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Analysis & Simulation of 25 KVA Distribution Transformer Design Using FEMM

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ABSTRACT: This paper summarizes a distribution transformer design with magnetic circuit theory and finite element method magnetic (FEMM). Distribution transformer is designed for output rating of 25 KVA, 11/0.433 kV & 11/0.25 kV in this paper. Finite Element Method Magnetics (FEMM) is a finite element package for solving 2D planar and axisymmetric problems in low frequency magnetic and electrostatics. It also provide engineers with a valuable means of more accurately quantifying the electric stress in the design. Finite element method magnetic (FEMM) has been analyzed to check and ensure the initial assumption data such as flux density and current density which are assigning in the proposed transformer design.

KEYWORDS: Core form Construction, Designed Theory, FEMM Analysis, Winding Connection, Design of Transformer.

I.INTRODUCTION

In AC electrical supply system that is used in all countries for supply to the consumers, the transformer is an indispensable component. In the normal propagation of power to consumers, the power is generated at about 11kV, then increase the voltage to the transmission level somewhere between 132-230 kV. When it reaches the end of the transmission route it is then transformed again to the sub-transmission level. It is then sent to distribution utility zone substations where it is again transformed down to 11 kV and is then sent on its final path to local street or pole transformers where it is broken down again to the final voltage of 400/230 volts. Transformers range in size from a thumbnail-sized coupling transformer hidden inside a stage microphone to huge units weighing hundreds of tons used to interconnected portions of power grids. All operate on the same basic principles, although the range of designs is wide. While new technologies have eliminated the need for transformers in some electronic circuits, transformers are still found in nearly all electronic devices designed for household voltage. Transformers are essential for high-voltage electric power transmission, which makes long-distance transmission economically practical. Transformers are used extensively by traditional electric utility companies, power plants, and industrial plants.

Transformer upto a size of about 500 kva, used to step down the distribution voltage to a standard service voltage or from transmission voltage to distribution voltage are usually known as distribution transformers. They are kept in operation all the 24 hours a day whether they are carrying any load or not. Energy is lost in iron losses throughout the day while the copper losses account for loss in energy when transformer is loaded. Therefore, distribution transformers should have their iron losses small as compared with full load copper losses. In other words, they should be designed to have maximum efficiency at a load much lower than full load (about 50%). Owing to low iron loss, the distribution transformers have a good all day efficiency. Distribution transformers should have a good voltage regulation & therefore they should be designed for a small value of leakage reactance. All electrical power that is supplied to consumers has to pass through transformers at some stage and in some cases the power may pass

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through at least four or five transformers between the generator and the user. Usually, at least two of those transformers can be classed as distribution transformers.

II.DESIGN CALCULATION OF 25 KVA TRANSFORMER

In this paper, 25kVA three-phase, core type, distribution transformer is designed. Designed line drawing dimensions of window in AUTOCAD as shown in figure 1. The specific of transformer are: For three-phase core type, distribution transformer, factor K=0.45~0.5.

