UniMAP

ENGINEERING POSTGRADUATE CONFERENCE 2009 (EPC2009)

Date : 18 - 19 JULY 2009
Venue : DRAGON AND PHOENIX, JEJAWI

Organized by :

POSTGRADUATE STUDIES OFFICE AND RESEARCH & DEVELOPMENT (R&D) UNIT
UNIVERSITI MALAYSIA PERLIS (UniMAP)

KNOWLEDGE . SINCERITY . EXCELLENCE www.unimap.edu.my

Organizing Committee

Patron

Brigadier General Dato' Professor Dr. Kamarudin bin Hussin
Vice-Chancellor, UniMAP

Advisors

Professor Dr Zul Azhar bin Zahid Jamal
Deputy Vice Chancellor (Research and Innovation)

Professor Dr Ali Yeon bin Md Shakaff
former Deputy Vice Chancellor (Academic and International)

Chairman

Professor Dr Mohd Yusoff bin Mashor

Deputy Chairman

Assoc Professor Dr Syed Alwee Aljunid bin Syed Junid

Organizing Secretariat

Mr Irma Azqrai Nin Sey bin Muhamad
Ms Norzaililah bt.Zainoddin
Mrs Zehan bt.Mat Saad
Mrs Annie Sumiyante bt. Mat Isa
Mrs Intan Zaheran bt. Azami
Mrs Norlizawati bt. Abdullah
Mr Hashim bin Abu Bakar

Technical Committee

Co-Chair

Assoc Professor Dr. Kenneth Sundaraj

Sub Committee Members

Dr. Mohd Fareq bin Abd Malek
Dr. Ir. Salmah bt. Hussiensyah
Dr. Muhamad Saifuldin bin Abdul Manan
Dr. Muhammad Syarhabil bin Ahmad
Ir. Dr. Mohd Asri bin Ab. Rahim
Mr. Mohd Hafiz bin Fazalul Rahiman
Mr. Mohd Hafiz bin Ismail
Ms. Mahyun bt. Ab Wahab
Mrs.Ku Syahidah bt. Ku Ismail
Mr. Mohd Zainuddin bin Mat Isa

Student Sub-Committee

Mr. Wahyu Hidayat
Mr. M.Hariharan
Mr. Ala'eddin Ahmad Saif
Mr. Faisal Amri Tanjung
Mr. Hayder Khalil
Mr. Tengku Faisal Zulkifli Hamid
Mrs.Mst Noorzahan Begum
Mr. Iqmal Tahir

Bursary Committee

Co-Chair

Mr Muhammad Khusairi bin Osman
Mr Hillal Adnan Fadhil

Arrangements Committee

Co-Chair

Mr Bashir Mohamad Gandhi

Sub Committee Members

Mr.Fathi Nashrullah
Mr.Iqmal Tahir
Mr.Zakaria Sembiring
Mr.LaaLaoui Yacine

Publicity Committee

Co-Chair

Mr M.Murugappan

Sub Committee

Mr.Satiyan s/o Marimuthu
Mr.Muhammad Naufal bin Mansor
Mr.Nasim Ahmed
Mr.Satheesh Kumar N
Ms.Lim Sin Chee

Opening Ceremony and Protocols Committee

Co-Chair

Ms Zainab Wafi

Sub Committee

Ms.Siti Nasuha bt Zainal Abidin
Ms.Noor Shalasiah bt Osman
Ms.Masita bt Raja Mohammad
Mr.Abdul Rahman Riza
Mr.Omar a.k.a Abdul Kareem

Food and Beverage Committee

Co-Chair

Mrs Siti Maryam bt Sharun

Sub Committee Members

Mr.Muhyi bin Yaakop
Ms.Naematurroziah bt Mokhtar
Mrs.Aida Sharmila Wati bt Wahab
Mr. Muhamad Khairul bin Ali Hassan

Registration Committee

Co-Chair

Mrs Nor Hazlyna bt. Harun

Sub Committee Members

Mr. Wan Mohd Ridzuan bin Wan Abd Majid
Ms. Haslina bt. Mohamed Hadi
Mr. Mohd Zubir bin Suboh
Ms. Nazifah bin Ahmad Fikri
Ms. Aimi Salihah bt. Abdul Nasir
Ms. Elsie Usun Francis

Publication Committee

Co-Chair

Mrs Norazila bt. Ali

Sub Committee Members

Mrs. Rafikha Aliana bt. A. Raof
Ms. Nur Farhan bt Kahar
Mrs Siti Hajar bt. Che Haris
Mr. Nornikman bin Hassan
Mr. Mohd Ezanudin bin Abdul Aziz
Ms. Nurul Husna Mohd Rais

Technical Sessions Committee

Co-Chair

Mr Laalaoui Yacine

Parallel Session

DAY	TIME	EVENT
1 (18-07-2009)	0830 – 1000	Opening Ceremony
	1000 – 1030	Morning Break
	1030 – 1300	Technical Track 1, Sessions A – F
	1300 – 1430	Lunch
	1430 – 1700	Technical Track 2, Sessions A – F
	1700 – 1730	Tea
2 (19-07-2009)	0830 – 1000	Technical Track 3, Sessions A – F
	1000 – 1030	Morning Break
	1030 – 1300	Technical Track 4, Sessions A – F
	1300 – 1430	Lunch
END		

Technical Track	Parallel Session	Venue
1 2 3 4	A	DKD 2
	B	DKD 3
	C	DKD 4
	D	DKD 5
	E	BKD 2
	F	BKD 3
DKD = Dewan Kuliah Jejawi III (Dragon & Phoenix)		

