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Research Notes

# Causes of Noise generation & its Mitigation in Transformer

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**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

## INTRODUCTION

Transformer in operation emits a noise, the magnitude of noise increases with increase in its capacity. 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[1]**

| Area Code | Category of Area/Zone | Limits in dB(A) | |
|---|---|---|---|
| | | Day Time | NightTime |
| (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.

## II. SOURCES OF SOUND GENERATION IN TRANSFORMER

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

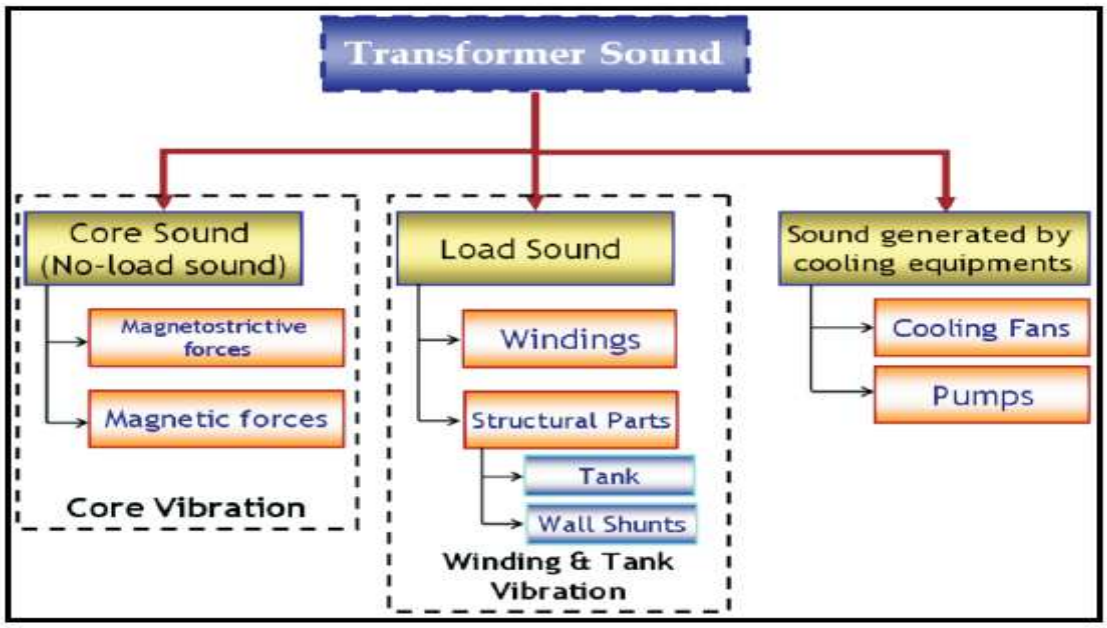