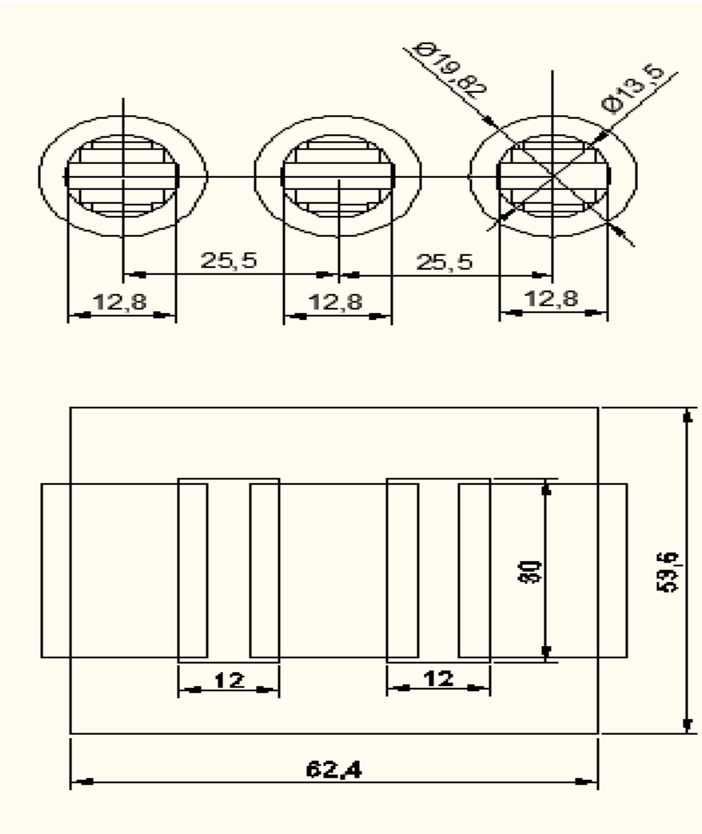

Fig 1. Designed line drawing dimensions of window in AUTOCAD

Distribution transformers (step down transformer) have their primary as delta connected & secondary as star connected. The primary side or the high voltage side winding has to receive high voltage and low current supply. Three phase delta connection assures that phase current is lesser than line current.

III.RESULT AND DISCUSSION

Finite Element Method Magnetic is a method used in calculation and design of problems that cannot be solved by classical methods due to the complexity of the geometry and parameters involved in the design. In the field of transformer design, FEMM is well established method and can generate accurate calculation of the transformer parameters like flux and inductance. In FEMM method, a graphical tool is used to draw exact transformer dimension. Every FEMM consists of three sections. There are pre processing, solution and post-processing.

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[A] Result of 25kVA, 11/0.25kV and 0.757A/36A transformer (for phase voltage & phase current):

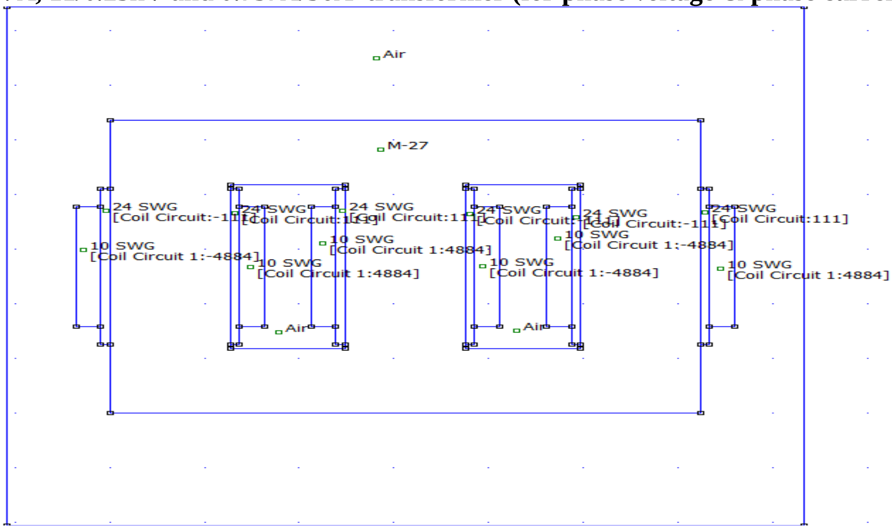

Fig 2. Designed of 25 kVA Transformer (Dimensions are Inches)

