International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 4 Issue 05, May-2015

# Parametric Analysis of External Noise Regression for Reliability Optimization in Transformers

Mahendra Singh
M.Tech Student, Department of Electrical Engg.
Lingaya's University
Faridabad,Haryana,India

Avtar K. Nadir
Professor & Dean
Department of Electrical Engg.
Lingaya's University
Faridabad,Haryana,India

Ms.Asha Chauhan
Asstt.Professor,
Department of Electrical Engg.
Lingaya's University
Faridabad,Haryana,India

***Abstract*—. In all the generation of Noise Core is the most Significant sources of Noise and generation of noise in this is having adopt different way of generation as per the rating of Transformer. Now a day the design are changed according to the land requirement and area to be minimized. Noise is the progression in the Transformer based on the rating of the Transformer. As the Capacity of the Transformer is increasing the level of the Noise in the Transformer is also increased and it should be adopted as per the recommended value.**

***Keywords*—Noise,dB,Noise Regression,CRGO.**

## I. INTRODUCTION

### Transformer Noise

New trends of Transformer [18] design to lead to change the design in such a way that noise to be reduced in such a level where its optimization [1] to be done not only in the Operational aspect but also Location. The new trend put noise [2] to be low for Power Transformer and Distribution Transformer [3]. Transformers located near a residential area are now adopted design for sound level as low as possible.

Users are now looking for a Transformer having reduced noise [5] level so that their operability as well as reliability to increased. The design and manufacture of a transformer with a reduced sound level require in-depth understanding of different sources of noise. Power Quality will depend on the noise level [10][15]. Transformer is having main sources of noise is

1. Core
2. Windings
3. Auxiliary Equipment

. Windings is also sources of Noise [6] generation and contributed in the life span of the Transformer. The Third sources of Noise Generation are the Auxiliary Equipment associated with Transformer[17] i.e Cooling Equipment like Fans, they are also Huge Sources of Noise[4] generation for the small and medium and Large capacity of Power Transformer..

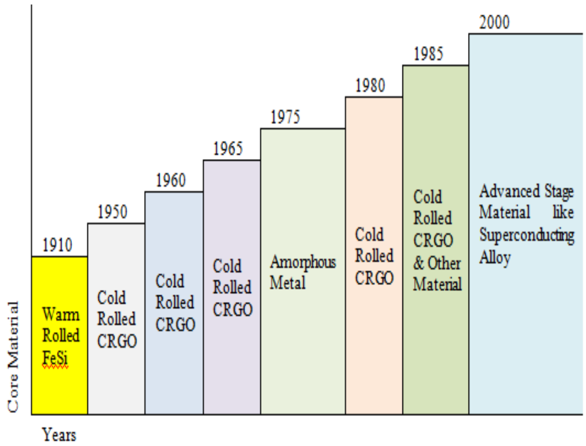


Fig 1.Core Material Development with years

### 1.1 Type of Transformer Noise

The noise generated in Power Transformers is defined by the Three Basic Parameters

1. Sound Pressure Level Method (Lp)
2. Sound Power Level Method (Lw)
3. Sound Intensity Method (Li)

### 1.2 Impact of Transformer Noise on Reliability of Transformer

External Noise: External noise is mainly contributed by Aerodynamic device and thus it is called Aerodynamic Noise [2]. The Aerodynamic noise is most contributed by the External Cooling Fan Device and a lot of The Noise are generated because of various number of Fans are connected in Series and Parallel Configuration [11]. The Noise generated by these fans mainly depends on the sweep Area of Fan and Speed of Fan and Blade configuration.

Noise Level [8]is also depend on the cooling method and types of cooling arrangements used for the Transformer .In Transformer Noise level vary according to environmental aspect and Operating condition. [9].

Transformer Core vibrates due to Magnetic Forces and Magnetostrictive Forces. Most of the Magnetic Forces developed due to non-linear Magnetic gaps at the corner joints of Limbs and yokes.

