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PUBLICATION OF

MALAYSIA-JAPAN INTERNATIONAL SYMPOSIUM ON ADVANCED TECHNOLOGY 2007 (MJISAT2007)

12-15th November 2007
Hotel Seri Pacific, KL

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Malaysia-Japan University Center(MJUC)

Co-Organizers:
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Center for Artificial Intelligence and Robotics (CAIRO)
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MJISAT 2007

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.:: Symposium Schedule ::.

Day I : Monday, 12th Nov 2007

14:30- 19:00	Registration
17:00- 19:00	Welcome Party

Day II : Tuesday, 13 th Nov 2007

08:00	Registration
09:00-10:00	Opening Ceremony
10:00-10:30	Coffee/Tea Break
10:30-11:00	Keynote Lecture I
11:00-11:30	Keynote Lecture II
11:30-12:00	Keynote Lecture III
12:00-12:30	Keynote Lecture IV
12:30-14:00	Lunch
14:00- 15:20	Technical Session 1
15:20-17:00	Technical Session 2
17:00-17:30	Coffee/Tea Break
20:00-22:30	Banquet Dinner

Day III : Wednesday, 14 th Nov 2007

08:30-10:10	Technical Session 3
10:10-10:30	Coffee/Tea Break
10:30-11:50	Technical Session 4
11:50-12:50	Technical Session 5
12:50- 14:00	Lunch
14:00-15:20	Technical Session 6
15:20-17:00	Technical Session 7
17:00-17:30	Coffee/Tea Break

Day IV : Thursday, 15th Nov 2007

08:30-10:10	Technical Session 8
10:10-10:30	Coffee/Tea Break
10:30-11:50	Technical Session 9
11:50-12:50	Technical Session 10
12:50-14:00	Lunch
14:00- 15:45	Forum and Round Table Discussion
15:45- 16:15	Closing Ceremony
16:15- 16:45	Coffee/Tea Break

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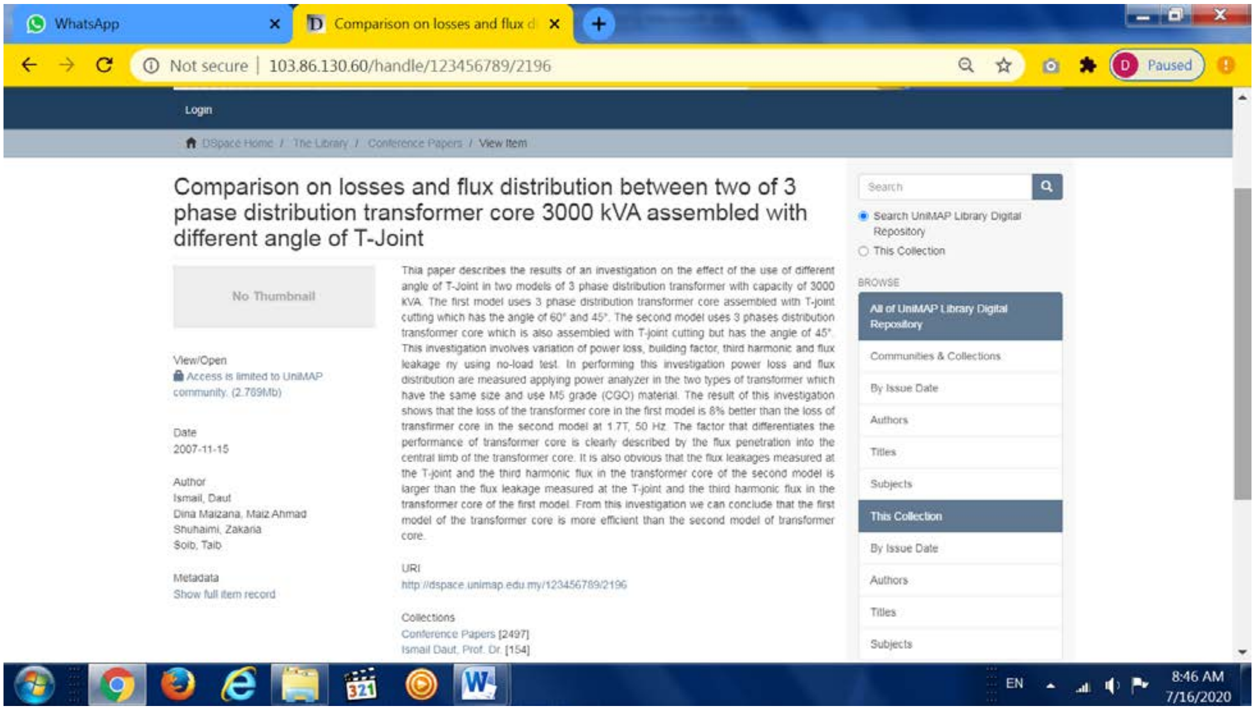