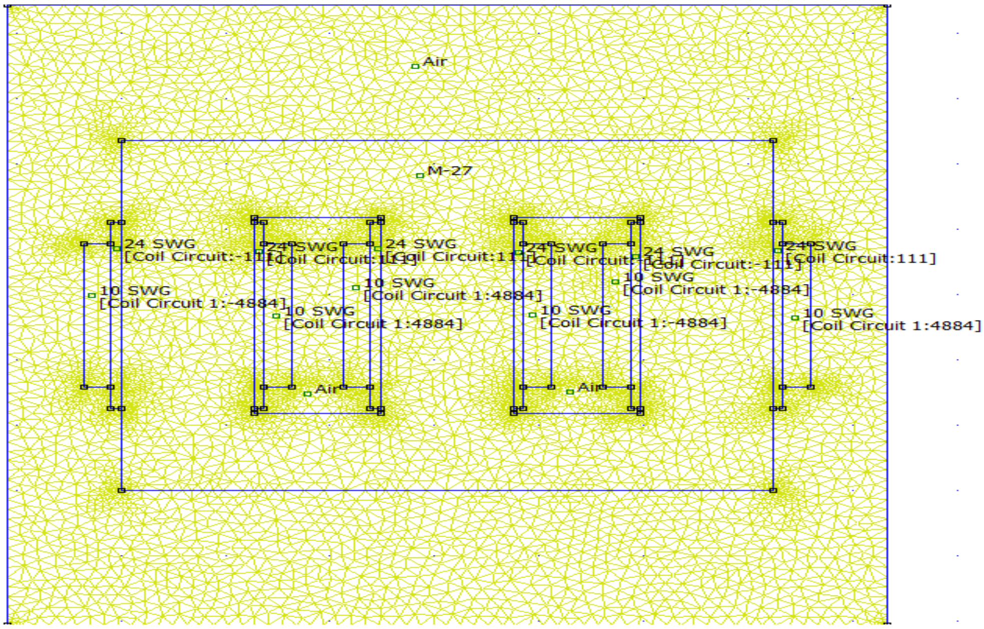

Fig 3. Designed of 25 kVA Transformer (during run mesh generator)

Figure (2) & (3) describes the drawing of 25 kVA by using finite element analysis based on magnetic circuit theory for phase voltage & phase current.

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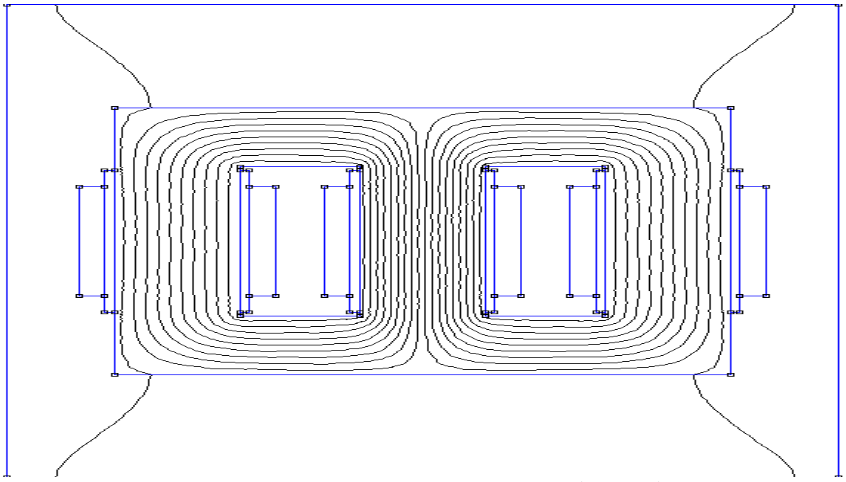

