ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering
Vol. 2, Issue 5, May 2013

Causes of Noise Generation & its Mitigation in Transformer

Ruchi Negi [1], Prateek Singh[2], Gaurav Kr. Shah[3]

Third year Student, Dept. of Electrical and Electronics Engineering, MIT, Moradabad, India[1]

Final year Student, Dept. of Electrical and Electronics Engineering, MIT, Moradabad, India[2]

Third year Student, Dept. of Electrical Engineering, MIT, Moradabad, India[3]

Abstract: This paper presents causes of noise generation in transformers and its mitigation. The ministry of environment has specified noise level for different areas i.e. industrial, commercial and residential. In this paper there are three causes of noise generation in transformer i.e. core sound, load sound and sound by cooling fans & pumps. Various methods are suggested in this paper in order to mitigate the sound in transformer.

Keywords: Magnetostriction, Magnetic Forces, Magnetic Hysteresis.

I. INTRODUCTION

Transformer in operation emits a noise, the magnitude of noise increases with increase in its capacity. It is common to see an electrical transformer near your locality. While passing by your street near to the transformers, you might have heard a continuous vibration like noise near the transformers which seems like "hum". Though it seems, nothing is moving inside it unlike electric motors and generators. Actually, inside the transformer there is no rotating part as in motors and generators, but still they produce the sound because of Magnetostriction Effect which occurs inside the transformer, Magnetostriction effect is one of the important property of ferromagnetic materials. Due to this property, whenever a ferromagnetic material comes in contact of varying magnetic field, it changes its dimensions. Inside a transformer is nothing but magnetic core wound by a number of turns of wires on two sides. In one side, AC voltage is applied and on another side stepped up or stepped down voltage is received. Well we might be aware that AC alternates its direction after every half cycle. Due to this variation in applied voltage, Varying magnetic field is produced and these varying magnetic fields changes dimensions of the ferromagnetic material used as the transformer component and it appears as vibrations. These vibrations are the source of the noise or "hmmm..." like sound in the transformers.
Earlier the sound produced by transformer had been of secondary importance. It has now become a matter of concern due to growing public concern about the environmental noise pollution. In INDIA and many other countries, the 'Ministry of Environment and Forest Notification' specifies the acceptable limits of sound level in dB as shown in **Table-1 below**.

Table 1: Ambient Air Quality Standards in respect of Noise

S.No.	Category of Area/Zone	Limits in dB(A)	
		Day Time	Night Time
(A)	Industrial area	75	70
(B)	Commercial area	65	55
(C)	Residential area	55	45
(D)	Silence Zone	50	40

Note:-
1. Day time shall mean from 6.00 a.m. to 10.00 p.m.
2. Night time shall mean from 10.00 p.m. to 6.00 a.m.
3. Silence zone is defined as an area comprising not less than 100 meters around hospitals,educational institutions and courts. The silence zones are zones, which are declared as such by the competent authority.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering
Vol. 2, Issue 5, May 2013

II. SOURCES OF SOUND GENERATION IN TRANSFORMER

There are three basic sources 5of sound generation in power transformer as shown in **Figure-1.**