In Power Transformer [16] Forces produced by the magnetostriction phenomenon are higher incomparision of magnetic forces in transformers. An alternating field sets the core [17] to vibration. This vibration is transmitted through the oil and tank structure to the surrounding air and creates hum and this coefficient of Magnetostriction is given by ε. $\varepsilon = \frac{\Delta l}{l}$

Where L and ΔL are length of lamination sheet and its change respectively.

Where E is the modulus of elasticity in the direction of force and A is the cross sectional area of a lamination sheet.

F=ε(t)EA

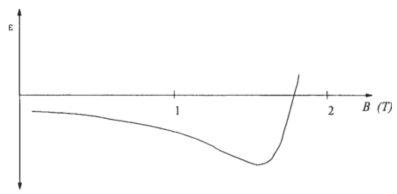


Fig 2 Magnetostriction Curve

The change in dimension is not linearly depending to the flux density. Magnetostriction can be positive or negative, depending on the type of the magnetic material, and the mechanical and thermal treatments.

Magnetic Characteristics in quality of yoke clamping has a significant influence on the noise [14] level. Apart from the yoke flux density, other factors which decide the noise level are:

a) Limb flux density,
b) Type of core material,
c) Leg center
d) core weight,
e) frequency

The noise level is depending on operating peak flux density and core weight. The change in noise level as a function of these two factors can be expressed as:

$$\Delta L = 10\ Log_{10}\left[\left(\frac{B_2}{B_1}\right)^8 \left(\frac{W_2}{W_1}\right)^{1.6}\right]$$

If core weight is assumed to change with flux density approximately in inverse Manner, for a flux density change from 1.6 T to 1.7 T, Then increase in noise level is 1.7 dB [≈64 $Log_{10}$(1.7/1.6)]. One of the ways of reducing noise is by designing transformer at lower operating flux density and this way reliability is to improve .thus in 0.1T Reduction the noise level to be reduced by 2 dB [9].

Bonding of laminations by adhesives and placing of anti-vibration and damping elements between the core and tank not only reduced the noise level but also it increases the strength of core [2]. When higher level of noise reduction is required than latest core material to be used and also good quality of Windings material to be used.

Table- I Development of Core Material

| Year | Core Material |
|---|---|
| 1910 | Warm Rolled FeSi Material |
| 1950 | Cold Rolled (CRGO) |
| 1960 | Cold Rolled (CRGO) |
| 1965 | Cold Rolled (CRGO) |
| 1975 | Amorphous Metal Material |
| 1980 | Cold Rolled (CRGO) |
| 1985 | Cold Rolled(CRGO) |
| 2000 | Advanced Stage Material like Superconducting Alloy |

## II.ANALYSIS OF NOISE

a) Sound Pressure Level

Lp=20* $Log_{10}$ (P/P0) [dB]

P is the Sound Pressure in Pa and P0 is reference sound Pressure.

b) Sound Power Level Lw

Lw= 10* $Log_{10}$ (W/W0) [dB]

W is sound Power and W0 is reference sound power.

c) Sound Intensity level Li

Li= 10 $log_{10}$ (I/I0)

I is sound Intensity [w/m$^2$] and I0 is reference value of sound intensity.

the measurement of the noise level is done as per the above equation.

d) Aerodynamic Noise Reduction

For Increasing the Capacity of the Transformer cooling fans are provided. By installation of these fans the capacity of the Transformer is increased. Fan dynamic revolution leads to maximum noise generation and also leads to generation hum sound[12]. Thus this type of noise generation is depend on the source of noise [6] generation and its various configuration and they are as below

1. Revolution of Fan
2. Sweep of Fan

Thus the fan revolution is restricted up to certain number of revolution so that the speed can be monitored and regulate. by optimization [13]of speed the Aerodynamic noise is reduced. With having large number of Blade's and having large length of the fan Blade the noise level also to be reduced and leads reducing the noise generation in Aerodynamic mode.