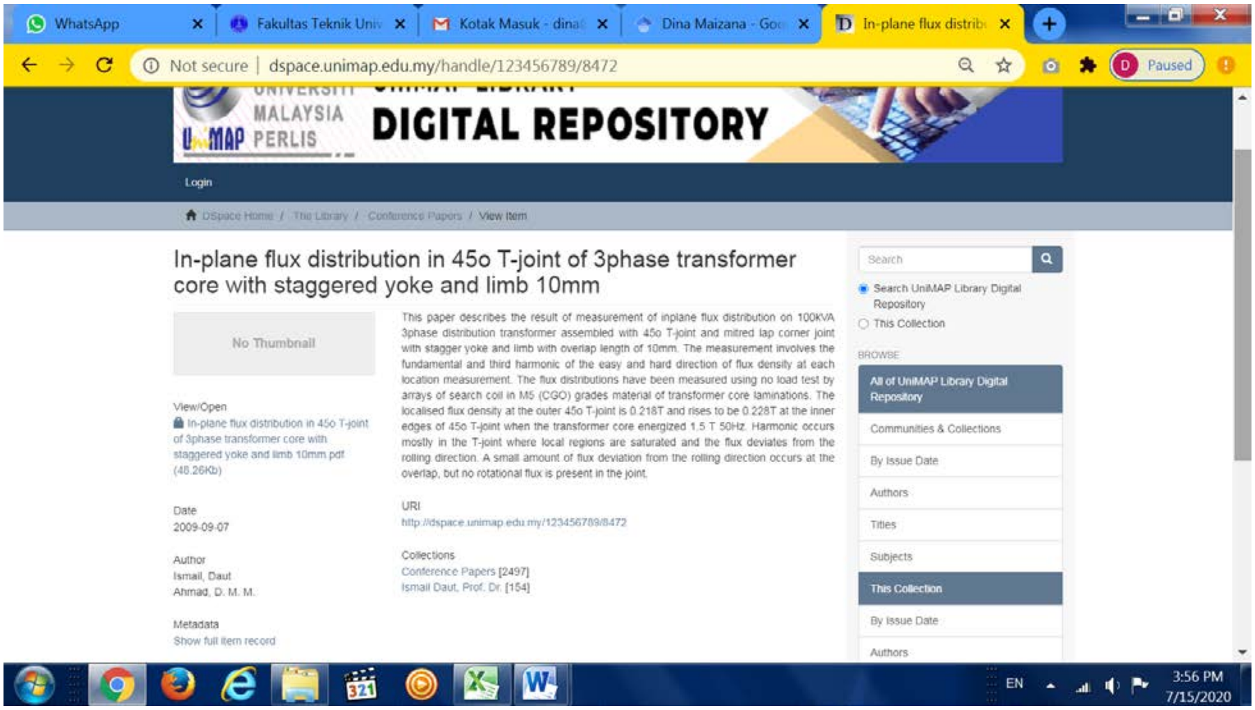
Day 1
Time : 1030 – 1300
Technical Track : 1

SESSION	PAPER
1A	**Predicting Characterization of Induction Motor Under Unsymetrical Faults Condition** Surya Hardi, I. Daut, C.M. Hadzer
	Design and Process Development of Silicon Nanowire Using Electron Beam Lithography for DNA Hybridization Detection S.F. Abd. Rahman, U. Hashim, A.M. Mohamed Nuri, M. E.A. Shohini, M. N. Md Nor
	Bill Consumption Electricity Saving Using Power Factor Correction Associated FA5501 Y.M.Irwan, I.Daut, M.Ezanni
	Design and Fabrication of Nanogap Biosensor for Label-free DNA Analysis Asmah Mat Taib[1], Uda Hashim[2], Nor Azah Yusof[3], Thikra S. Dhahi[4]
	Magnetic Flux Measurements between Grain Oriented & Non Grain Oriented Materials Using Single Sheet Tester M. Asri, I. Daut , Rosnazri Ali
	Spacer Patterning Lithography for Nanogap Patterning Muhamad Emi Azri Bin Shohini, U.Hashim
	In-plane Flux Distribution in 45° T-joint of 3Phase Transformer Core with Staggered Yoke 10mm Dina M.M. Ahmad and Ismail Daut
1B	**Developing a Nonholonomic Autonomous Mobile Robot and a Literature study of Motion Control Algorithm** Rudzuan Mohd Nor, Hazry Desa, Mohd Sofian M. Rosbi and R. Nagarajan
	Developing of a Stable Target Trajectory Tracking Control for a Mobile Robot based on Vision System Mohd Saifizi Saidon, Hazry Desa, Paulraj Murugesa, Mohd Sofian Mohammad Rosbi
	Vowel Recognition based on Spectral Envelope Using Bandwidth Approach [2]Shahrul Azmi M.Y., [3]Paulraj M.P., [4]Sazali Yaacob
	Simultaneous Localization and Mapping: A Survey William Low[1] R. Nagarajan[2] Sazali Yaacob[3]
	SATELLITE ATTITUDE CONTROL DESIGN USING ADAPTIVE PARAMETRIC BLACK BOX CONTROLLER Normah Ahmed, M.Y Mashor, A.H. Adom, S. Yaccob

Day 1
Time : 1430 – 1700
Technical Track : 2

SESSION	PAPER
2A	**Investigation of Harmonic Effect of Computer (PC) and Notebook in Residential Customer** R. Chan Bahaudin, I. Daut, C.M. Hadzer
	NVM Flash Memory: An overview and modeling floating gate device using concept F-N tunnelling Engineered Tunnel Barrier M Rosydi Zakaria[1], Uda Hashim[1], Azlan Zainal Ramzan Mat Ayub and Zarimawaty Zailan[1]
	Normal Flux Distribution in 45° T-joint of Three Phase Transformer Core with Staggered Yoke 10mm Dina M.M. Ahmad and Ismail Daut
	Micropatterning of Vinyl-functional Silsesquioxane Incorporated with Chelated Titanate Thin Film for Optical Waveguides Applications M. T. Zainuddin and U.Hashim
	Test of 0.5 HP AC Induction Motor Based on DC Resistance and Block Rotor Test N. Gomesh, I. Daut, A. Rosnazri
	The n-ISFET fabrication using Si_3N_4 as a Sensing Membrane for pH Measurement N.Syuhada M.D, Asma S.R, U.Hashim, Chin S.F, Noorsakinah A. B, N.Adila J
2B	**A Guided Particle Swarm Optimization Algorithm for Facial Emotion Detection** Bashir Mohammed Ghandi, Ramachandran Nagarajan, Hazry Desa
	Model Reference Adaptive System Based on Neuro Controller Siti Maryam Sharun, , Normah Ahmed, M.Y. Mashor, Sazali Yaacob
	Development of Automatic Stuttering Recognition System Lim Sin Chee, Ooi Chia Ai, Prof.Sazli Yaacob
	Development of Attitude Control System on RCM3400 Microcontroller Muhyi Yaakop, Sazali Yaacob, Abdul Rahman Mohd Saad , Zaridah Mat Zain , Paulraj M , M Harihran, R. Nagarajan,Warren Soh Kay , Ahmad Sabirin Arshad
	Odour Sensor Chamber Development for Electronic Nose Abdullah A.H., Adom. A.H, Md Shakaff A.Y, Ahmad M.N

http://dspace.unimap.edu.my/handle/123456789/8472



In-plane flux distribution in 45o T-joint of 3phase transformer core with staggered yoke and limb 10mm

This paper describes the result of measurement of inplane flux distribution on 100KVA 3phase distribution transformer assembled with 45o T-joint and mitred lap corner joint with stagger yoke and limb with overlap length of 10mm. The measurement involves the fundamental and third harmonic of the easy and hard direction of flux density at each location measurement. The flux distributions have been measured using no load test by arrays of search coil in M5 (CGO) grades material of transformer core laminations. The localised flux density at the outer 45o T-joint is 0.218T and rises to be 0.228T at the inner edges of 45o T-joint when the transformer core energized 1.5 T 50Hz. Harmonic occurs mostly in the T-joint where local regions are saturated and the flux deviates from the rolling direction. A small amount of flux deviation from the rolling direction occurs at the overlap, but no rotational flux is present in the joint.

