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Reduction of Stray Losses in Distribution Transformer using different materials of Clamping

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Abstract - *In the complex scenario of today's Transmission and Distribution emphasis on efficiency is the foremost priority. Due to design considerations such as materials, cost, sustainability, reliability there is very little scope to further reduce losses in a Distribution transformer.*

However, the objective of attaining maximum efficiency needs a different approach such as reducing the stray losses which have not taken into account till now.

Stray losses due to leakage flux in metallic parts include tanks, bushings, clamping plates, outer package of the core limbs.

This paper presents the case study involving the estimation of stray losses and ways to reduce it using different clamping material in Distribution Transformer 3 phase 100 KVA,11/0.443 KV.

Key Words: Stray Losses, Clamping Plates, Distribution Transformer, Leakage flux.

1. INTRODUCTION

Transformer in today's energy Transmission and Distribution scenario is the vital static device which amounts almost 1/3rd of Transmission and Distribution losses.

In real life, the main issues that faces any device are the losses. So, detecting, quantifying and reducing the losses is very important as much as possible.

Losses in transformer constitute of two main components: No load losses and Load losses. In this load losses consist of I^2R and stray losses.

Copper losses became a primary factor at high power levels. Various methods to reduce copper losses include increasing the voltage of distribution lines, shunt compensation, reduction of harmonics, load balance and demand side management.

Stray losses which varies from 10% to 40% of total losses, is actually the by-product of copper loss.

Stray losses when is increased as compared to estimated value, results in increase of temperature causing hot spot in electrical as well as magnetic circuit in the transformer, which ultimately leads to transformer lifecycle declination.

In India, Bureau of Indian Standards has adopted the Indian standard 4th revision which constitutes mainly IS 1100(Part 1) & IS 1180 (Part 2) they address Distribution transformer primarily of REC range up to 100 KVA,11KV

According to this standard there are multiple energy efficiency ratings such as Level 1, Level 2, Level3.

Level 3 transformer attains a maximum efficiency of 98.15%.

1.1 Case Study

For calculation of losses, 3 phase, 100KVA, 11/0.443 KV Distribution Transformer with usual steel clamping is used. Routine tests such as Ratio test, Insulation Resistance Test, Magnetic Balance test, Resistance Measurement test, DVDF test, High Voltage Test, Polarity test were carried out. All the tests were performed at room temperature of 26^0C and corrected to reference temperature of 75^0C.

Further to find out losses i.e. Iron losses, Copper losses and Stray losses transformer was subjected to load test at 0%, 25%, 50%, 75% and 100%.

After calculation of stray losses, clamping of transformer was replaced with wooden material. The same transformer after the modification was subjected to same level of load test.

1.2 Objective

- The objective is to improve the efficiency of the transformer by reducing the stray losses and meeting today's market situation in the transformer field with requirements of high reliability, high loss evaluation and low cost which imposes pressure on large distribution transformer producers for a permanent improvement of their design solutions and one of the most important component in this attempt of improving transformer design is the reduction of transformer losses, and in particular the reduction of the so-called stray losses.
- The project is designed to implement the changes in materials being used for clamping rings in order to reduce the stray losses in distribution transformer.
- The main focus is on reducing stray loss due to clamping which hold the laminated core in a transformer tightly.

- The current Clamping are made up of Mild Steel which have ferromagnetic properties which aids to magnetic leakage flux.

By proposing change in material of clamping to wood reduction in stray losses will be calculated

2. ESTIMATION OF LOSSES PRIOR TO MODIFICATION

After Routine test individual losses such as Copper loss, Iron loss and Stray loss was found out using practical approach. Using power analyzer, the no load loss which gives iron loss was recorded as 171 Watt. Further for Copper losses transformer was loaded at 0%, 25%, 50%, 75% and 100%. And total load losses at each level was calculated. Then total loss was corrected for the reference temperature of 75^0C, then Stray losses at each load level was calculated for ambient temperature and reference temperature of 75^0C.