Thus the Aerodynamic Speed Noise Reduction can be measured as below

$$\Delta F_{WA} \text{(Fan)} = 70 \operatorname{Log}_{10} (D/D0) + 50 \operatorname{Log}_{10} (N/N0) + K1 + K2$$

Where K1=Intrinsic Noise factor
Where K2=Environment Impact Factor

Thus the Noise [14] Reduction may be adapted by the way to adopting the both the configuration with speed and diameter to be low as much as possible. The Optimization of Transformer will be done based on the configuration and type of Configuration used.

The Reliability of Transformer can be improved in view of reduction of Noise and also by reducing the losses in Transformer are below.

1. Using More Material
2. Better Material
3. New Advanced material
4. Improved material for LV & MV Voltage Level.
5. Improving in cooling medium and Reduced Noise level

III. NOISE RATIO CORRELATION & REGRESSION

Noise error is generated with respect to the error in the signal transmitted with noise and it is co-related with the factor for synchronizing the error in the ratio of the error in the noise and defined with Diameter of the Fan and speed of the fan for external co-relation of the factor. The diagrammatical analysis of this noise ratio correlation for the transformer was done in the different cases given in the result section.

A) Noise Optimization: Estimation of Noise Error Case-1:

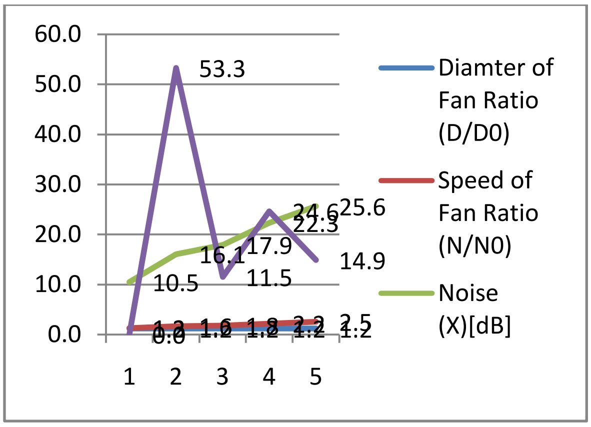


Fig 3 Noise Error & Speed of Fan

Case-2

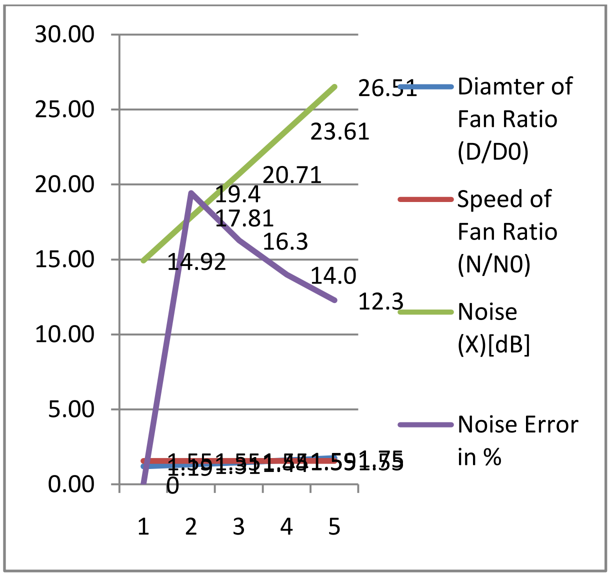


Fig 4 Noise Error & Speed of Fan

Case-3

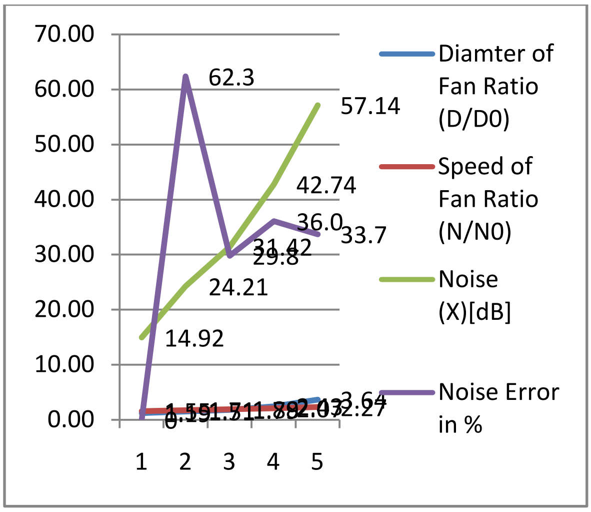


Fig 5 Noise Error & Speed of Fan

B) Noise Optimization: Noise Error, Noise Correlation, Noise Regression

Case-1

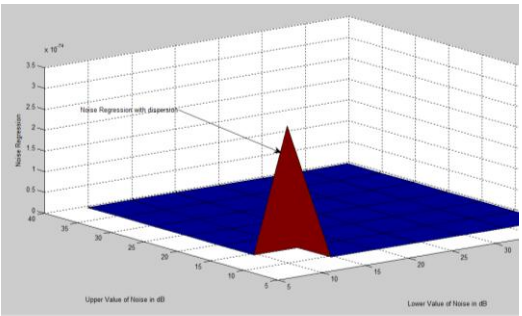

Fig 6 Noise Correlation & Noise Regression

Case-2

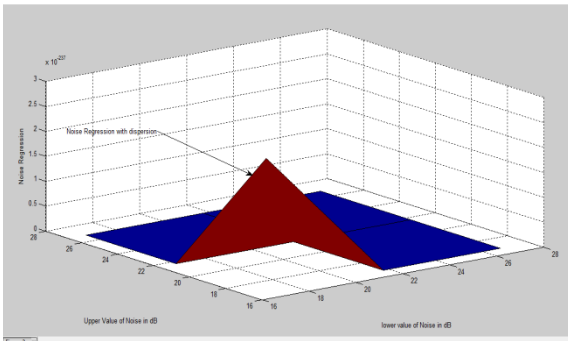

Fig 7 Noise Correlation & Noise Regression

Case-3

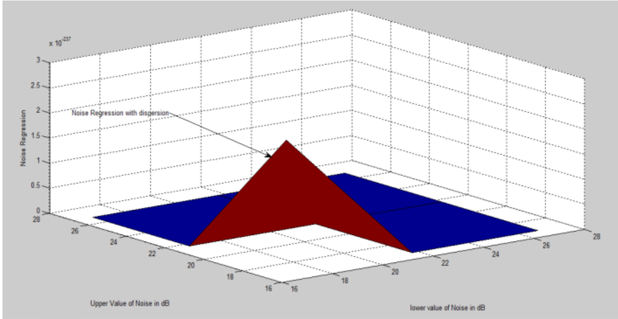

Fig 8 Noise Correlation & Noise Regression

Case-4

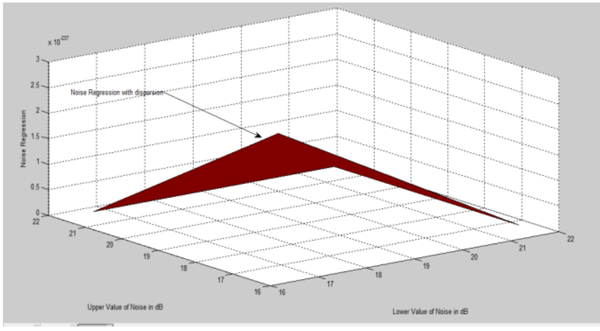

Fig 9 Noise Correlation & Noise Regression

## IV. CONCLUSION

External Noise is dynamic Index which is going to change every space of Progression. The External Noise regression and correlation will depend on the Profile of Noise Level and Correlation is spontaneous with moment of noise and thus the Noise Regression is on the Platform is depend of the external causes and by the virtue of external noise.