View/Open
In-plane flux distribution in 45o T-joint of 3phase transformer core with staggered yoke and limb 10mm.pdf (48.26Kb)

Date
2009-09-07

Author
Ismail, Daut
Ahmad, D. M. M.

Metadata
Show full item record

URI
http://dspace.unimap.edu.my/123456789/8472

Collections
Conference Papers [2497]
Ismail Daut, Prof. Dr. [154]

In-plane Flux Distribution in 45° T-joint of 3Phase Transformer Core with Staggered Yoke 10mm

Dina M.M. Ahmad and Ismail Daut
School of Electrical System Engineering, Universiti Malaysia Perlis (UniMAP),
P.O Box 77, d/a Pejabat Pos Besar
01007 Kangar Perlis, Malaysia
Email address: dina@unimap.edu.my and ismail.daut@unimap.edu.my

Abstract

This paper describes the result of measurement of in-plane flux distribution on 100kVA 3phase distribution transformer assembled with 45° T-joint and mitred lap corner joint with stagger yoke of 10mm. The measurement involves the fundamental, third and fifth harmonic of the easy and hard direction of flux density at each location measurement. The flux distributions have been measured using no load test by arrays of search coil in M5 (CGO) grades material of transformer core laminations. The localised flux density at the outer 45° T-joint is 0.147T and rises to be 0.206T at the inner edges of 45° T-joint when the transformer core energized 1.5 T 50Hz. Harmonic occurs mostly in the T-joint where local regions are saturated and the flux deviates from the rolling direction.A small amount of flux deviation from the rolling direction occurs at the overlap, but no rotational flux is present in the joint.

1. Introduction

Transformer iron loss can be reduced either by improving the quality of the steel or by using better building and design techniques. The efficiency of a transformer core is also largely dependent upon the design of the joints at the junctions of the yoke and limbs. In these regions the flux may deviate from the rolling direction of the steel or become distorted so that local areas of the high loss are produced. [1] The use of grain-oriented silicon iron has been the main beneficial factor in increasing transformer efficiency. [2]

The behaviour of this investigation is to understand the in-plane flux distribution of the transformer core built from electrical steel (M5) with 3% silicon iron assembled with 45° T-joint and mitred lap corner joint with stagger yoke of 10mm by using arrays of search coil.

2. Experiment apparatus and measuring techniques

The main apparatus consist of a model cores three-phase 100kVA transformer assembled with three limbs core with T-joint cutting angle 45° assembled from CRGO (M5 grades) 3% Si-Fe material. The core has 550 mm x 580 mm with the limbs and yokes 100 mm wide as shown in figure 1. The experimental cores assembled with T-joint 45°, mitred overlap corner joints with staggered yoke and overlap length is 10mm as shown in figure 2 and assembled from 0.3 mm thick laminations of M5 grain-oriented silicon iron (CRGO). Associated instruments are used to measure the fundamental, third and fifth harmonic content of the localised flux density distribution.

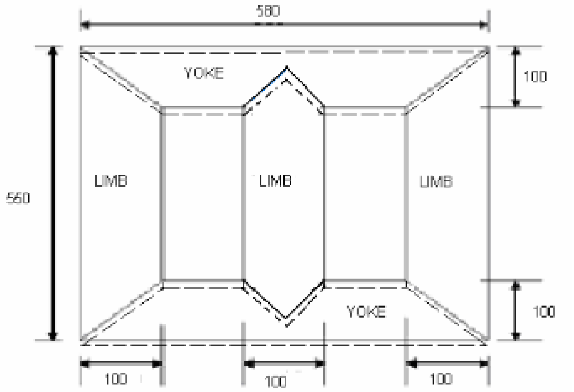


Figure 1 Dimension (mm) of 100kVA transformer model

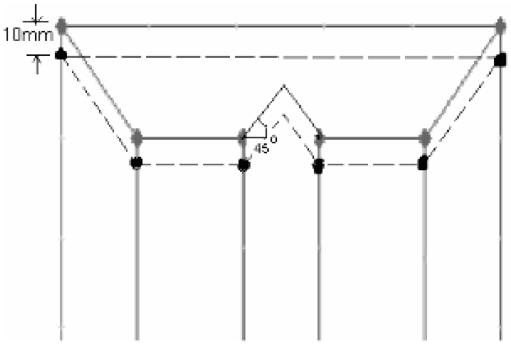


Figure 2. Transformer core type T-joint 45°

The localized flux density distribution in individual laminations is measured using search coils. The samples are drilled with an aid of drilling machine. It is constructed from 0.15 mm diameter wire treaded through 0.8 mm diameter holes 10 mm a part as shown in figure 3. Each measuring position suitable coils are wound to measure the easy and hard direction flux density. The search coil induced voltages are analysed to find the magnitude and plane coil induced voltage of flux density by using power analyzer [PM6000] as shown in figure 4.

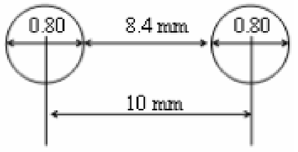


Figure 3 Dimensions [mm] of the holes drilled in the specimen

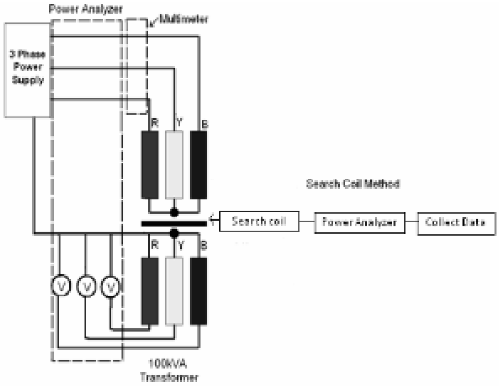


Figure 4 The diagram of the methods that used to measure the localised flux density

The magnitude and direction with reference to the x axis of the in-plane instantaneous flux density can be written in the form [3]:

$$|b| = \frac{1}{4fNAn}[\bar{e}_x{}^2 + \bar{e}_y{}^2]^{1/2} \qquad (1)$$

And

$$\alpha = \tan^{-1}\left(\frac{e_y}{e_x}\right) \qquad (2)$$

Where

f = frequency supply

N = Number of transformer winding

A = Cross section area of transformer core lamination that measured

n = number of layer of transformer core lamination

e_x = maximum value of the component of induced emf in the easy direction

e_y = maximum value of the component of induced emf in the hard direction

Sample calculation as follow:

From transformer frame are obtain number of turn is 254 turns, area of lamination is 0.000003m^2 with number of layer is 15 layers and frequency supply is 50 Hz. When the supply adjusted to transformer at 1.5T so at the search coil will find the induced emf by oscilloscope measurements at easy direction is 190mV and hard direction is 180mV. By using the equation (1) will find the flux density at this point is 103mT.