Comparison on Losses and Flux Distribution between Two of 3 Phase Distribution Transformer core 3000 kVA Assembled with Different Angle of T-Joint

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Abstract

This paper describes the results of an investigation on the effect of the use of different angle of T-Joint in two models of 3 phase distribution transformer with capacity of 3000 kVA. The first model uses 3 phase distribution transformer core assembled with T-joint cutting which has the angle of 60° and 45°. The second model uses 3 phases distribution transformer core which is also assembled with T-joint cutting but has the angle of 45°. This investigation involves the variation of power loss, building factor, third harmonic and flux leakage by using no-load test. In performing this investigation power loss and flux distribution are measured applying power analyzer in the two types of transformer which have the same size and use M5 grade (CGO) material. The result of this investigation shows that the loss of the transformer core in the first model is 8 % better than the loss of the transformer core in the second model at 1.7T, 50 Hz. The factor that differentiates the performance of transformer core is clearly described by the flux penetration into the central limb of the transformer core. It is also obvious that the flux leakages measured at the T-joint and the third harmonic flux in the transformer core of the second model is larger than the flux leakage measured at the T-joint and the third harmonic flux in the transformer core of the first model. From this investigation we can conclude that the first model of the transformer core is more efficient than the second model of transformer core.

1. INTRODUCTION

The design and assembly of 3-phase with 3 limb laminated cores play a major part in determining the efficiency of transformers. In this paper the past most of the detailed experimental work on overall power loss in transformers was carried out on model cutting T-joint core and all having the same dimension. The iron loss of a transformer core is usually greater than the nominal Epstein loss of the core material and the increased loss can be expressed in terms of the core Building Factor (B.F), the ratio of core loss to nominal loss[1,2]. The objective of this investigation is to make direct comparison between the performances of the cores of transformer different cutting angle of T-joint built from identical grades of electrical steel (M5) as shown in Figure 1.

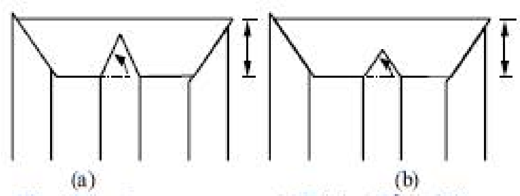

Fig. 1 Transformer core type (a) T-joint 60°, and (b) T-joint 45°.

2. EXPERIMENTAL APPARATUS AND MEASURING TECHNIQUES

Every transformer has 12 packets as shown in Figure 2; each packet of the transformer core has different sizes as shown in Table 1. The first model of the transformer core assembled with 4 inner packets of core yoke is cut with 60° T joint and other packet is cut with 45° T-Joint. For the first model of the transformer core does not only 60degree T-joint because difficulties in handling the yoke sheet of the 60° T-joint during the core assembled. In the second model of the transformer core assembled all of the packets of core yoke are cut with 45° T-joint.

Two of the transformer core are assembled by using 0.3 mm thick of laminations of M5 grain-oriented silicon iron (CGO) consisting of 3% silicon 97% iron. Each core comprises of 96 layers which every packet has four layers but the first packet which has eight layers as shown in Figure 2. Each core could be energized to 1.7 T with less than 1.5% third harmonic distortion and the power loss, the 3[rd] harmonic of component distortion are measured with repeatability better ± 1% using a three phase power analyzer. Flux leakages at T-joint are measured with magnetic field. The distribution fluxes in the transformer core for four packet of two transformer core by using the Finite Element Method two dimensions.

Table 1 Size of two transformer core.