## REFERENCES

1. A.Prieto, M.Cuesto, P.Pacheco, M.Oliva, L.Prieto, A. Fernandez "Optimization of power transformers based on operative service conditions for improved performance" CIGRE 2012.
2. Ljubomir Lukic1, Mirko Djapic1, Dusica Lukic2, Aleksandra Petrovic "ASPECTS OF DESIGN OF POWER TRANSFORMERS FOR NOISE REDUCTION" 4th International Conference on Noise and Vibration" University of Nis.
3. Ron Widup, Shermco Industries "Dry-Type Power Transformers: Understanding Transformer Isolation and Noise, 2010.
4. Wiktor Marek Zawieska "A Power Transformer as a Source of Noise" International Journal of Occupational Safety and Ergonomics (JOSE) 2007, Vol. 13, No. 4, 381–389.
5. Xiaojun Qiu a,*, Xun Li a, Yanting Ai b, Colin H.Hansen a "A waveform synthesis algorithm for active control of transformer noise: implementation" Applied Acoustics 63 (2002) 467–479, ELSEVIER.
6. Toshiaki Yanada, and Kazumi Ishikawa "Analysis and Performance Evaluation of Noise-Reduction Transformer" World Academy of Science, Engineering and Technology Vol:6 2012-05-20.
7. Luiz Eduardo Borges da Silva1, Erik Leandro Bonaldi2, Levy Ely de Lacerda de Oliveira2, Germano Lambert-Torres2, Giscard F. C. Veloso1, Ismael Noronha1, Felipe dos Santos Moreira3, José Nielze Caminha3 "Early Failure Detection in Power Transformers" Journal of Power and Energy Engineering, 2013, 1, 30-40.

8. A Report on Large Power Transformer " MHI Report" 2005.
9. A New Era in Transformer Design: PEAK™ Transformers Provide Increased Overload Capacity or a Smaller, Lighter Footprint. IEEE Std C57.154™-2012 standard.
10. Katarzyna Strzalka-Goluszka "Guide for electrical design engineers" Leonardo Energy (Power Quality).
11. Shuo Wang, F. C. Lee, "Investigation of the Transformation Between Differential-Mode and Common-Mode Noises in an EMI Filter Due to Unbalance", IEEE Trans. Electromagnetic Compatibility, vol. 52, Issue 3, pp. 578-587, Aug 2010.
12. I. W. Hofsajer, "Planar transformer with integrated shielding against differential to common mode conversion and capacitive currents", IET Electron. Letter, vol. 41 Issue 6 pp. 363-365, Mar 2005.
13. X. Margueron, A. Besri, P. -O. Jeannin, J. -P. Keradec, G. Parent, "Complete Analytical Calculation of Static Leakage Parameters: A Step Toward HF Transformer Optimization", IEEE Trans. Ind. App., vol. 46, Issue 3, pp. 1055-1063, May-Jun 2010.
14. P. Kong, F. C. Lee, "Transformer structure and its effects on common mode EMI noise in isolated power converters," in Proc. IEEE Appl. Power Electron. Conf. (APEC), Texas, 2010, pp. 1424–1429.
15. M. L. Heldwein, H. Ertl, J. Biela, J. W. Kolar, "Implementation of a Transformerless Common-Mode Active Filter for Offline Converter Systems", IEEE Trans. Industrial Electron., vol. 57, issue 5, pp. 1772-1786, May. 2010..
16. Dejan Susa "DYNAMIC THERMAL MODELLING OF POWER TRANSFORMERS" TKK Dissertations 9 Espoo 2005.
17. GAYATRI AGNIHOTRI, SAVITA NEMA, R. K. NEMA "Amorphous Core Distribution Transformers: Challenges, Opportunity and Loss Capitalization for Power Applications in India" Recent Researches in Circuits, Systems, Mechanics and Transportation Systems ISBN: 978-1-61804-062-6.
18. A.H.Al-Badi, Senior Member IEEE,A.Elmoudi,I.Metwally Senior Member IEEE, A.Al-Wahabi,H.Al-Ajmi and M.Al Bulushi " Analysis and Performance Evaluation of Noise-Reduction Transformer" Proceedings of The International Multi Conference of Engineers and Computer Scientists 2011 Vol II, IMECS 2011, March 16-18,2011,Hong Kong