The primary induced emfs in the windings of the three phase transformers core were monitored by three identical voltmeters and voltages displayed during the measurement were only allowed to vary well within ± 0.4% of the induced voltage corresponding to the required flux density.

Flux distribution in the Cold Rolled Grain Oriented (CRGO) is measured by using an array of search coils to get the satisfactory result. In this investigation an array of single turn search coil is employed to measure in-plane (longitudinal and transverse) of flux density in the lamination within the transformer core as indicated in figure 5.Because the flux tends to deviate out of the longitudinal direction in some region, small 10mm search coils are used to measure localized longitudinal and transverse flux component. The locations are chosen to cover the areas where the flux is more likely to vary direction so as to find distribution of the flux behavior as shown in figure 5.

The testing process is done by using the No-Load Test Frame. The No-Load Test Frame consisting of three windings for each three phase core are designed in order not only to avoid introducing stress to the laminations but also to keep the magnetism exactly constant in all limbs of the cores. Each winding only extends along 85% on each limb in order to enable the stagger length of the three phase core to be varied. An extra softwood base 200mm high is used to raise the overall height of the core, in order to minimize the effect of the stray flux on the localized measurements.

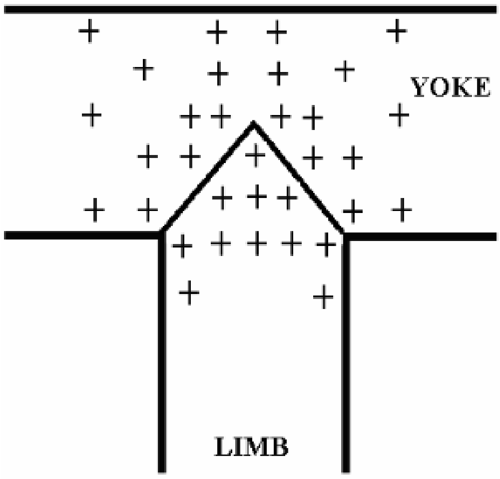


Figure 5 Location of orthogonal search coils in the three phase core

Installation search coil takes quite a long time in completing this step which every hole needs to be inserted with search coil. Search coil is the enamel copper coated 0.1mm diameter wire. Each set of test point (4 holes) consist of easy and hard direction where the holes of easy and hard direction will be inserted search coil and the leads are twisted together. All the holes at testing point need to be repeated the same method of inserting and twisting the leads.

After the search coils are wound and the leads twisted together, the holes are filled with polyurethane varnish to give added insulation protection. The search coil leads, which are twisted to prevent any spurious pick up, are stuck to the lamination by a polyurethane varnish. The leads from all the search coils are taken to a junction box placed in the core to prevent any interference from the core or magnetising windings.

3. RESULTS AND DISCUSSION

The instantaneous magnitude and direction of flux at this instant is shown in figure 6 on a larger scale. At this instant the total flux in the centre limb reaches its maximum and outer limb carry half their maximum flux. A small amount of flux deviation from the rolling direction occurs at the overlap.

The rotational flux produced in the T-joint region of the three-phase three limbs transformer core are due to a combined effect of alternating and rotating fields. This rotational flux illustrates the locus of the variation of the variation of the localized flux distribution throughout the magnetizing cycle. The rotational flux of the fundamental component (50Hz) of flux density in the 10mm staggered core at a core flux density of 1.5T is shown in figure 7. A large rotational flux is present in the yoke area which near with centre limb. Rotational flux in this region is more circular. Some large rotational flux is also observed in or near the T-joint region.

Figure 8 shows the rotational flux of the third harmonic component of flux density in the T-joint of the core assembled with 45° at core flux density of 1.5T. The extent of rotating flux at this frequency is more widespread. As with the 50Hz component, a large amount of rotating flux is present in the T-joint region between the right yoke and centre limb in all four cores. A small rotating flux occurs also observed in the middle of centre limb region in all four cores. There is more rotational flux present in this region.

The major axes of the locus do not always follow those of the fundamental component (particularly the 45° T-joint of core) but tend to be parallel to butt joints over much of the core where the fundamental components also deviate from the longitudinal direction of the strip in the yoke.

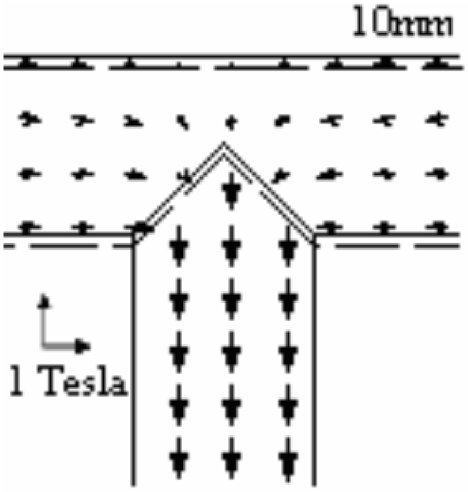


Figure 6 Distribution of localized flux density at 45° T-joint

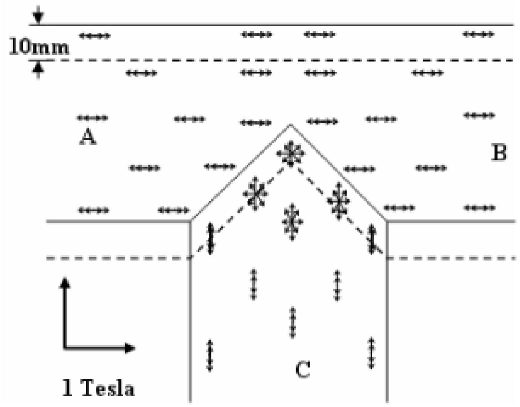


Figure 7 Locus of the fundamental component of localised flux density in 45^0 T-joint staggered core with overlap length 10 mm at 1.5T, 50Hz

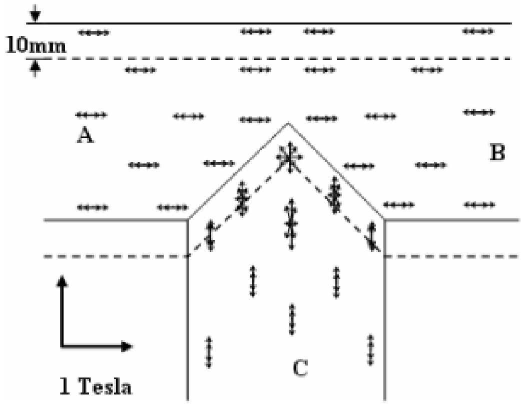


Figure 8 Locus of the third harmonic component of localised flux density in 45^0 T-joint staggered Core with overlap length 10 mm at 1.5T, 50Hz

Figure 9 shows that the rotational flux of the fifth harmonic component of flux density in the T-joint of the core assembled with 45° at core flux density of 1.5T is more widespread. The magnitude of the rotational flux is small compared with that of the fundamental and third harmonic. The distribution of the fifth harmonic component is classified to a region near to and within the T-joint.