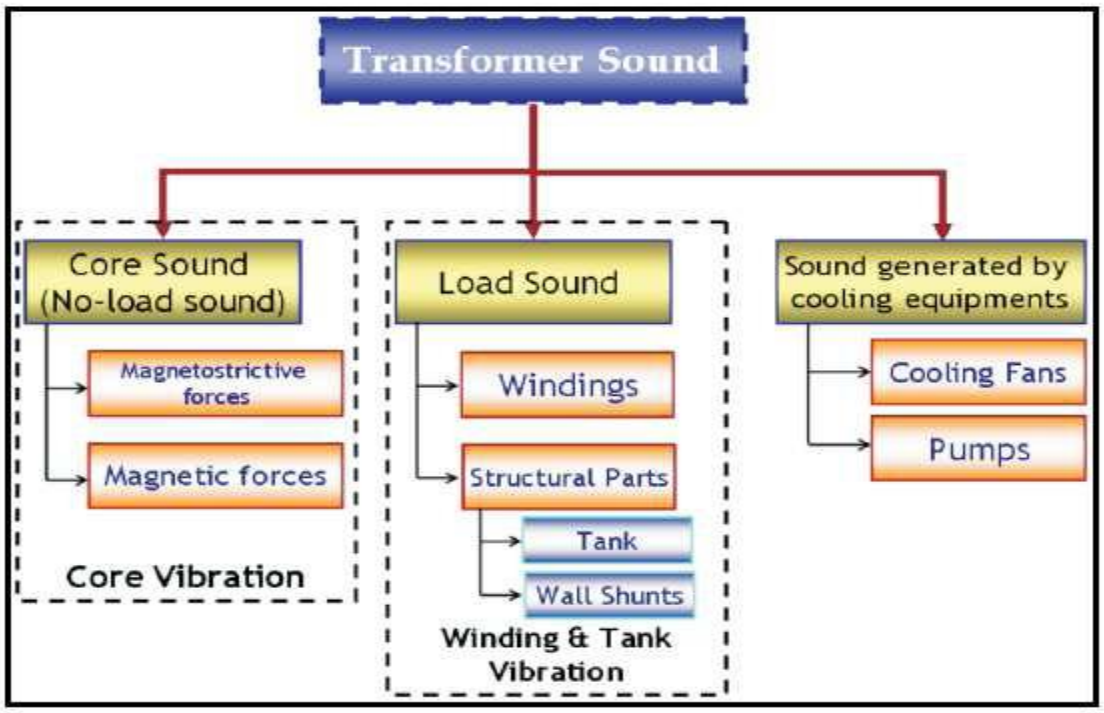

Figure 1: Transformer Sound

1. **Core Noise:** Transformer Noise is caused by a phenomenon called Magnetostriction, which occurs inside the transformers. Magnetostriction is a phenomenon by which a metallic objects experiences a distortion in its shape when it is placed inside a magnetic field. The objects can experience a change in the dimensions, expansion or contraction. Inside a transformer, the core, which is made in the form of laminated sheets, also undergoes expansion and contraction due to the changing magnetic flux. This expansion and contraction occurs twice in an ac cycle. The fundamental frequency of the noise or vibration is double that of the frequency of the power supply. Thus, a supply with a frequency of 50 Hz will cause noise or vibration whose fundamental frequency is 100 Hz.

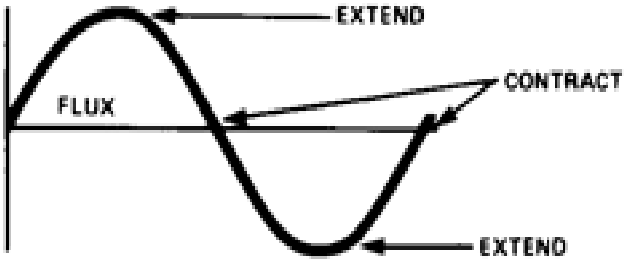

Figure 2: Magnetostriction

2. **Load Noise:** Load noise is caused by vibrations in tank walls, magnetic shields, and transformer windings due to the electromagnetic forces resulting from leakage fields produced by load currents. These electromagnetic forces are proportional to the square of the load currents.
   The load noise is predominantly produced by axial and radial vibration of transformer windings. However, marginally designed magnetic shielding can also be a significant source of sound in transformers. A rigid design

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering
Vol. 2, Issue 5, May 2013

for laminated magnetic shields with firm anchoring to the tank walls can greatly reduce their influence on the overall load sound levels.

The frequency of load noise is usually twice the power frequency. An appropriate mechanical design for laminated magnetic shields can be helpful in avoiding resonance in the tank walls. The design of the magnetic shields should take into account the effects of overloads to avoid saturation, which would cause higher sound levels during such operating conditions.

The presence of harmonics in load current and voltage, most especially in rectifier transformers, can produce vibrations at twice the harmonic frequencies and thus a sizeable increase in the overall sound level of a transformer.

Through several decades, the contribution of the load noise to the total transformer noise has remained moderate. However, in transformers designed with low induction levels and improved core designs for complying with low sound-level specifications, the load-dependent winding noise of electromagnetic origin can become a significant contributor to the overall sound level of the transformer.

