International Journal of Scientific and Technical Advancements

ISSN: 2454-1532

Intelligent System for SFRA of Transformer

Richa Kapoor[1], Himanshu Vijay[2]
[1]Electrical & Electronics Engg., HCST, Mathura U.P
[2]Electrical & Electronics Engg. Dept., Anand Engineering College, Agra U.P

Abstract**—**Sweep frequency response analysis (SFRA) of transformer have attained great popularity due to its wide interest. It is considered as very sensitive technique to analyze the winding movement of power transformer. It works on the principle of measuring the impedance of transformer for a different range of frequencies and thus comparing the results. It permits detection of changes in the clamping pressure as well as possible modes of winding distortion such as radial, axial, twisting; Thus Faults, which can either, change the winding inductance or the winding capacitance, can be detected. SFRA provides early indication of a mechanical damage in transformer where as Conventional monitoring model such as DGA are unable to detect mechanical damage unless and until it convert into a dielectric or thermal fault. In this paper an analysis of different faults under different test, is been tried to be detected without opening the transformer. This Technique can be applied to power transformer and distribution transformer.

Keywords**—** SFRA, intelligent system, sample analysis.

I. INTRODUCTION

Sweep Frequency Response Analysis (SFRA) is a tool to indicate the movement & dislocation of core or winding in transformers. The process involves measurement, observing performance of a transformer winding transmitting a low voltage signal that varies in frequency. The performance of a transformer is dependent on its impedance, the capacitance and inductance, which are related to the physical construction of the transformer. The deviation in frequency response as calculated by SFRA techniques indicates a physical change inside the transformer, the reason for the same is needed to be identified and investigated. Sweep Frequency Response Analysis (SFRA) test done by swept frequency method gives a qualitative analysis of the physical condition of the transformer core and winding. The loss of physical integrity might occur due to:

- Electromechanical forces due to fault currents
- Release of clamping pressure due to winding shrinkage.
- Transportation and relocation. Of transformer
- Natural calamaties like earth quake, lighting stroke etc.

Normally, a transformer is expected to withstand a number of short circuits during its lifetime, but once a while it will create some slight winding movement, and due to which, the ability of transformer to bear further short circuits will then be severely reduced. Another factor is that the winding shrinkage also occurs with age, which lead to a reduction in clamping pressure and short circuits withstand capacity. It is thus, desired to check the mechanical condition of transformer periodically during their life span. Conventional transformer condition monitoring model such as DGA are unable to detect mechanical damage unless and until it convert into a dielectric or thermal fault, so a specialist model is clearly required for the assessing and monitoring of mechanical condition. The improvement in SFRA is worth developing as it can give a non- indication of winding movement, and as early indication of a developing problem.

II. SFRA PRINCIPLE

Sweep Frequency Response Analysis work on the principle of measuring the impedance of transformer for a different range of frequencies and thus comparing the results .There are two ways of introducing the wide range of frequency either by injecting an impulse into the winding or by making a frequency sweep using sinusoidal signal. Sweep Frequency Response Analysis (SFRA) is a tool that can give an indication of core or winding movement in transformers. This is done by performing a measurement, a simple one, looking at how well a transformer winding transmits a low voltage signal that varies in frequency. Just how well a transformer does this is related to its impedance, the capacitive and inductive elements of which are intimately related to the physical construction of the transformer. Changes in frequency response as measured by SFRA techniques may indicate a physical change inside the transformer, the cause of which then needs to be identified and investigated [5].

III. PROPOSED INTELLIGENT SYSTEM FOR SFRA

A knowledge based intelligent model for SFRA was needed, because SFRA tool is required day by day for the better health for power transformer. There is no such smart tool for analysis of SFRA results. Effective system can predict more précised analysis of SFRA data with the help of Knowledge based intelligence and appropriate computer programming. The block diagram of proposed Intelligent system is shown in figure 4. A suitable matlab code has been developed for knowledge based intelligent system analysis.

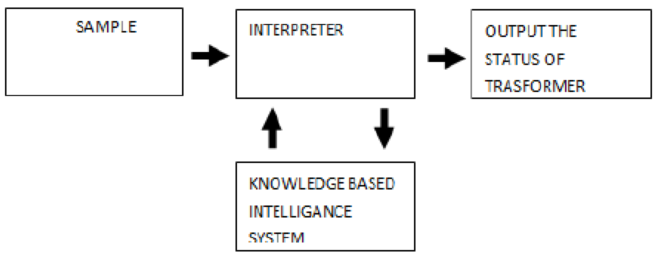

Fig. 3.1: Block diagram of intelligent system.

Richa Kapoor and Himanshu Vijay, "Intelligent system for SFRA of transformer," *International Journal of Scientific and Technical Advancements*, Volume 2, Issue 4, pp. 191-194, 2016.