A large amount of rotating flux is present in the T-joint region between the right yoke and centre limb in the core. Rotating flux in this region is elliptical with the 45° T-joint of core showing the highest value. A small rotating flux occurs also observed in the middle of centre limb region in the core.

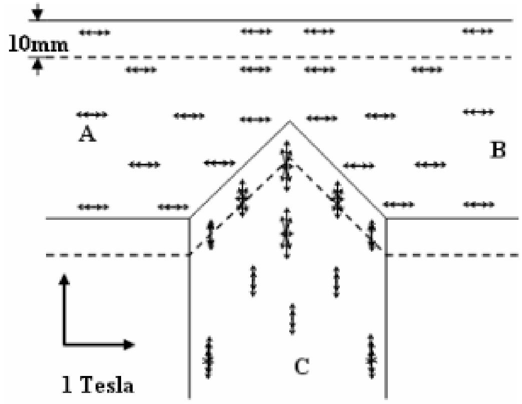


Figure 9 Locus of the fifth harmonic component of localised flux density in 45^0 T-joint staggered cores with overlap length 10 mm at 1.5T, 50Hz

Figure 10 shows the measuring point of location and localized flux densities at 45° T-joint that are measured by using the search coil on transformer core. This result is produced by calculating localized flux density after the search coil measures the vector of the voltage in the easy and hard direction at the lamination.

The flux density in the yoke then drops rapidly as the flux distributes itself equally between the laminations. The flux density reaches a peak at the inner of 45° T-joint; this is caused by the saturated material. The minimum flux density occurs at the outer of 45° T-joint of transformer core lamination. The localised flux density will increase from the outer to the inner edge of the 45° T-joint. The localised flux density at the outer 45° T-joint is 0.147T and rises to be 0.206T at the inner edges of yoke at 45° T-joint when the transformer core energized 1.5 T 50Hz.

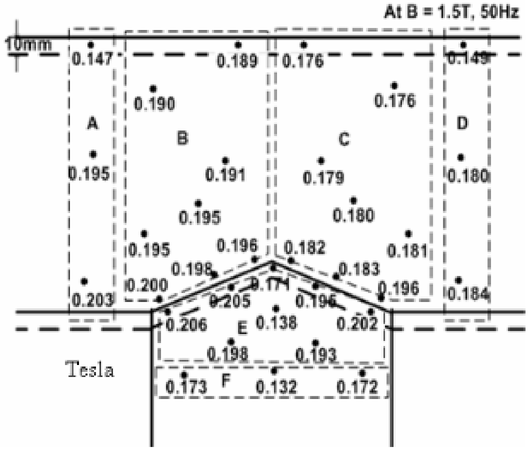


Figure 10 Local variations in the Tesla of the fundamental peak in-plane flux density of the lamination in 23^0 T-joint of three phase staggered core with overlap length 10 mm at 1.5T, 50Hz

The local variation in magnitude of the third harmonic component of peak in-plane flux density in the 45° T-joint at a core flux density of 1.5T is shown in figure 11. Most of the high third harmonic flux occurs in the T-joint region. The high third harmonic of peak in-plane flux occurs at the inner edge of right yoke passes over to the Butt-joint of centre limb is 22.2mT. Harmonic occurs mostly in the T-joint where local regions are saturated and the flux deviates from the rolling direction. However, it has been confirmed experimentally that harmonics circulated in individual laminations in the limbs and yokes.

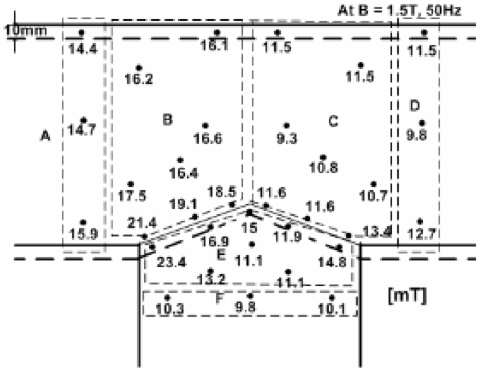


Figure 11 Local variations in the mT of the third harmonic peak flux density to the fundamental component in-plane of the lamination in 45^0 T-joint of three phase staggered core with overlap length 10 mm at 1.5T, 50Hz.

The local variation in magnitude of the fifth harmonic component of peak in-plane flux density in the 45° T-joint at a core flux density of 1.5T is shown in figure 12 to be very small.

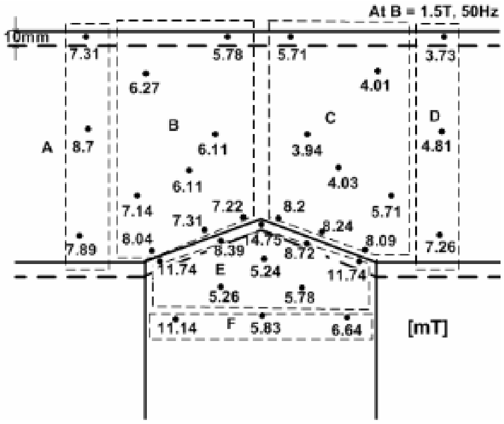


Figure 12 Local variations in mT of the fifth harmonic peak flux density to the fundamental component in-plane of the lamination in different T-joint of three phase staggered core with overlap length 10 mm at 1.5T, 50Hz.

4. Conclusion

The flux distribution in cores assembled with M5 material was found varies along overlap area of the stagger at the T-joint. The localised in-plane flux density will increase from the outer to the inner of the 45° T-joint. The localised flux density at the outer edges 45° T-joint is 0.147T and rises to be 0.206T at the inner edges of 45° T-joint when the transformer core energized 1.5 T 50Hz. A large rotational flux is present in the yoke area which near with centre limb. Rotational flux in this region is more circular.

The high third harmonic of peak in-plane flux occurs at the inner edge of right yoke passes over to the Butt-joint of centre limb is 22.2mT.Harmonic occurs mostly in the T-joint where local regions are saturated and the flux deviates from the rolling direction.

A small amount of flux deviation from the rolling direction occurs at the overlap, but no rotational flux is present in the joint.