3. **Fan and Pump Sound:** Power transformers generate considerable heat because of the losses in the core, coils, and other metallic structural components of the transformer. Fans that blow air over radiators or coolers remove this heat. Noise produced by the cooling fans is usually broadband in nature. Cooling fans usually contribute more to the total noise for transformers of smaller ratings and for transformers that are operated at lower levels of core induction.

III. MITIGATION OF TRANSFORMER SOUND

The various methods are used for mitigation of transformer sound are as follows:

(a).No-Load sound mitigation:

Flux density: No-load sound level of core mainly depends on Magnetostriction and magnetic forces. The magnitude of Magnetostriction could be reduced by lowering flux density. Flux density is inversely proportional to the core weight. Therefore, that if we reduce the flux density in order to reduce the sound, core weight increases which in turn increases the cost.

Choice of CRGO material: CRGO material, which is used for making the core, should have properties such as low loss, high permeability and low noise generation from core.

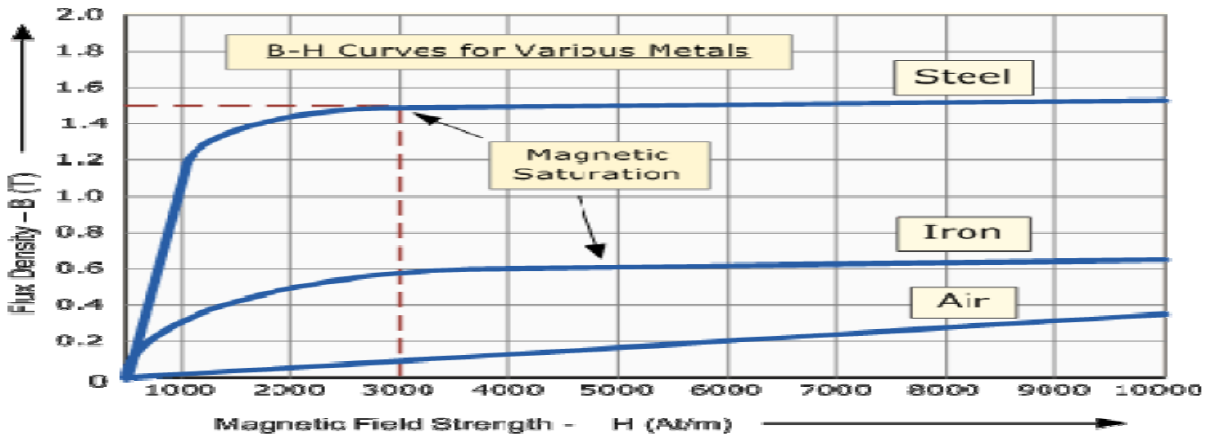

Figure 3: B-H Curve for magnetic materials

(b)Magnetic Hysteresis Loops For Soft And Hard Materials: Magnetic Hysteresis results in the dissipation of wasted energy in the form of heat with the energy wasted being in proportion to the area of the magnetic hysteresis loop. Hysteresis losses will always be a problem in AC transformers where the current is constantly changing direction and thus the magnetic poles in the core will cause losses because they constantly reverse direction.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering
Vol. 2, Issue 5, May 2013

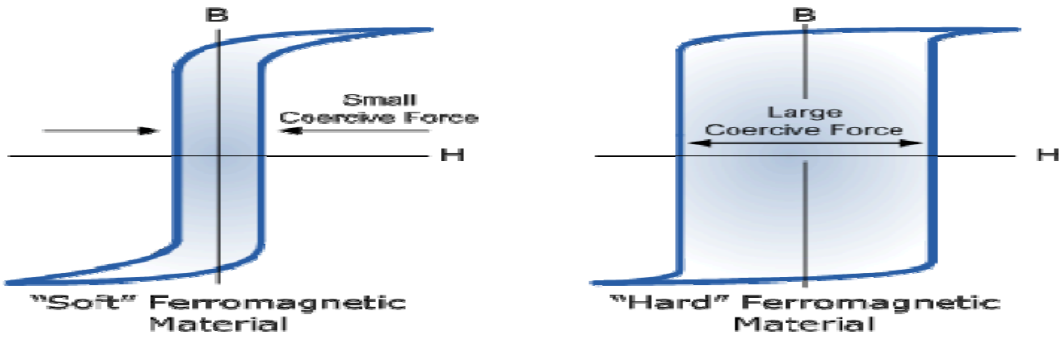

Figure 4: Magnetic Hysteresis Loops

Rotating coils in DC machines will also incur hysteresis losses as they are alternately passing north the south magnetic poles. The shape of the hysteresis loop depends upon the nature of the iron or steel used and in the case of iron which is subjected to massive reversals of magnetism, for example transformer cores, it is important that the B-H hysteresis loop is as small as possible.