3.1 Analysis And Interpretation With Knowledge Based Expert System

The knowledge based intelligent system give hint of probable fault in transformer. The use of knowledge based intelligent system can improve reliability and repeatability of analysis of SFRA data. A lot of research has been done to generate intelligent system for the detection of different faults in transformer. Intelligent system has been introduced to give indication of fault directly to user. There is a protocol of analysis using SFRA the best method is to compare results to those obtained previously as a baseline. But when baseline results are not available then we can rely on three further types of comparison over baseline comparisons

• Analogzing with sister unit of similar parameter
• Phase to phase comparison of short circuit test results
• Phase to phase comparison of open circuit test results

3.2 Features of Knowledge Based Intelligent System Tool for SFRA

• admix for normal user
• Incorporate for advanced user
• Interface for advanced user with user defined limits for analysis
• Integrate with phase to phase comparison analysis
• Interface for baseline comparison analysis

3.3 Application of Knowledge Based Intelligent System for SFRA

Stage 1: SFRA data is collected.
Stage 2: A matlab coding is done for loading data in workspace as input for the knowledge Based Intelligent system .
Stage 3: Classification of data is done based on the table 3.1
Stage 4: Checks the probable fault level in each frequency band as mentioned in table 3.2
Stage 5: Calculate the probable fault in percentage.
Stage 6: Displays the results of analysis done if fault is present then display the corresponding fault with the help of table 3.2

Table 3.1: Probable fault with range of difference in magnitude at same frequency.

Deviation in db	Probable fault level
< 2db	Very low
2 db - 3.5 db	Low
3.5 db – 5 db	High
5db<	Very high

Table 3.2 Probable faults with range of frequency.

Frequency Band	Probable fault
< 2kHz	Core deformation, open circuits, shorted turns & Residual magnetism
2kHz to 20kHz	Bulk winding movement relative to each other, clamping structure
20kHz to 400kHz	Deformation within the main and tap windings
400kHz to 2MHz	Movement of main and tap winding leads, axial shift

IV. RESULTS ANALYSIS THROUGH KNOWLEDGE BASED EXPERT

Analysis has been done with the help of matlab programming and based on our programming we found appropriate results which are given below. In our analysis we have used Knowledge based Intelligence system with phase to phase comparison method in this was carried out on power transformer described in table 4.1.

Table 4.1

Transformer Details	Transformer (A)
Manufacturer	Apex electric ltd
Location	Ghurkari substation H.P(India)
Year of Manufacturer	1994
Winding	3
HV	132kV
LV	33kV
Transformer Rating	16 MVA
Tap position	6

These are substation Power transformer and we have obtained appropriate results with the help of knowledge based expert system. And results obtained by analysis of transformer are given below.

4.1 Open Circuit Test Result

Open circuit test has been done on A, B, C phase respectively. In figure 4.1 analysis has done for phase A & B and obtained results shown in pie chart which indicates overall percentage probable fault level obtained from each zonal analysis according to table 3.2. Similarly for phase B & C and phase C & A in figure 4.2 & 4.3 respectively and Its overall probable fault level also shown in respective pie chart.

For phase A & B

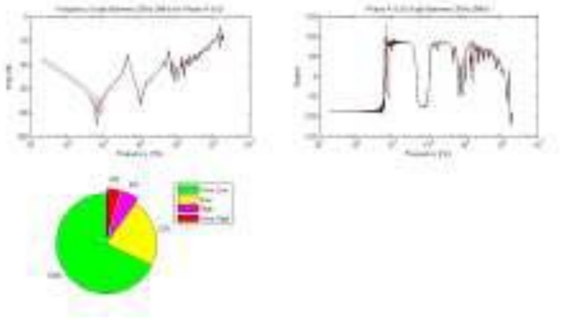

Figure 4.1

The result gives us the frequency graph between 20 Hz –2 MHz for phase A& B as well as phase A& B graph for the same band. It also gives pie chart illustrating the healthy condition of the transformer ie 68% of transformer is healthy, 22 % is in good condition, 6% is prone to unhealthy condition and 4 % is faulty which is negligible

Richa Kapoor and Himanshu Vijay, “Intelligent system for SFRA of transformer,” *International Journal of Scientific and Technical Advancements*, Volume 2, Issue 4, pp. 191-194, 2016.

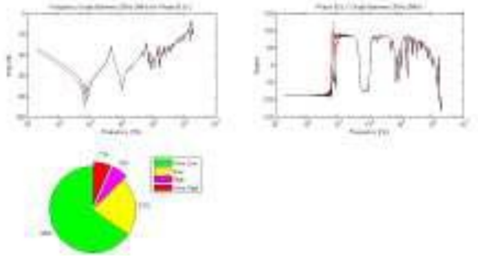

Figure 4.2

For phase C & A

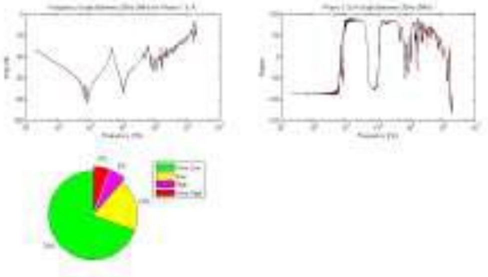

Figure 4.3

Similar to phase A & B it can be seen that that phase B& C and phase C& A the fault percentage is 7 % and 6 % respectively which can be neglected. Now the Short circuit test for the same set up and same frequency range is done for all the three phases and similarly the results can be represented.