The local variation in magnitude of the fifth harmonic component of peak in-plane flux density in the 45° T-joint at a core flux density of 1.5T is to be very small

10. References

[1] Jones, A. J., Moses, A. J., Comparison of the Localized Power Loss and Flux Distribution in the Butt and Lap and Mitred Overlap Corner Configurations, *IEEE Tans. ON MAG., VOL. MAG-10*, No. 2, june 1974.

[2] Mansel A Jones and Antony J. Moses, Comparison of the Localized Power Loss and Flux Distribution in the Butt and Lap and Mitre Overlap Corner Configurations, *IEEE Trans. On Mag., Vol, MAG-10,* No.2, June 1974

[3] Daut, I and Moses, A.J., Some Effects Of Core Building On Localised Losses And Flux Distribution In A Three-Phase Transformer Core Assembled From Powercore Strip, *IEEE Trans. On Mag., Vol. MAG-26*, No 5, pp. 2002, Sept 1990

[4] Daut, I.,"*Investigation of Flux and Loss Distribution in Transformer Cores Assembled From Amorphous Powercore Material*", 1992, PhD Thesis University of Wales

[5] Beckley P., *Electrical Steels for rotating machines*, The Institution of Electrical Engineers, 2002.

[6] Indrajit Dasgupta, *Design of Transformers Handbook*, Tata Mc- Graw Hill, India, 2002.

[7] James H. Harlow, *Electric Power Transformer Engineering*, CRC Press LLC, 2004.

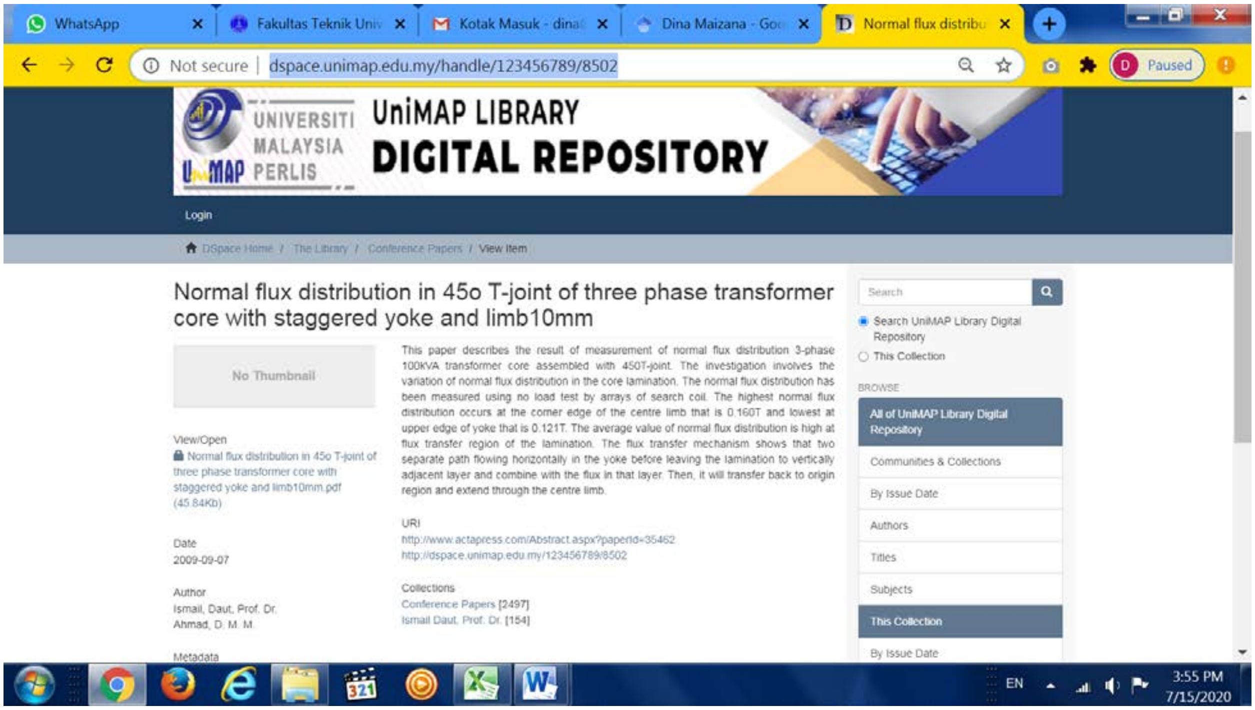
[8] Daut I., Dina M.M. Ahmad and S. Taib, Measurement of flux distribution on 100kVA 3phase distribution transformer assembled with 60° T-joint and mitred lap corner joint with stagger yoke by using search coil, MUCET2008 8th-10th March 2008, Hotel Putra Palace, Perlis, Malaysia.

[9] Daut, Dina M.M. Ahmad, and S. Taib , Measurement of Flux Distribution on 100kVA 3phase Distribution Transformer Assembled With 45° T-Joint And Mitred Lap Corner Joint With Stagger Yoke By Using Search Coil, IASTED AsiaPES2008, 2nd-4th April 2008, Meritus Pelangi Beach Resort Hotel, Langkawi, Malaysia, ISBN CD: 978-088986-732-1

[10] Daut, Dina M.M. Ahmad, and S. Taib , Comparison Between The Localized Power Loss and Flux Distribution in a Three Phase Distribution Transformer 100 kVA Assembled From Various Type of T-Joint Geometry with Staggered Yoke, IASTED AsiaPES2008, 2nd-4th April 2008, Meritus Pelangi Beach Resort Hotel, Langkawi, Malaysia, ISBN CD: 978-088986-732-1,

[11] Dina M.M. Ahmad, Ismail Daut, Measurement of Flux Distribution on 100kVA 3phase Distribution Transformer Assembled With 23° T-Joint and Mitred Lap Corner Joint with Stagger Yoke by Using Search Coil, The 2ndInternational Power Engineering and Optimization Conference (PEOCO2008), Shah Alam, Selangor, MALAYSIA. 4-5 June 2008.

http://dspace.unimap.edu.my/handle/123456789/8502



Normal flux distribution in 45o T-joint of three phase transformer core with staggered yoke and limb10mm

No Thumbnail

View/Open

Normal flux distribution in 45o T-joint of three phase transformer core with staggered yoke and limb10mm.pdf (45.84Kb)

Date

2009-09-07

Author

Ismail, Daut, Prof. Dr.
Ahmad, D. M. M.

Metadata

This paper describes the result of measurement of normal flux distribution 3-phase 100KVA transformer core assembled with 450T-joint. The investigation involves the variation of normal flux distribution in the core lamination. The normal flux distribution has been measured using no load test by arrays of search coil. The highest normal flux distribution occurs at the corner edge of the centre limb that is 0.160T and lowest at upper edge of yoke that is 0.121T. The average value of normal flux distribution is high at flux transfer region of the lamination. The flux transfer mechanism shows that two separate path flowing horizontally in the yoke before leaving the lamination to vertically adjacent layer and combine with the flux in that layer. Then, it will transfer back to origin region and extend through the centre limb.