(c) Cooling fans & oil pumps sound mitigation: Standard size of fan used are 18 & 24 inch with speed of 900-950 rpm and their sound level is in the range of 64-65dB. The fan noise is a function of speed and circumfential velocity. If the size of fans will be reduced number of fans increases. Therefore, it is better to increase number radiators. Therefore, ONAN cooling is preferred than ONAF cooling.

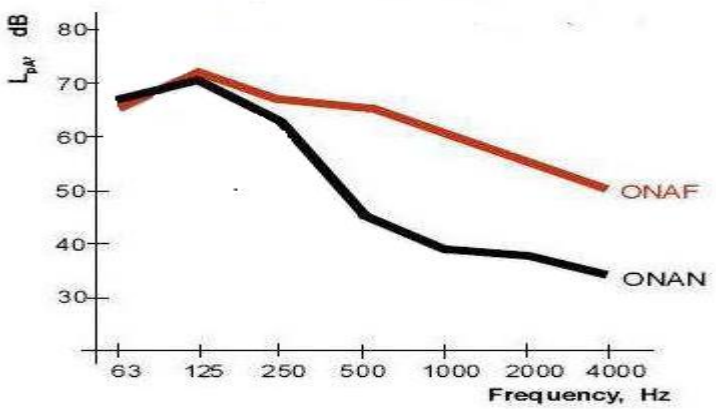

Figure 5: Noise Spectrum

IV. CONCLUSION

Transformer cores can make acoustical noise like humming and rattling. The mechanisms that cause this noise inside the core have been explained. Proper transformer design, wiring, and, above all, grounding, are the only effective means of reducing the three types of noise problems. Grounding should be controlled and use the lowest impedance path possible (i.e., bonding) to the central reference ground system to insure maximum attenuation of noise sources. To achieve the maximum protection from a transformer, not only must it be applied properly, but also the transformer should be one specially designed for isolation usage. Since this process can't be stopped so the question arises is how to reduce this kind of noise. There are many ways to achieve that, one of the ways include sound insulation which can be done by:

1. We can use cushion padding and oil barriers which can help in insulating the sound of vibration and hence it will reduce the noise appearing to the users.
2. Insulation of sound from Ground and Air near to the transformers.
3. Using proper innovation designs and materials like stiffeners while constructing the walls of the transformer tanks.

Some of the other ways that can be used are proper fixing and clamping of the laminations and frames of the transformers. If further reduction in audible noise is desired for a given transformer construction, the designer can reduce the peak flux density.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering
Vol. 2, Issue 5, May 2013

REFERENCES

[1]. Ministry of Environment & Forest Notification Govt. Rule, New Delhi, Feb 14th 2000.
[2]. J.G. Charles, "The effect of the level of Magnetostriction upon noise & vibration of model Single-phase transformer." Electrical Research Association (ERA), January-1967.
[3]. Jeewan Puri, Causes and Effects of Transformer Sound Levels.
[4]. S. V. Kulkarni, S. A. Khaparde, "Transformer engineering design and practice", 2004.
[5]. H. V. Paghadar, "Mitigation of Audible Sound in Transformer"Trafotech-2010.
[6]. T. Yanada, M. Matsuda, 0. Ichinokura and T. Jiiizenji. "Performance and Noise Attenuation Mechanism of Noise Reduction Trai1sforme.r." IEEE Trans. Magn., vol. 30, pp. 4860-4862. 1994.
[7]. Ji Shengchang, Cheng Jin, Li Yanming, "Research on Vibration Characteristics of Windings and Core of Oil –filled Transformer", Journal of Xi'an Jiaotong University，Vol.39, No.6, pp. 616~619, 2005.