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# Different Clamp Stress Impact on Losses and Flux Distribution between Two of 3 Phase Distribution Transformer 1000 kVA assembled with Stagger Yoke of Transformer Core Lamination


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***Abstract*-The power loss of transformer core are depends on a large extent on mechanical stress. This paper describes the result of an investigation on effect different clamp stress of core lamination in the two of 3 phase distribution transformer 1000kVA assembled with 45 degree corner joint and 90 degree T-joint. The investigation involves the variation of power loss, building factor, the total harmonic distortion of flux and flux leakages. The power loss and flux distribution have been measured using no load test in two types of model of setting of core built from the same size and type of M5 (CGO) grades material of laminations. The loss of the transformer core assembled with 24 Nm clamping stress of core lamination is 3 % better than the loss of the transformer core assembled with 12 Nm clamping stress of core lamination over the whole flux density range , 50 Hz. The flux leakage at the corner joint in the core assembled with 24 Nm clamping stress of core lamination is lower than the other two of the transformer cores, over the whole flux density range. The total harmonic distortion of flux is smaller in the transformer core assembled with 24 Nm clamping stress of core lamination and is larger in the transformer core assembled with 12 Nm clamping stress of core lamination. Using 24 Nm clamping stress of core lamination in transformer core is more efficient than using the other two types of clamping stress of transformer core lamination.**


## I. INTRODUCTION

The clamping stress is the most important form of stress in transformer cores so it can be expected that a combination of all stress should not increase that the total loss by more than 20% [1]. Application of compressive stress increases the power loss noticeably [2] and it has been shown that greater emphasis should be put on improving core clamping than on the core joint configuration [3]. The various factors which contribute to the total no load loss and magnetising power of transformers it is difficult to directly quantify the effect of stress.

The objective of this investigation is to know the power loss of the transformer core of identical geometry built and the grades of electrical steel (M5) with 3% silicon iron assembled with stagger yoke of transformer core laminations with different clamping stress.

## II. EXPERIMENTAL APPARATUS AND MEASURING TECHNIQUES

Two of three phases with 3 limb stacked cores are assembled with T-joint 90$^0$ mitred overlap corner joints is shown in Figure 1. The outer core dimensions are 970 mm x 780 mm with the limb of 150 mm wide. The two cores are assembled using 0.3 mm thick of laminations of M5 grain-oriented silicon iron (CGO) with a nominal loss of 1.12 W/kg at 1.5 T and have stagger yoke of core with overlap length of 10 mm from other adjacent lamination when setting the transformer core lamination as shown in Figure 2. Each transformer core comprises of 60 layers. One of the transformer has 12 Nm clamping stress of core lamination as shown in Figure 3. The other transformer core has 24 Nm clamping stress.

Each core could be energized 1 T to 1.8 T with less than 1.5% third harmonic distortion and the power loss is measured with repeatability better than ± 1% using a three phase power analyzer. Flux leakages at corner joint are measured with magnetic field meter.

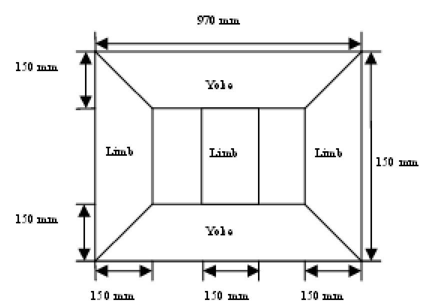


Figure 1 Dimension (mm) of 1000 kVA transformer core model

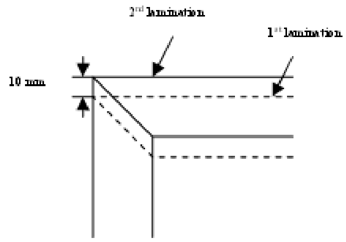


Figure 2 Staggered cores (dotted lines show position of adjacent lamination)

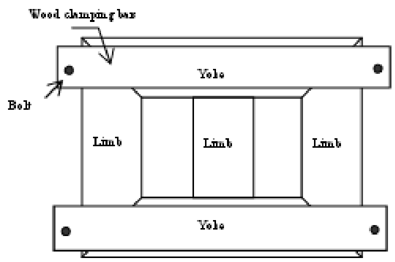


Figure 3 Transformer core assemble with clamping stress.