4.2 Short Circuit Test Result

For phase A & B

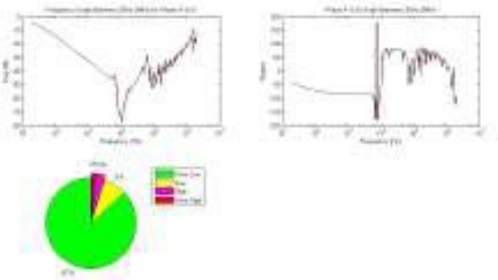

Figure 4.4

For Phase B&C

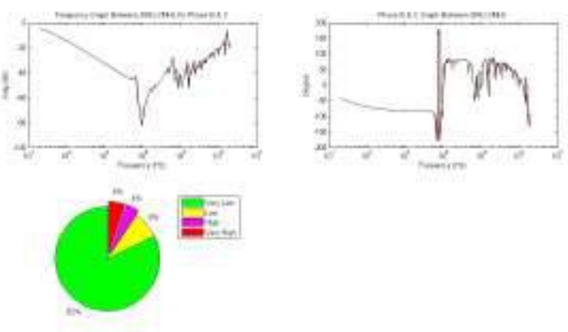

Figure 4.5

For Phase C& A

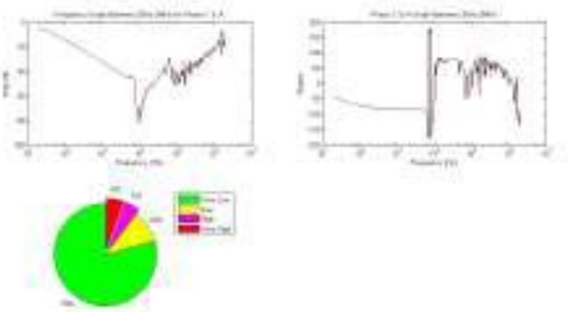

Figure 4.6

V. CONCLUSION

This paper has given detail about the various steps involved in area of application of intelligence system. The Knowledge based intelligence system so evolved has been implemented for the SFRA of different power transformers. Data analyses were done with the help of Knowledge Based Intelligence System and it was concluded that the structural health of core and winding is good and there is no indication of any deformation or displacement of winding in transformer. The development of this intelligent system is supported by our experience and further development is carried out to enhance the system

REFERENCE

[1] S. A. Ryder, "Diagnosing transformer faults using frequency response analysis," *IEEE Electrical Insulation Magazine*, 0883-7554/03March/April 2003 Vol. 19 No. 2.

[2] J. Fuhr, "Benefits and limits of advanced methods used for transformer diagnostics," *IEEE Electrical Insulation Conference Montreal Qc Canada*, 31 May - 3 June IEEE 2009

[3] S. A. Ryder, "Frequency response analysis for diagnostic testing of power transformers," *Electricity Today*, vol. 13 no. 6, pp. 14-19, IEEE 2001.

[4] Simon A. Ryder, "Transformer diagnosis using frequency response analysis: Results from fault simulations," 0-7803-7519-X/02 IEEE 2002

[5] J. Secue, E. Mombello, E. Muela, "Approach for determining a reliable set of spot frequencies to be used during a sweep frequency response analysis (SFRA) for power transformer diagnosis," 978-1-4244-2218-0/08 IEEE 2008

[6] Singh J, Sood Y. R, Jarial R. K , P. V, "Novel method for detection of transformer winding faults using Sweep Frequency Response Analysis," *Power Engineering Society General Meeting IEEE*, 24-28 June 2007 Page(s):1 – 9

[7] J. R. Secue, E. Mombello, "Sweep frequency response analysis (SFRA) for the assessment of winding displacements and deformation in power transformers," *Electric Power Systems Research*, 78 (2008) 1119–1128 Elsevier 2008

[8] J. Secue, E. Mombello, "New methodology for diagnosing faults in power transformer windings through the sweep frequency response analysis (SFRA)," 978-1-4244-2218-0/08 IEEE 2008.

[9] M. Wang, A. J. Vandermaar, K. D. Srivastava, "Transformer winding movement monitoring in service—Key factors affecting FRA measurements," September/October 2004 — vol. 20 no. 5 IEEE 2004

[10] Carlos González, Jorge Pleite, Rosa Ana Salas, Juan Vazquez, "Transformer diagnosis approach using frequency response analysis method," 1-4244-0136-4/06 IEEE 2006.

Richa Kapoor and Himanshu Vijay, "Intelligent system for SFRA of transformer," *International Journal of Scientific and Technical Advancements*, Volume 2, Issue 4, pp. 191-194, 2016.