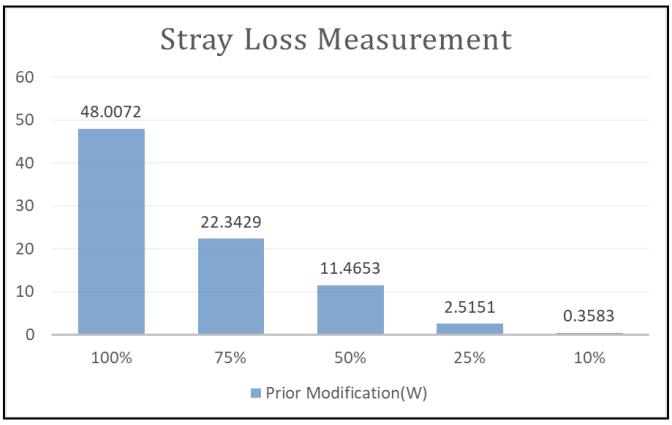

Chart -1: Stray losses at different load levels prior to modification

Fig -1: Transformer with mild steel clamping

3. ESTIMATION OF LOSSES AFTER MODIFICATION

After making the changes in clamping material i.e. replacing the steel clamping with wood. The load loss test as performed prior to modification was carried out again using power analyzer. No load losses stand at 166 Watts. After that the calculation of stray losses at different load levels was done which gives the result as shown in chart below.

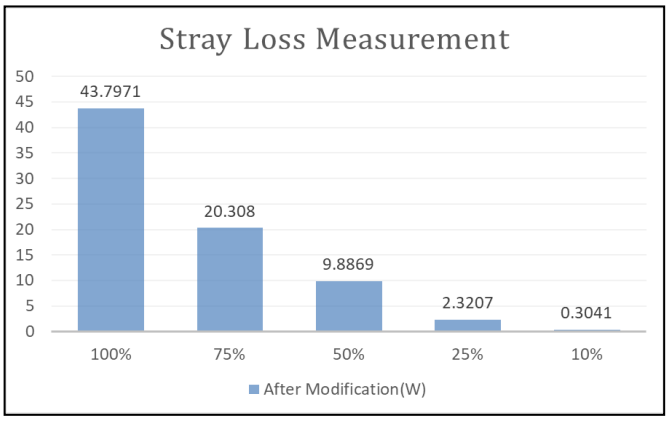

Chart -2: Stray losses at different load levels after modification

Fig -2: Transformer with wooden clamping

4. RESULT

After the calculation of stray losses for both material, it is to be noted that wood has certain advantage in reducing stray losses. Further wood has the strength required to hold up the core laminations tightly. It can be assessed that using a diamagnetic material can reduce stray losses.

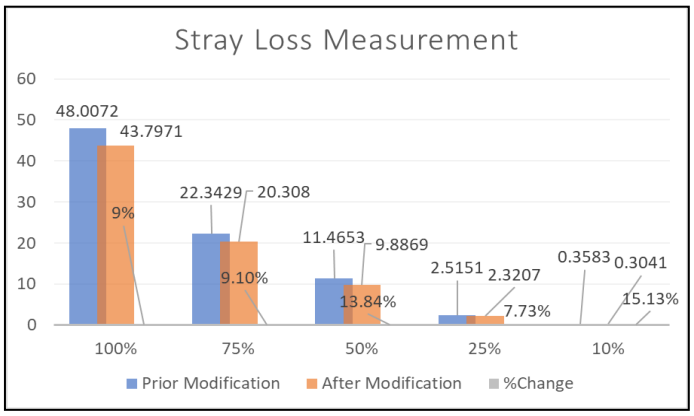

Chart -3: Percentage decrease in stray loss at various load levels

5. CONCLUSION

Replacement of clamping material with that of the wood directly influence the linkage of leakage magnetic flux with the clamping of transformer. With the use of wood the source with which the leakage flux is linked with is replaced resulting in reduced leakage flux , thus reduced Stray losses and overall reduction of losses in transformer.

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