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Comparison between the Nominal Loss in 3%SiFe and Amorphous Transformer Core Materials

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Abstract.
An investigation of nominal loss in 3%SiFe and amorphous of the transformer core materials will evaluate in this paper. The investigation involves the variation of power loss, flux leakage, and total harmonic distortion. The nominal loss has been measured using Epstein test frame with three layers of lamination. The loss in the amorphous transformer core material is 57.46% better than the transformer core with 3% SiFe material at flux density of 1.2T, 50 Hz. The flux leakage at corner in the 3% SiFe transformer core material is the lowest than the two of transformer core material, over the whole flux density range. Total harmonic distortion flux is the largest in the amorphous of transformer core materials and the smallest in the 3% SiFe of transformer core material. Using the amorphous material in transformer core is more efficient than the two of transformer core materials.

Introduction

Amorphous and 3% SiFe material are including material that used in the manufacture of transformer core [1-7]. For amorphous material which is the magnetic characteristic only investigate with induction from 1 to 1.6T. Because the amorphous alloy has less flux density than the 3%SiFe to achieve saturate. It can reduce the transformer core size and reduce the transformer core loss and audible noise [8]. The study of differences in the efficiency of the application of these two materials in the transformer core has also been much investigated [9-10]. Which is the core loss of transformer core assembled with amorphous material is 85% lower than silicon steel core [5].

The rising volumes of material used and the associated testing mean that the cost and convenience of testing for grading is an important matter. The Epstein test has been of long standing value to design engineers who have learned how to translate the figures arising from the Epstein test into useful predictions of machine performance. A climate of change, however, has developed [11].

The objective of this investigation is to compare the nominal losses of cores materials of identical geometry built in 3% Sife and amorphous material.

Materials and Methods

Two single phase stacked cores are assembled using 0.3 mm thick laminations of 3%SiFe materal and 0.04 mm thick lamination of amorphous material, butt overlap corner joint. Each core is 280 mm x 280 mm with the limb 30 mm wide. Each core comprised of three layers with arrange as shown in Fig. 1. The Epstein test could be energized from 1 to 1.5 T, nominal loss and total harmonic distortions are measured with power analyzer. The layout of the Epstein test frame as shown in Fig. 2. The Epstein test involved exciting a magnetizing winding (700 turns spread over 175 turns per limb of the squared) so that the sample attained the desired peak induction. [11] Flux leakage at corner joint and limb are measured with magnetic field meter.

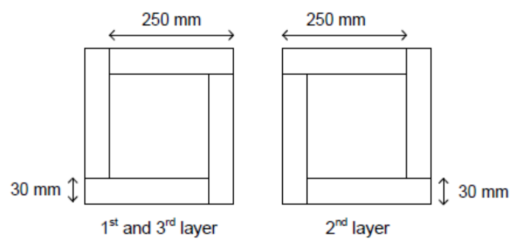

Figure 1 The arrangement of every layer

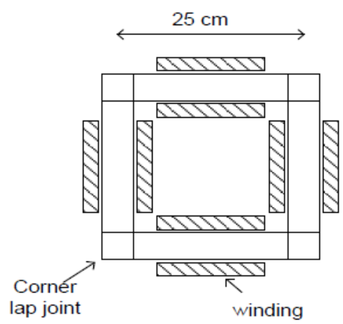

Figure 2 Outline of 25 cm Epstein frame

Result and discussion

From experiment result will found the graphs as shown in figure such as. Fig. 3 shows the variation of overall nominal loss with flux density in the core. The core with amorphous material has lowest loss over the complete range. Loss of transformer core is influence by the hysteresis loss and eddy current loss. The hysteresis loss only effect by the kind of the material but eddy current loss is effect by the thickness of material. The two materials are made from different ingredient of material. The 3% SiFe is consist of two kind materials like Silicon and Ferrite while the amorphous is consist Silicon, Ferrite and Boron. And the amorphous material is easy conduct and saturate than the 3% SiFe. From the thikness of these materials are show that the amorphous material very thin than the 3% SiFe. Hence flux flow in the 3%SiFe material still left in the lamination when induce the core at similar flux density and frequency as shown in Fig. 4.