URI

http://www.actapress.com/Abstract.aspx?paperId=35462
http://dspace.unimap.edu.my/123456789/8502

Collections

Conference Papers [2497]
Ismail Daut, Prof. Dr. [154]

Normal Flux Distribution in 45° T-joint of Three Phase Transformer Core with Staggered Yoke 10mm

Dina M.M. Ahmad and Ismail Daut
School of Electrical System Engineering, Universiti Malaysia Perlis (UniMAP),
P.O Box 77, d/a Pejabat Pos Besar
01007 Kangar Perlis, Malaysia
Email address: dina@unimap.edu.my and ismail.daut@unimap.edu.my

Abstract

This paper describes the result of measurement of normal flux distribution on 100kVA 3phase distribution transformer assembled with 45° T-joint and mitred lap corner joint with staggered yoke of 10mm. The investigation involves the variation of normal flux distribution in the core lamination. The normal flux distribution has been measured using no load test by arrays of search coil. The highest normal flux distribution occurs at the corner edge of the centre limb that is 0.158T and lowest at upper edge of yoke that is 0.092T. The average value of normal flux distribution is high at flux transfer region of the lamination. The flux transfer mechanism shows that two separate path flowing horizontally in the yoke before leaving the lamination to vertically adjacent layer and combine with the flux in that layer. Then, it will transfer back to origin region and extend through the centre limb.

1. Introduction

Power transformers are usually employed in electric power stations, high voltage transmission lines and large utilities. On the other hand, distribution transformers can be found in small and midsize industries, hotels, hospitals, schools, entertainment centers, residential areas and etc [1].

Transformers are ubiquitous in all part of the power system, between all voltage levels, and exist in many different sizes, types and connections [2]. Grain-oriented 3% silicon-iron is used for transformer cores where high efficiency and low weight are often paramount [3]. The efficient operations of power transformer cores depend on a large extend on the design of the joints between their limbs and yokes. The most complex joint in three limb cores are the T-joints at the intersection of the centre limb and yokes. Under ideal conditions the total flux in the limbs of a transformer core has a sinusoidal waveform, but in the corners of the core the flux is far from sinusoidal. The additional loss caused by the flux distortion can lead to localized heating within the joints [4].Previous research work had been carried out on interlaminar flux density distribution (normal flux) at T-joints and corners of transformer cores built with grain-oriented Si-Fe laminations in various configurations[4]. The interlaminar flux change has already been used to estimate additional localized loss of transformer cores and also to help achieve optimum joint configuration of a transformer core.

The objective of this research is to measure normal flux distribution on the lamination of transformer core that built from the electrical steel (M5 grade material) or 3% silicon-iron assembled with 45° T-joint mitred lap corner joint with staggered yoke by using arrays of search coils.

2. Experiment apparatus and measuring techniques

The main apparatus consist of a model cores three phase 100kVA distribution transformers are assembled with 45°T-joint, mitred overlap length of 10mm as indicated in figure 1. Each core is 550 mm x 580 mm with the limbs and yokes 100 mm wide as indicated in figure 2. The core is built from 0.3 mm thick laminations of M5 grain oriented silicon iron (CRGO) [8]. A core comprises of 15 layers. The system for measuring normal flux density is shown in Figure 3.

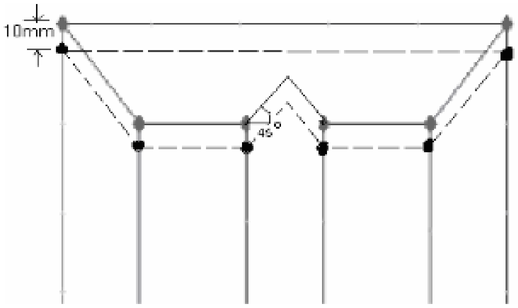


Figure 1 45° T-joint transformer core type with staggered yoke 10mm

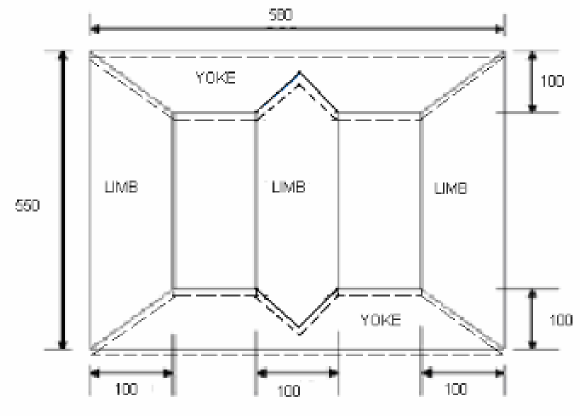


Figure 2 Dimension (mm) of 45° T-joint 100kVA transformer model

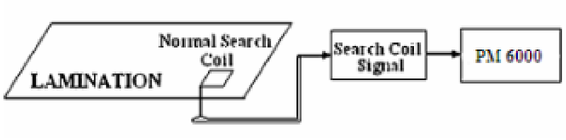


Figure 3 Associated system for measuring normal flux density.

In order to study the normal flux density variation, normal search coil arrays are used to measure normal flux density variation along and across the lamination. The squares of 10mm x 10mm normal search coils of 0.15mm diameter copper wire stuck on test laminations in the T-joint of the transformer core using polyurethane varnish. The solderable enamel copper wire is to thin enough for winding the single turn search coils, without affecting the flux distribution to any degree. Each pair of search coil leads is twisted together tightly to avoid stray voltage. The locations chosen must cover the areas where the flux is more likely to vary direction so as to find the mechanism distribution of the flux behavior. The location of the investigation for the transformer core is shown in figure 4.

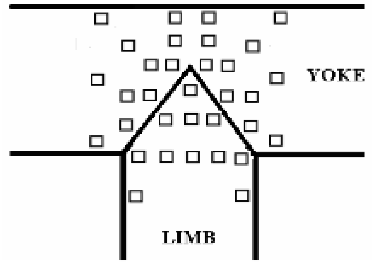


Figure 4 The normal search coils position in the T-joint of transformer core

3. Results and discussion

Fundamental normal flux density at T-joint flowing in a direction normal to the plane of the lamination in the staggered yoke 10mm 1.5T, 50Hz is shown in figure 5.