Fig 4. Flux lines circulate in three legs core & yoke of Transformer

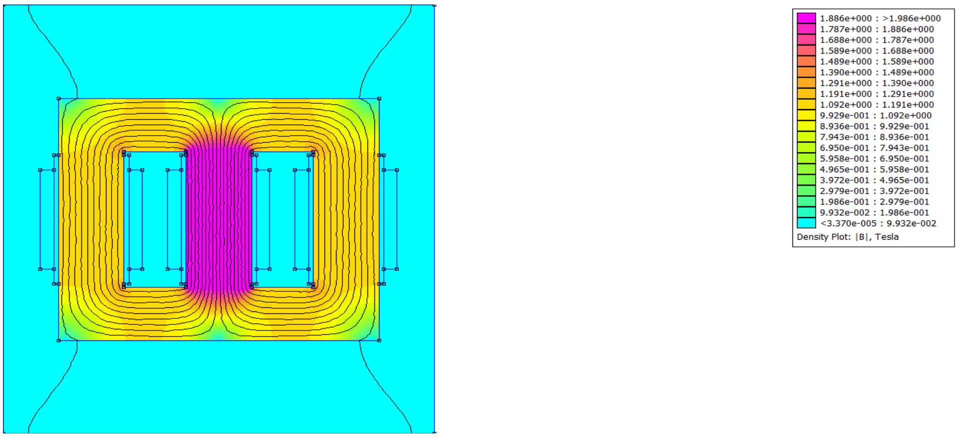

Fig 5. Flux density plot

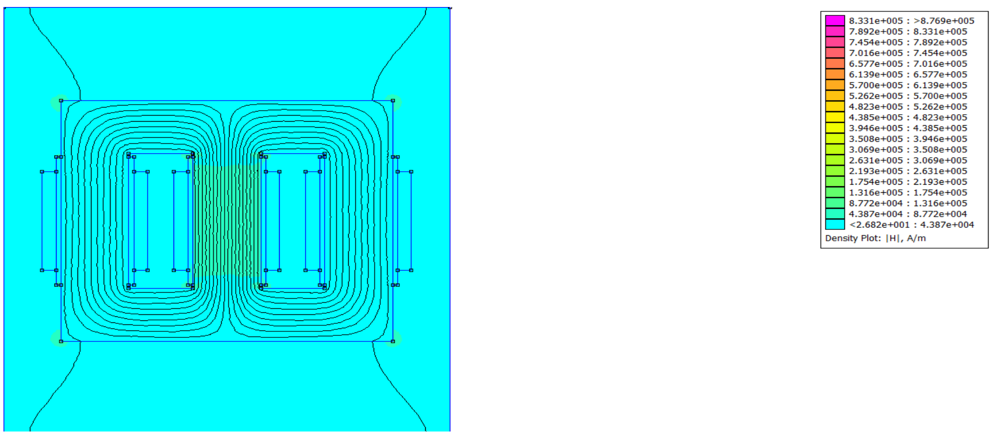

Fig 6. Field intensity plot

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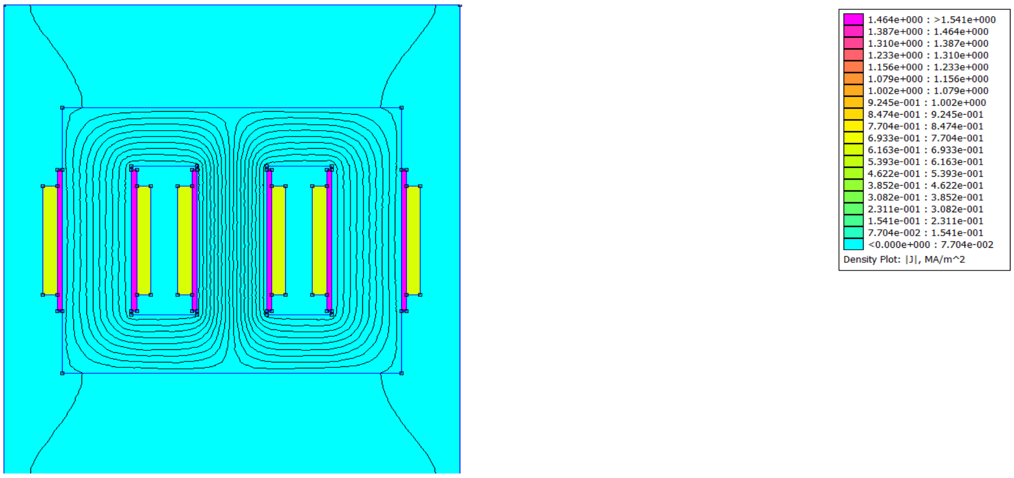

Fig 7. Current density plot

The Flux lines circulate in three legs of core & yoke of Transformer as shown in figure(4). The measured magnetic flux density at iron core is maximum 1.886T in figure (5). The field intensity is 3.508e+5 in Figure (6). The current density in low voltage winding and high voltage winding are 1.387 A/mm^2 and 1.002 A/mm^2 as shown in figure (7). Total losses at full load are 0.901kw and efficiency at full load is 96.5% by using finite element method.

