NEW MODEL FOR EDDY CURRENT LOSS CALCULATION AND APPLICATIONS FOR PARTIAL CORE TRANSFORMERS

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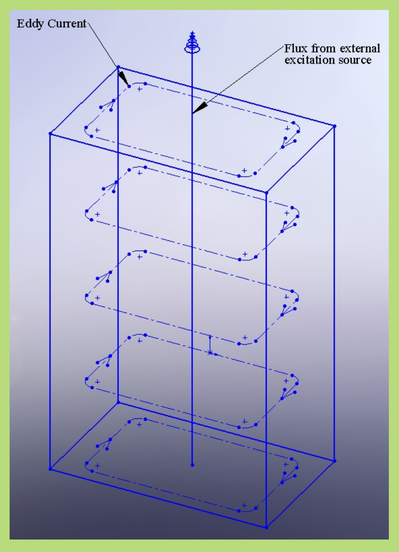
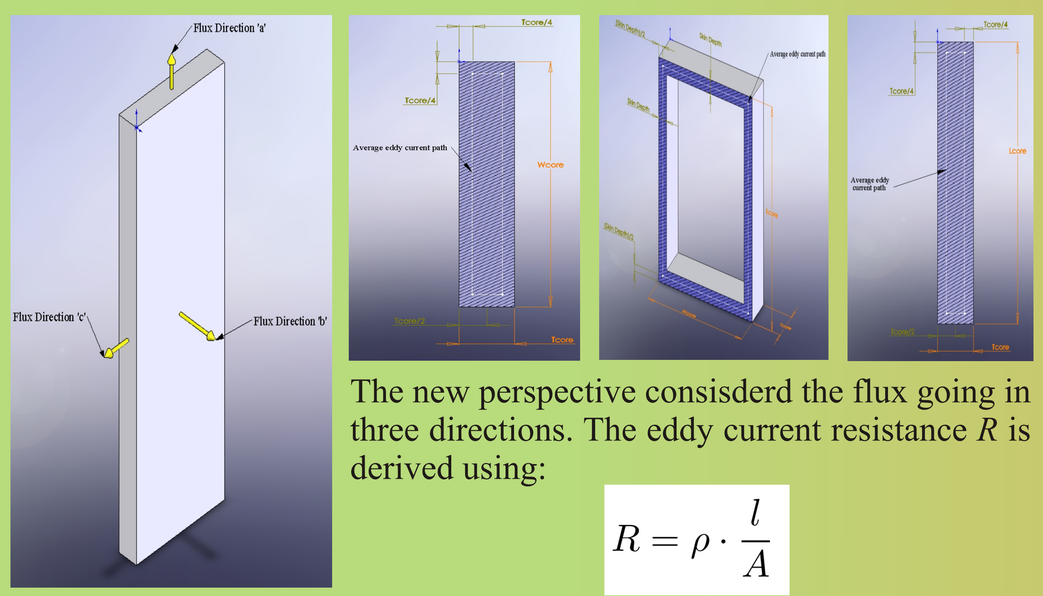
Eddy Current Effect



When magnetic flux is generated by an external AC voltage source, and passes through a piece of metal, an emf is induced. This gives rise to a current in the metal which produces a flux that opposes the original magnetic field. This current is called an eddy current as it resembles the circulating current of water in the eddy of a river. The eddy current creates a power and hence an energy loss in the metal. In order to reduce the eddy current loss the metal is usually laminated aligned with fluc directions.

New Perspective of Eddy Current Loss in a Lamination



The new perspective consisderd the flux going in three directions. The eddy current resistance R is derived using:

$$R = \rho \cdot \frac{l}{A}$$

Where ρ is the resistivity, l is the lenght of eddy current pathway, and A is the cross sectional area of the eddy current pathway.

Therefore, the eddy current power loss can be derived by using the formula:

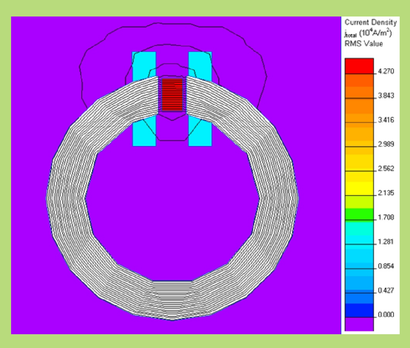
$$P = \frac{V^2}{R}$$

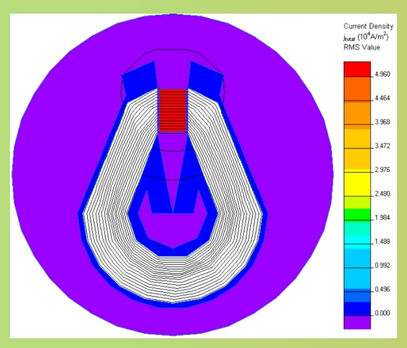
Where V is the voltage induced in each lamination and R is the eddy current resistance.