Packet	Dimension (mm)	Wide of limb and yoke (mm)	T-Joint Angle (°)	
			1[st] Transformer	2[nd] Transformer
1	3120 x 3250	520	60	45
2	3110 x 3240	510	60	45
3	3100 x 3230	500	60	45
4	3080 x 3210	480	60	45
5	3060 x 3190	460	45	45
6	3040 x 3170	440	45	45
7	3020 x 3150	420	45	45
8	2990 x 3120	390	45	45
9	2960 x 3090	360	45	45
10	2930 x 3060	330	45	45
11	2890 x 3020	290	45	45
12	2830 x 2960	230	45	45

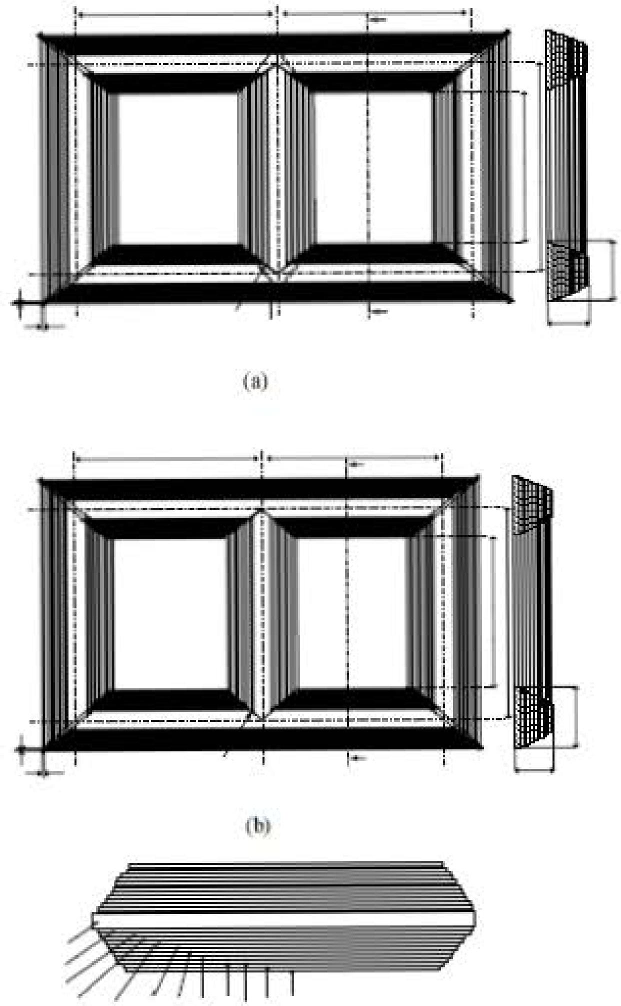

Fig. 2: Dimension of two model of 3 phase of 3000 kVA transfomer core. (a)The first model of the transformer core assembled with 4 inner packets of core yoke is cut with 60° T joint and other packet is cut with 45° T-Joint. (b)The second model of the transformer core assembled with all of packet of core yoke is cut with 45° T-joint. (c)Twelve packets in transformer core.

3. EXPERIMENTAL RESULT AND DISCUSSION

Figure 3 shows the variation of overall power loss with flux density in the three phase cores. The power loss of the first model of transformer core was 8 % better than the power loss of the second model of the transformer core at 1.7T, 50 Hz.

The B.F of each core reaches a peak at around 1.6 T as shown in Figure 4. The distortion of losses is lower in the first of the transformer core at 1.5 T the B.F is 8 % lower than the BF of the second of the transformer core. The B.F of the first of the transformer core is lower over the whole flux density range. There are several differences in the power loss variation in the two of transformer core. The second model of the transformer core has larger rotational flux in the T-joint. The localised rotational flux is more elliptical (with the major axis along the rolling direction) in the other core [4, 5].

Figure 5 shows the average flux distribution on 4 inner packet of the transformer cores calculated using finite element method software at ωt = 0. Figure 5 (a) shows the T-joint 60° of the transformer core more uniform flux entering centre limb at core, compared with figure 5 (b) shows the T-joint 45° of the transformer core. For other packages using same angle of T-joint and same sizes that are not have calculation in the finite element method because the flux distribution that will be shown is same pattern. And important factor is shows different flux distribution on the core lamination assembled with different T-joint angle for four inner packets.

Figure 6 shows that the flux leakages measured at the T-joint of the first model of the transformer core is lower than the flux leakages of the second model of the transformer core, over the whole flux density range. Not many flux leakage of the first model of the transformer core which it is not usefulness to the electric energy conversion of the transformer core.