[B] Result of 25kVA, 11/0.433kV and 1.31A/36A transformer (for line voltage & line current):

Figure (8) & (9) describes the drawing of 25 kVA by using finite element analysis based on magnetic circuit theory for line voltage & line current.

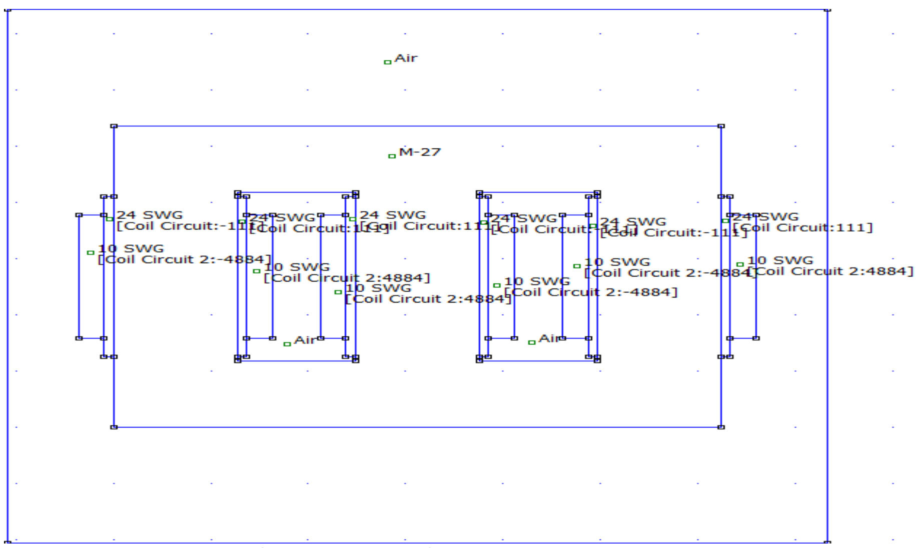

Fig 8. Designed of 25 kVA Transformer (Dimensions are Inches)

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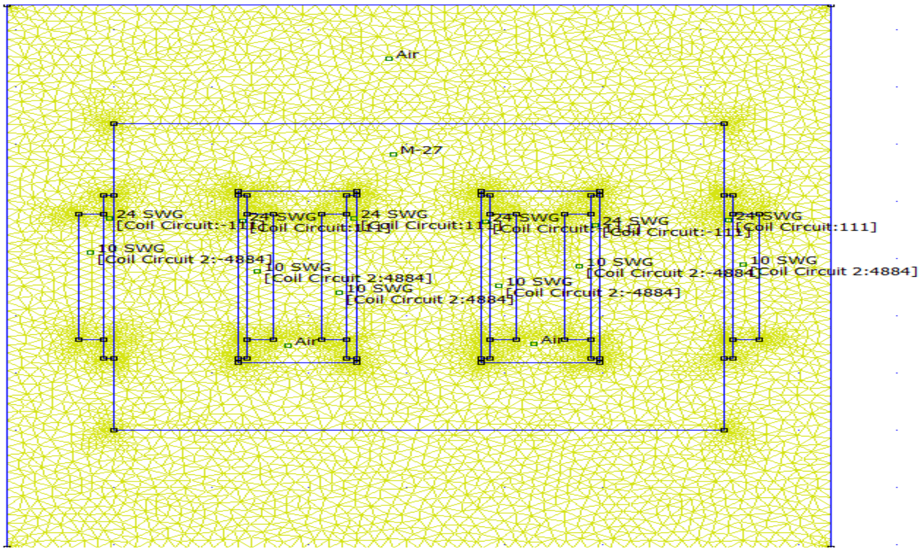