## III. EXPERIMENTAL RESULT AND DISCUSSION

Figure 4 shows the variation of overall power loss with flux density in the three phase cores. The power loss of the transformer core assembled with 24 Nm clamping stress of core lamination is 3 % better than the loss of the transformer core assembled with 12 Nm of core lamination over the whole flux density range, 50 Hz.

The B.F of each core reaches a peak at around 1.5 T as shown in Figure 5. The B.F of the core assembled with 24 N-m clamping stress of core lamination is lower over the whole flux density range. There are several differences in the power loss variation in the two cores. The transformer core assembled with 12 N-m clamping stress of transformer core lamination has the larger rotational flux in the Corner joint.

Figure 6 shows that the flux leakages measured at corner joint of the core assembled 24 N-m clamping stress of core lamination is lower than that at corner joint of the core assembled with 12 Nm clamping stress of core lamination, over the whole flux density range.

Figure 7 shows that the total harmonic distortion (THD) of flux is larger in the core assembled with 12 Nm clamping stress of core lamination and smaller in the core assembled with 24 N-m clamping stress of core lamination, over the whole flux density range. Clamping reduces the noise and joint air gaps at corners and T-Joint [4].

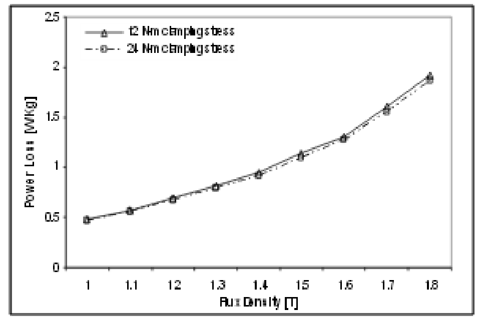


Figure 4 Graph Power Loss from measurement

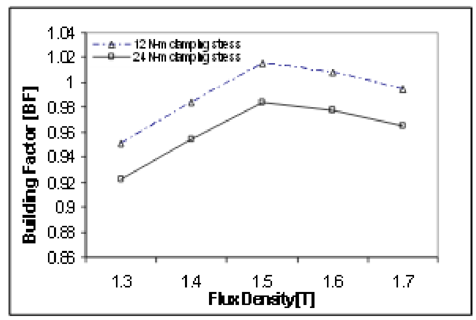


Figure 5 Building factor for different clamping stress of core lamination of transformer core

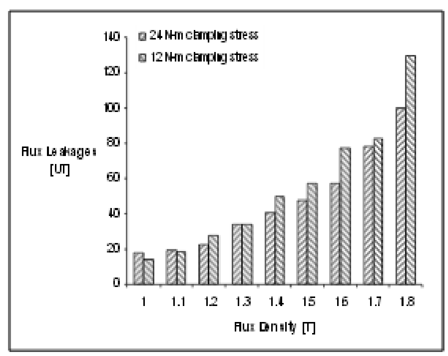


Figure 6 Flux leakages at corner joint

## IV. CONCLUSION

From the result of this investigation we can find smaller power loss, smaller Building Factor, smaller flux leakage and smaller total harmonic distortion of flux on the core is assembled with 24 Nm clamping stress of core lamination. In other words, the core assembled with 24 N-m clamping stress of core lamination is more efficient than the core assembled with 12 N-m clamping stress of core lamination.

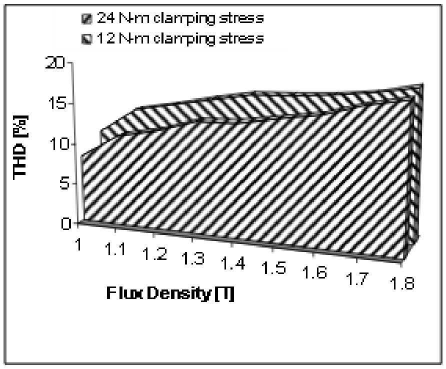


Figure 7 Total harmonic distortion of flux

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