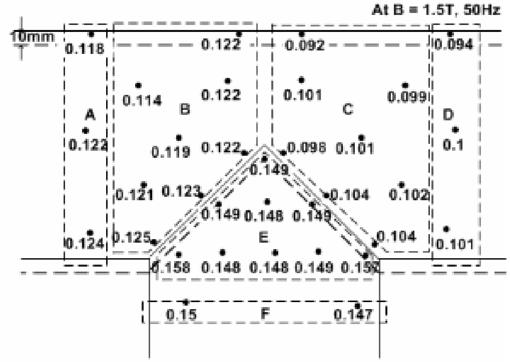


Figure 5 Distribution of the normal direction of fundamental flux density at T-joint with overlap length of 10mm during 1.5 at 50Hz.

The magnitude of the normal flux density is high at and close to an intersection between two adjacent laminations. The highest normal flux occurs at the corner edges of centre limb that is 0.158T and lowest at upper edge of yoke that is 0.092T at flux density 1.5T, 50Hz. The average magnitude of normal flux density is largest at the overlap region and smallest at the upper edge of the right yoke. The fundamental normal flux density increases as it approaches the T-joint and gradually decrease as it travels further away from the joint. The magnitude of fundamental normal flux density traveling between joints reaches minimum at the mid point of centre limb. This alteration in the fundamental normal flux density is due to increase and decrease of flux density that has been energized.

The instantaneous magnitude and direction of flux at this instant is shown in figure 6 at this instant the total flux in the centre limb reaches its maximum and both right and left yoke carry half their maximum flux.

Since the yokes carry only half the maximum value of the total flux, the majority of the flux from the outer of right and left yoke is carried through the inner half of butt-joint of centre limb and the largest flux concentration is found in the upper edges of centre limb.

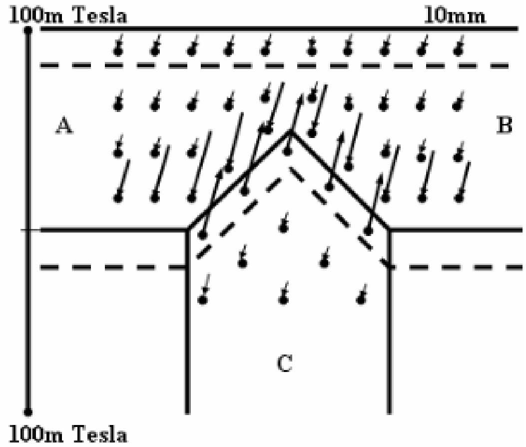


Figure 6 Distribution of the fundamental component of localised normal flux density in the 45° T-joint of three phase core built at different instant in time when $\omega t=60^{\circ}$.

Flux path and flux transfer mechanism between laminations at the T-joint has been illustrated as figure 7 for staggered yoke arrangement. The diagram shows that the flux transfer mechanism between yoke and limb in the T-joint may occur simultaneously at the same instant in time. This can be seen for example at the A and B region where two separate path flowing horizontally before leaving the lamination to vertically adjacent layer of D and F respectively and combines with the flux in that layer. Consequently, the core material in this region approaches saturation. At the same time, this existing flux will transfer back to the C region and extend to the whole length of the middle limb. It has been noticed that the magnitude of normal flux density high at the butt-joint and decrease as the distance away from the joint.

4. Conclusion

From the result of this investigation, the normal flux distribution in the cores assembled with 45°T-joint was found varies along overlap area of the staggered at the T-joint. High normal flux distributions occur in the corner edge of the centre limb that is 0.158T and gradually decrease as it travels far away from the joint area.

The flux transfer mechanism between yoke and limb in the T-joint may occur simultaneously at the same instant in time. The magnitude of normal flux density is high at the butt-joint and decrease as the distance away from the joint.

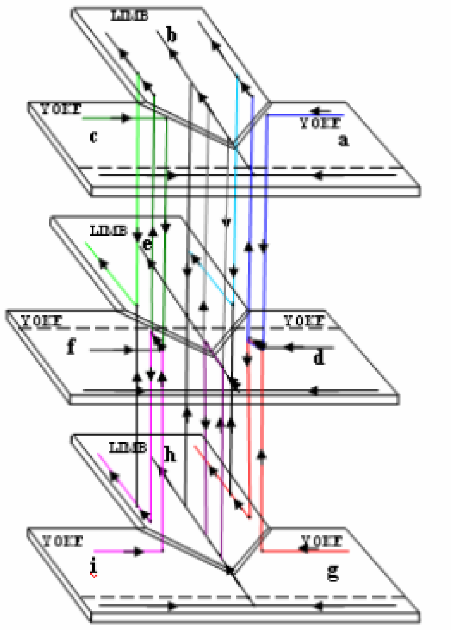


Figure 7 Flux transfer between laminations of staggered yoke limb arrangement at the T-joint.

10. References

[1] C. Hernandez, M.A. Arjona, and Shi-Hai Dong, "Object-Oriented Knowledge-Based System for Transformer Design" *IEEE Transactions On Magnetics*, vol Mag-44, No. 10, October 2008.

[2] O.A. Mohammed, Fellow, IEEE, N.Y. Abed and S. Liu, "Investigation of the Harmonic Behavior of Three Phase Transformer Under Nonsinusoidal Operation Using Finite Element and Wavelet Packets."

[3] J. Moses, T. Meydan, and H. F. Lau, "Domain Structures in Silicon-Iron in the Stress TransitionStage," *IEEE Transactions On Magnetics*, vol. 31, No. 6, November 1995.

[4] Xiao Guang Yao, Moses, A. J. and Fatih Anayi, "Normal Flux Distributions in a Three Phase Transformer Core Under Sinusoidal and PWM Excitation," *IEEE Transactions On Magnetics*, vol. Mag-43, No. 6, June 2007.

[5] Moses, A. J., B. Thomas, and J. E.Thompson, "Power Loss and Flux Density Distributions in the T-Joint of a Three Phase Transformer Core," *IEEE Transactions On Magnetics*, vol. Mag-8, No. 4, December 1972.

[6] Jones, A. J., Moses, A. J., Comparison of the Localized Power Loss and Flux Distribution in the Butt and Lap and Mitred Overlap Corner Configurations, *IEEE Tans. ON MAG., VOL. MAG-10*, No. 2, june 1974.

[7] Mansel A Jones and Antony J. Moses, Comparison of the Localized Power Loss and Flux Distribution in the Butt and Lap and Mitre Overlap Corner Configurations, *IEEE Trans. On Mag., Vol. MAG-10*, No.2, June 1974

[8] Daut, I and Moses, A.J., Some Effects Of Core Building On Localised Losses And Flux Distribution In A Three-Phase Transformer Core Assembled From Powercore Strip, *IEEE Trans. On Mag., Vol. MAG-26*, No 5, pp. 2002, Sept 1990

[9] Daut, I.,"*Investigation of Flux and Loss Distribution in Transformer Cores Assembled From Amorphous Powercore Material*", 1992, PhD Thesis University of Wales

[10] Beckley P., *Electrical Steels for rotating machines*, The Institution of Electrical Engineers, 2002.