Fig 9. Designed of 25 kVA Transformer (during run mesh generator)

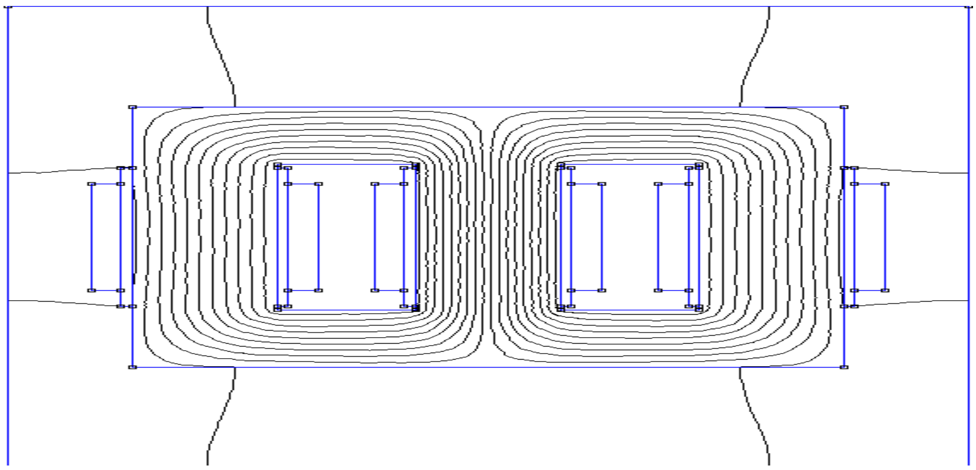

Fig 10. Flux lines circulate in three legs core & yoke of Transformer

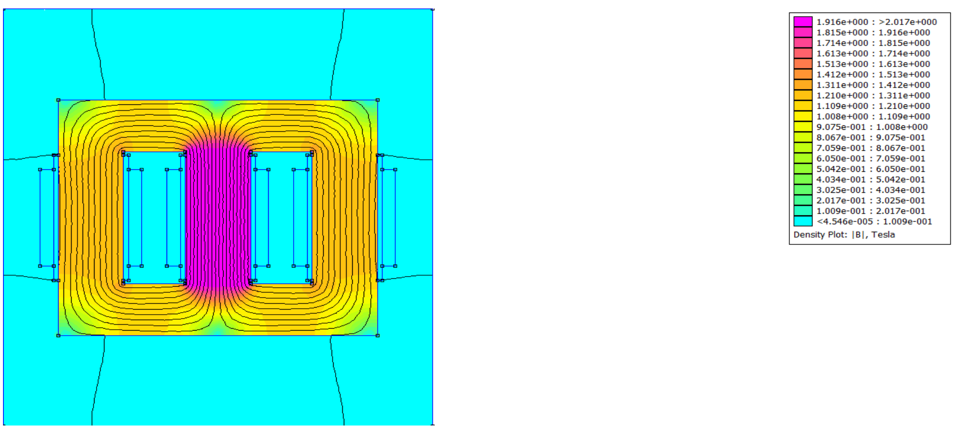

Fig 11. Flux density plot

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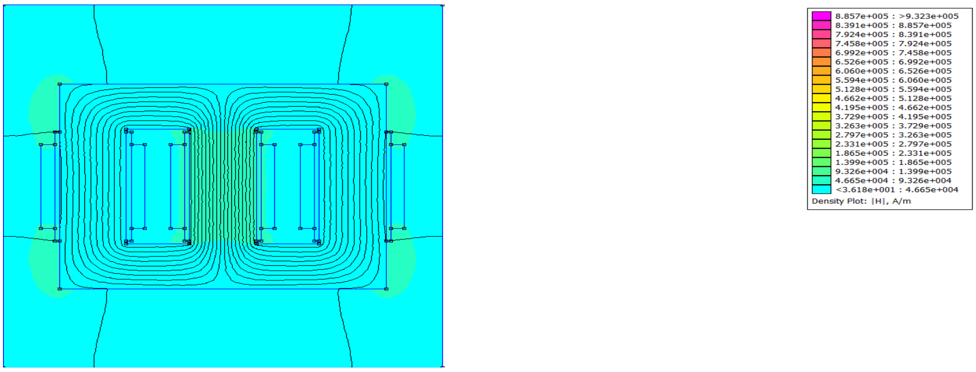

Fig 12. Field intensity plot

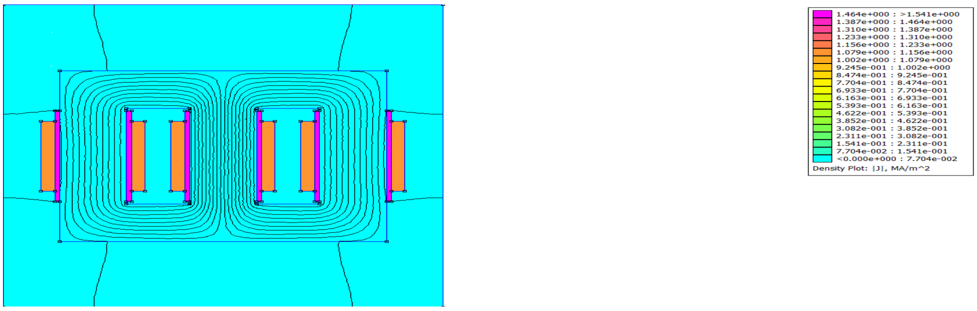

Fig 13. Current density plot

The Flux lines circulate in three legs of core & yoke of Transformer as shown in figure (10). The measured magnetic flux density at iron core is maximum 2.017T in figure (11). The field intensity is 3.729e+5 in Figure (12). The current density in low voltage winding and high voltage winding are 1.387 A/mm^2 and 1.233 A/mm^2 as shown in figure (13). Total losses at full load are 0.901kw and efficiency at full load is 96.5% by using finite element method.

IV.CONCLUSION

To design a transformer, it should be known the basic principles and theory of transformer. 25 kVA, 11/0.433 kV & 11/0.25 KV three-phase, delta-star connected, core type distribution transformer is designed by finite element method magnetic. For distribution transformer, the current