**Fig.1: Transformer Sound[5]**

**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

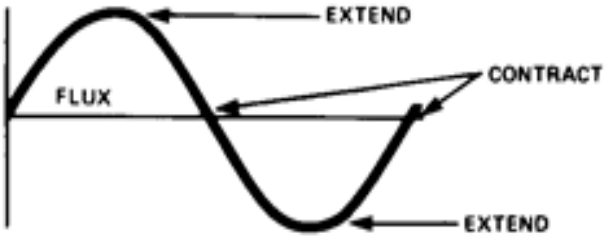



**Fig.2: Magnetostriction**

**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 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.

**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.

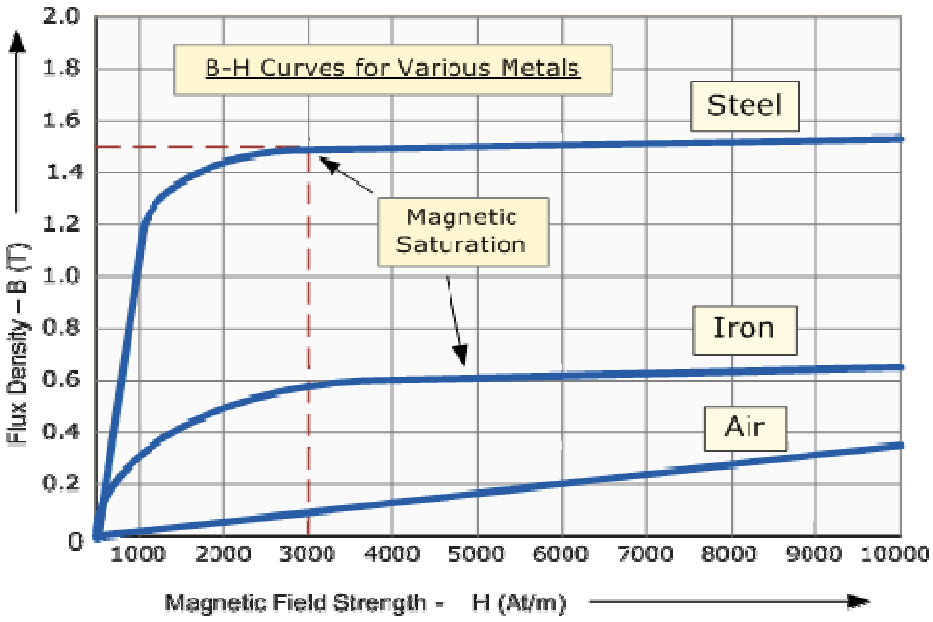



**Fig.3: B-H Curve for magnetic materials[4]**

**(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.

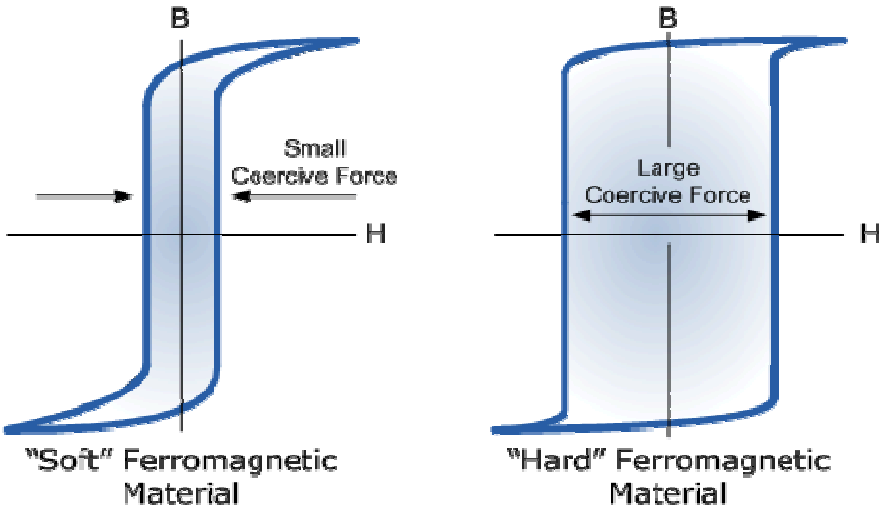
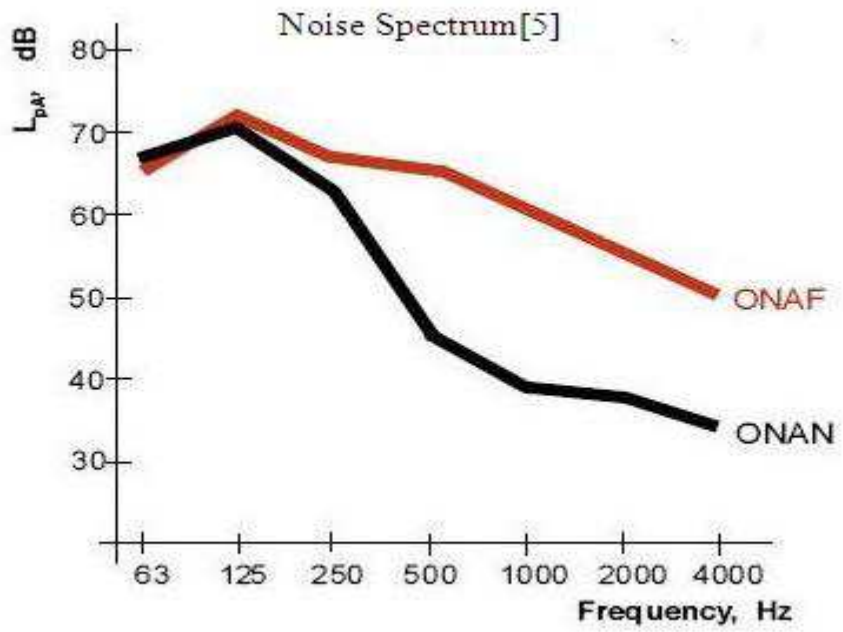



**Fig.4: Magnetic Hysteresis Loops[3]**

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.

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