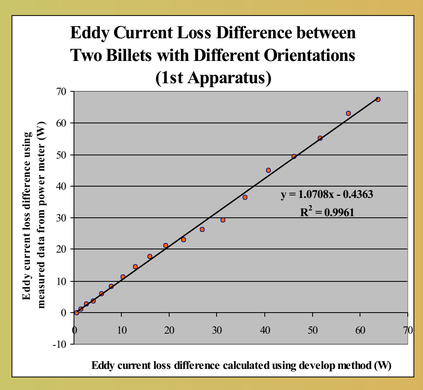
Apparatus and the Results

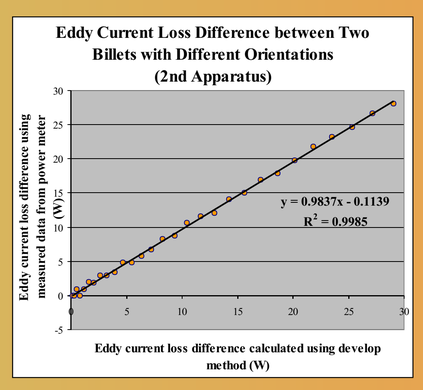
The arrangement included two billets with different orientated laminations, and two C-core uniform flux generator.

The flux distributions and current densities for the two billets and apparatus are simulated using Finite Element Analysis (FEA) progr







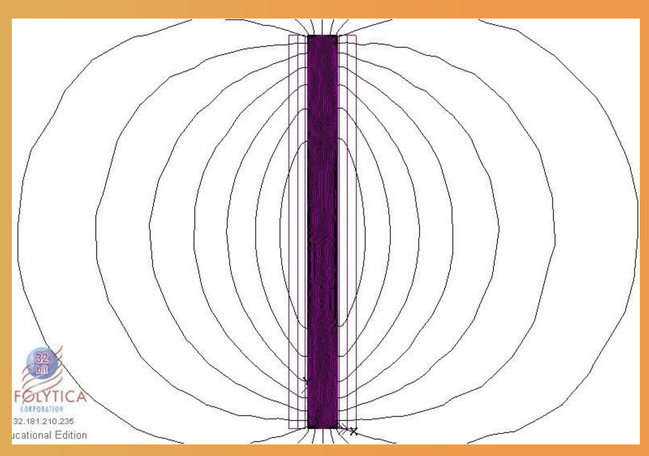


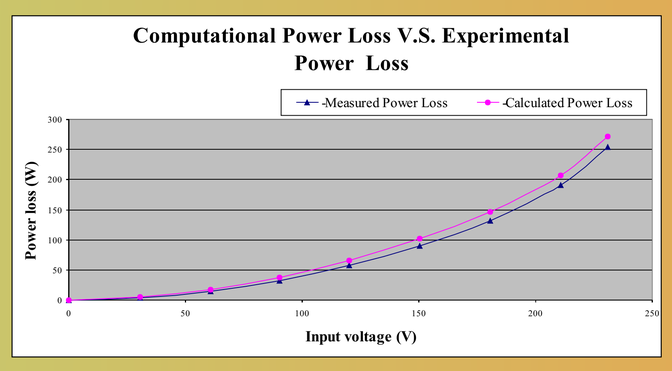
From the regression analysis results of two apparatus, the high correlations between calculated and measured values are turned. From the slope and the R vaule returned from regression analysis, the eddy current power loss in laminations from different directions can be accurately predicted using the new method.

Applications for Partial Core Transformer

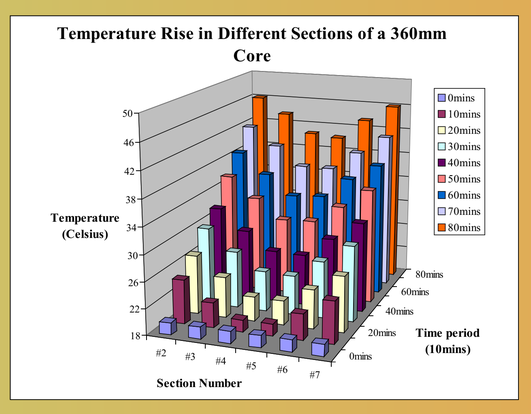
For a single phase transformer, between the conventional full core and an air core, one of the developments has been to make a transformer without the limbs and yokes of the full core model, but retaining the core material inside the windings. This has been named the partial core transformer.

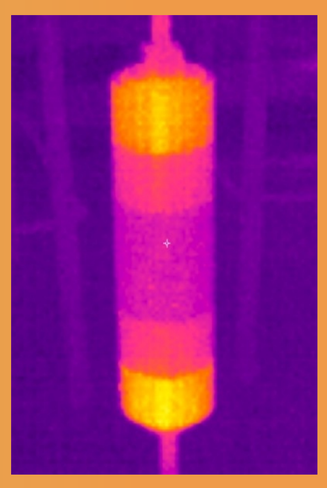
FEA program simulation displays a sideview of the flux pattern for a partial core transformer. The core loss computation using the developed method results the calculated values close to the measurements.





Using thermal imager (FLUKE Ti20) observes the heat distribution from the core, which matches the predictions from the developed method.





Conclusion

- A new perspective of eddy current power loss has been investigated using three directions.
- The eddy current power loss in laminations in different directions can be accurately predicted using the developed method.
- The developed method successfully applied to calculate the eddy current loss in partial core transformer.
- The visualization of the core loss is represented by the temperature distribution from the core.