density should be chosen 1.1 to 2.3A/mm^2. In this paper, the current density was 1.387A/mm^2 for low voltage winding and 1.233 A/mm^2 for high voltage winding. FEA can be used to further verify or enhance a design. FEA describes the contour plot of the flux in the transformer core and yoke. The values of flux density, field intensity and current density are described by using finite element method magnetic software.

REFERENCES

[1] A. K. Sawhney and Dr. A. Chakrabarti : " Electrical Machine Design " , 5th Ed., Dhanpat Rai & CO. (P) LTD.
[2] Antônio Flavio Licarião Nogueira, " Finite Element Analysis Of A Welding Transformer " IJRRAS 18 (3) ● March2014.
[3] BlackburnT R: Distribution Transformers: Proposal to Increase MEPS Levels, Technical Report, Equipment Energy Efficiency Program, (2007).
[4] Colonel, W.M.T. Mclyman.: Transformer and Inductor Design Handbook, 3rd Ed., Revised and Expanded, Marcel Dekker, Inc. Idyllwild, California, U.S.A, (2004).
[5] Dr. Mittle, V.N. and Arvind Mittal: Design of Electrical Machine, 5th Ed., Standard Publishers Distributors.
[6] Martin J. Heathcote: The J and P transformer Book, 12th Ed., Reed Education and Professional Publishing Limited, (1998).