Asian Journal of Convergence in Technology **Volume V Issue I**
ISSN NO: 2350-1146 I.F-5.11

Health Condition Monitoring of Transformer: A Review

Ms.Niyanta Patel,*M.Tech Student ,CGPIT, Bardoli,*Prof. Darshan R. Vora, and Prof. Ankit singh Basera, *Assistant Professor, CGPIT, Bardoli Surat, India*

***Abstract*—In power system network Transformers are one of the most vital asset equipment so it requires special care and observation. Health Monitoring of transformers before problems occur it can stop unscheduled faults that are cost of maintance or repair and outcome in a misplacement of service. Monitoring system can help the transformer life cycle as well as authenticity. Monitoring is observing the statistics of transformer and identifies data of history of transformer. The main goal of this paper is to convey need of condition monitoring, types of failure occurs in transformers and to review mitigation methodologies adopted for health condition monitoring of transformers.**

Keywords— Condition monitoring, Need of monitoring; On line monitoring; benefits of condition monitoring; Faults in transformer; condition monitoring techniques

I. INTRODUCTION

In our life electricity plays an important role. Human life of single moment depends upon the electricity. The most critical equipment of distribution and transmission of electricity is transformer as we know transformer are both the side of network load side distribution transformer installed which distribute the low power to consumers same as generation side Power transformer installed both operation condition is important in electrical network[5]. Most transformers will under rated condition for their long service life. whatever, considerable advantages can be acquire by utilizing power transformer beyond current practices that are based on the standard data need for electrical service is increase to hire transformers to the brimming while maintaining system responsible.

If apparatus are subjected to current low or high voltage ,overloading, heating, failures that is affecting the reliability of power system then Presently the load and the decreasing the life cycle of the apparatus.

Therefore the monitoring and identificaption of transformers becomes more and more important, whereby monitoring is the collection of data during service (on-line) or during maintenance or test periods (off-line) and analysis the technical evaluation and explanation of the recorded data distribution transformer with the different parameter of variation like Load current, Moisture ,Oil temperature, Overloading, Winding temperature, Bushing condition The ineffective cooling, Oil flow are major causes of failure of transformer.

II. NEED OF MONITORING SYSTEM

A. On-Line Monitoring

On line condition monitoring can be also called permanent monitoring system. The machine parameter is measured from selected points to compare[5] with constant or standard particular values.

On line monitoring can be say that it is the record of historical data of a transformer. Identification is the explanation of these monitored data including the history of the transformer and the judgment of the failure rate.

With the aim of reduced maintenance and a reliable electrical power supply in connection expand the life cycle of transformer it can be evaluated by store the important data of transformers so an on-line monitoring system is specially suitable for utilization.

Online monitoring systems would help to reduce life cycle an reduction of unscheduled operation and reduce maintenance costs of power transformers. For expansion of lifecycle evaluation play an important improvement in transformer condtion.To determine paper insulation failure need monitoring parameter of winding hot spot temperature, top oil temperature [1] The more accuracy of transformer another parameter need to monitor that is temperature of winding, temperature of oil,current and voltage.

B. Benefits of condition monitoring

The Condition monitoring has a many benefits and these advantage can be brief as follows[11]:

1) It limit the repairing costs of equipment.

2) It can reduce the cost during maintained period of equipemnt.it can detect the impending faults and intercept it.

3) Quality of supply and safety of persons are affect by limits the probability of destructive failure.

4) It limits the extremity of any damage incurred and reduces repair activities.

5) It can detect failure of the root causes and Provides a very good fault diagnosis system.

6) Integrated condition monitoring provide information about the plant life cycle by means of condition monitoring of all of important apparatus.

III. Faults In Transformers

Transformer consist magnetic core, set of copper windings which is primary and secondary are isolated to core and each other. Failure of transformer can be depend on following reasons like core, insulation, winding. The power transformer magnetic core and windings are main to multiple forces during operation such as[8]

1. Vibration in core due to electric flux
2. Thermal heating by overloading
3. Expansion during thermal cycles
4. Due to eddy current core affected

According to different types of faults of transformer are classified as external faults and internal faults. External faults can be define as a faults which can be occurred outside or surface of transformer as well internal fault can be define as a faults which can be occurred in (insulation, winding)inside in transformer.[10].

