misaligned with the axes of the excitation coils of the tester, or not perpendicular to each other, the measured values will not be the true components on the X and Y axes of the magnetic field. Theoretically, the error caused by this misalignment can be eliminated by using the coordinate transformation. However, it is difficult to obtain the true misalignment angles of sensing coils due to the effect of internal field.

In order to identify and correct the misalignment angle of the **H** sensors in an SST, alternating fields are applied to the X and Y axes respectively. In the ideal case of an isotropic material, subject to an alternating field **H**, **M** is aligned with **H**. Consequently an actual misalignment angle of sensing coils can be easily evaluated. In practice due to non-uniform distribution of magnetic particles and asymmetric shape of the measured specimen, **M** always leads or lags **H**. Therefore, the internal field $\mathbf{H_i}$ is not aligned with **H** as shown in Fig.1.

Fig.1 illustrates that an alternating field **H** acts in X axis. Due to the effect of magnetization or internal field, the **H** vector is dragged away from the X axis. This leads to an extra or additional misalignment angle. The additional misalignment angle created by $f(\mathbf{M})$ depends on both magnitude of **M** and its equilibrium direction.

The measured misalignment angles of **H** sensing coils can be simply expressed as

$$\alpha_i(\mathbf{M}) = \alpha_i + \alpha_i(f(\mathbf{M})) \qquad (i = x,y) \qquad (1)$$

where α_i is the actual misalignment angle, and $\alpha_i(f(\mathbf{M}))$ the additional misalignment angle, which depends on the variation of magnetization of the material under test.

As mentioned above, due to the effect of the internal field $\mathbf{H_i}$, it is quite difficult to obtain the correct (actual) misalignment angle, and thus the angular error of H sensing coils cannot be properly corrected. This will lead the asymmetry of **H** loci in measurement and discrepancy of rotational core loss in calculation between the two opposite rotating directions.

Correction of Misalignment

To eliminate the error caused by the additional misalignment angle, it is essential to evaluate $\mathbf{H_i}$. Actually, it is not easy to get the function relation between the $\mathbf{H_i}$ and **M** for the specific magnetic material specimen. Alternatively, a convenient method by averaging the value point by point in two opposite directions is derived. Then the correct **H** loci and rotational core losses can be simply obtained.

A 50×50×1.25 mm square sample of SOMALOY^{TM} 500 soft magnetic composite material was tested. Fig.2 depicts the rotational core losses corresponding to various circularly rotating flux densities in clockwise and anti-clockwise directions, the averaged rotational core losses vs. **B** are shown by the solid line. The results are reasonable.

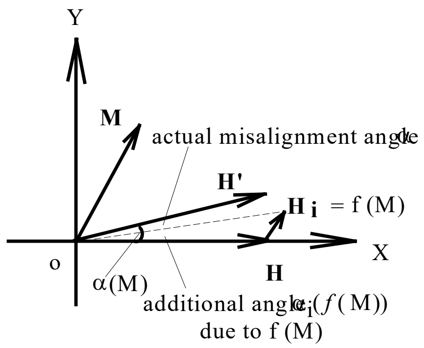

Fig.1 Additional misalignment angle created by **M**.

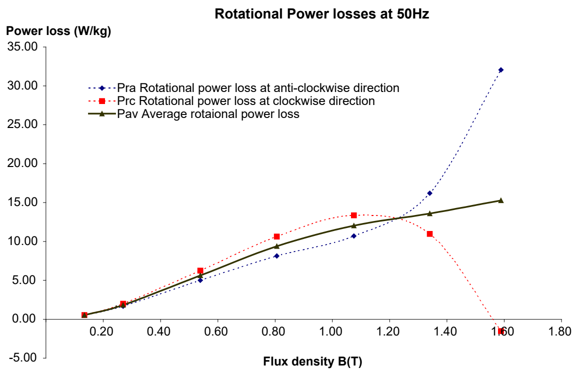

Fig.2 Rotational core losses

More results and detailed discussions will be presented in the full paper.

References

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