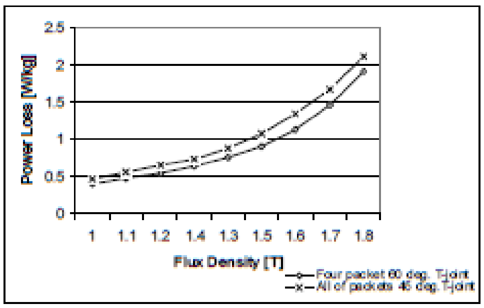

Fig. 3: Graph of power loss from measurement

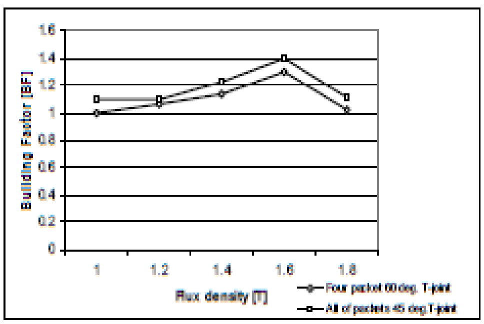

Fig. 4: Building factor for each T-joint

Flux distribution is found to have variations between the joints. It will generate harmonic flux in the limbs and yoke. Figure 7 shows that the 3rd harmonic flux is larger in the second model of the transformer core and smaller in the first model of the transformer core, over the whole flux density range. Harmonic flux is one of cause of power loss in the transformer core. Harmonic flux increases the iron losses of transformer core so it is important to minimise the harmonic content.

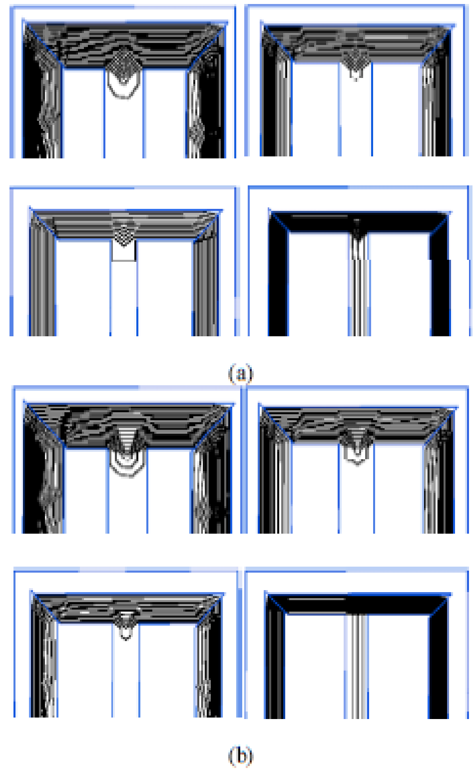

Fig. 5: Variation of magnetic flux lines in transformer core built M5 material use Software with ωt=0 (a) 4 Inner Packet T-joint 60° of three-phase transformer core laminations, (b) 4 Inner Packet T-joint 45° of three-phase transformer core laminations.

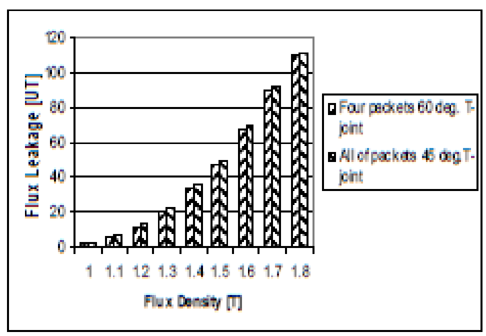

Fig. 6: Flux leakages at T-joint

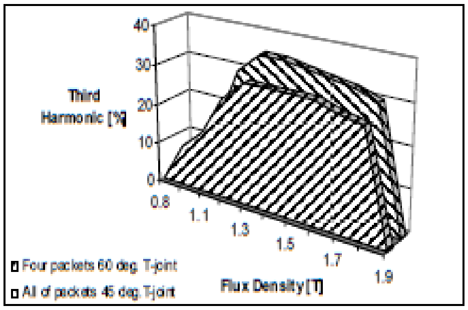

Fig. 7: Harmonic analysis of third component distortion

4. Conclusions

From the result of this investigation it is obvious that is the first model of the transformer core we can find smaller power loss, smaller building factor, smaller 3rd harmonic distortion and smaller flux leakages at T-joint. And the first model of the transformer core shows that there are more flux lines entering the centre limb of the core compared to the second model of the transformer core. In other words, the first model of the transformer is more efficient than the second model of the transformer core.

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Biographies

Ismail Daut received his B. Elect. Eng. (Hons) from University of Science Malaysia in 1980 and MSc in Electrical and Electromagnetic Engineering from University of Wales, College of Cardiff, United Kingdom in 1991 and PhD in Energy Conservation and Power Engineering from University of Wales, College of Cardiff, United Kingdom in 1994. His research interest includes energy conversion, electrical machine design and high voltage He has authored and co-authored more than 100 technical papers in the national, international journal and conferences.

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