On the surface of core lamination is occur the leakage flux as shown in Fig. 4. It shows that the flux leakages at the corner in the core assembled with 3% SiFe material is the lowest than the core assembled with amorphous material. As showed in Fig. 5 in over the whole flux density range. When the flux density adjusted at similar flux density and frequency, the flux induces into amorphous material is fill up quickly than the 3% SiFe if it sees from the material lamination thickness size. Hence at the surface of amorphous core material the flux is quickly leaked than the 3% SiFe core material. But it is difference with that occurs at the core limb. It shows the flux leakages measured at the limb in the core assembled with amorphous material is the lowest than the core assembled with 3% SiFe, over the whole flux density range sees Fig. 6.

Fig. 7 shows that the total harmonic distortion of flux is the largest in the core assembled with 3% SiFe material and the smallest in the amorphous material at 1.2 T, 50 Hz. It is because the amorphous material is more stable than the 3% SiFe. It can be shown in term of these materials. The 3%SiFe is much harder than the amorphous material when the 3%SiFe is adjusted at similar flux density and frequency. In this material will be produced the vibration that much harder than the amorphous material as shown in Fig. 4.

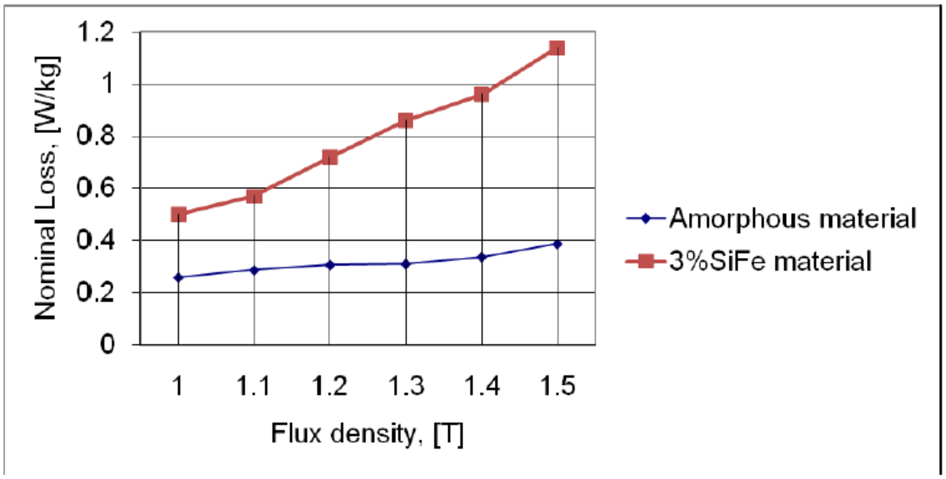

Fig.3 Graph of nominal loss from measurement

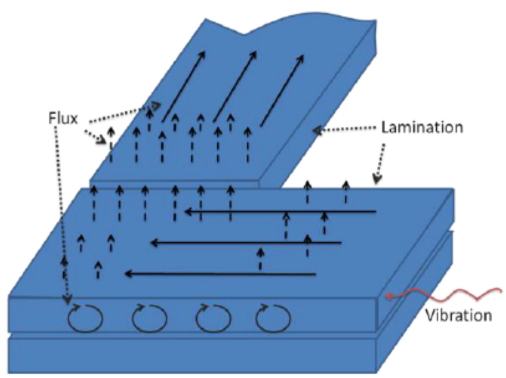

Fig.4 Phenomenon that occurs in the core lamination

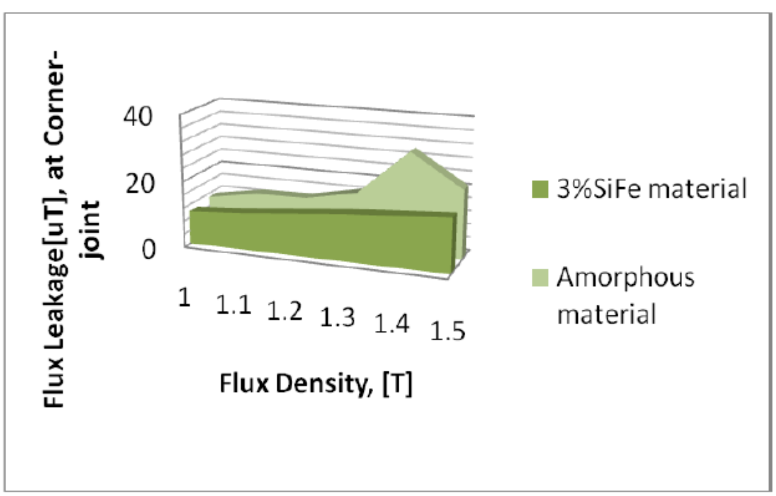

Fig.5 Flux leakages at corner

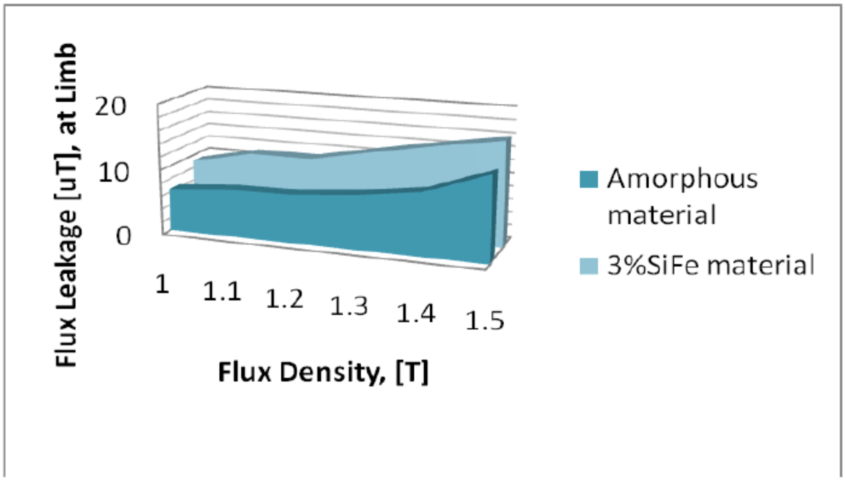

Fig.6 Flux leakages at limb

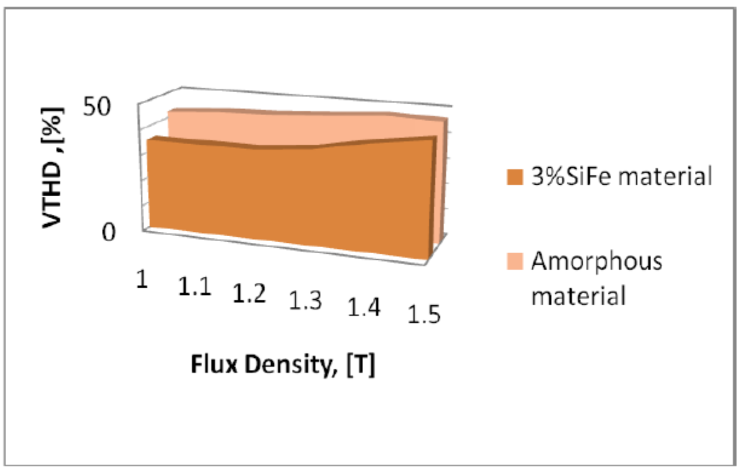

Fig.7 The total harmonic distortion of flux

Conclusion

In the transformer core will flow flux into lamination, leakage on the surface and still left in the lamination of core. With different thickness and ingredient of core material so will produce the different loss. The vibration will cause the total harmonic distortion in the core will be increase. It appears from the hardness of the material.

From the result we can find the smallest nominal loss, flux leakage at the limb and total harmonic distortion at the core assembled with amorphous material. In other words, the core assembled with amorphous material is more efficient than other material.

Acknowledgements

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