It would cause serious damage in transformer. Due to internal fault 70 to 80 percent of transformers are failures. These results are increase and it should be examine to whole the existence of transformer.

A. Over Temperature

If the transformer winding and oil temperature is within particular limit compare to absolute temperature extra load current cannot damage to the transformer.ambient temperature of 30°C (86°F) is depend on 24 hour ambient temperature . Oil temperature increases is the causes failure of insulation of transformer winding due to over voltage and over current [7].

B. Over Excitation

The frequency is inversely proportional to the applied voltage and directly proportional to flux of core in transformer. Increasing of flux is the cause of increase the input voltage or frequency decrease. Increases exciting Current, transformer heating, noise, surplus flux are responsible for the over excitation in transformer [7].

C. Over Load

In transformer voltage and current cross their exceed of specifications then it is called overloading of transformer. generally full-load current is excess four time of fault currents that do not include ground. [8].

D. Core Fault

Overheating and multiple earthing is the main reasons of core fault.. The main causes leading to core failure: core components of iron clamps touch core because of injure. Due to noise and core vibration pressure iron started loosening. Grounding is poor. Iron chips insulation is aging. If the core is not properly installed it is overheating[2]

The most happen failure and fault occur in the transformer protection system . Fig-1 shows generally occur the fault in transformer which is given in the percent(%) [14]

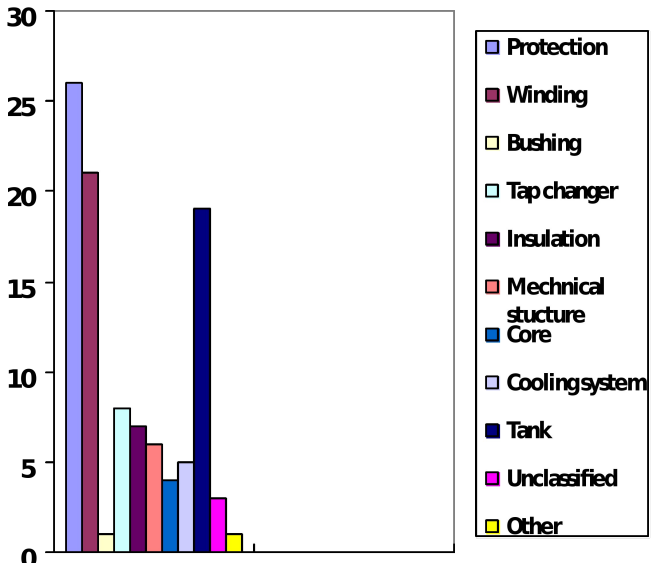

Figure 1 failure in transformer

IV. Transformer Condition Monitoring Techniques

According to different types of faults of transformer are classified as external faults and internal faults. External faults can be define as a faults which can be occurred outside or surface of transformer as well internal fault can be define as a faults which can be occurred in (insulation, winding)inside in transformer. It would cause serious damage in transformer. Due to internal fault 70 to 80 percent of transformers are failures. For the life whole life of transformer these effects should be evaluated.condtion monitoring can be classified as follow:

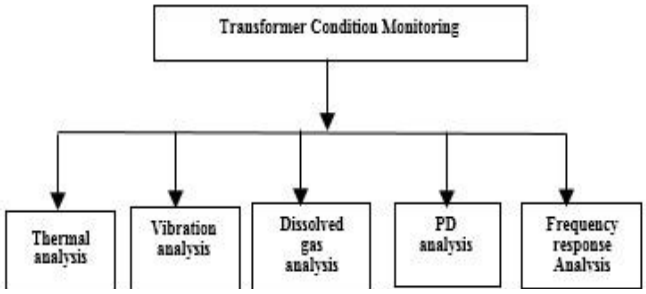

Figure 2 Transformer Condition Monitoring Techniques

A. Thermal analysis

For detection of fault and condition monitoring of transformer thermal analysis is used [4].Thermal behavior of transformer can be also change because of different fault occur in transformer.analyzing of HST might be discover by uncommon condition occur in transformer.In transformer Overload is the most common condition for analysis of thermal techniques (Young 1998).

B. Vibration analysis

Mechanical defect is the most common reason to do vibration monitoring. In vibration monitoring data of vibration signal take and identify the fault in transformer as well as they compared with different techniques of transformer health condition monitoring methods[4].

Vibration of winding, vibrations of core, and on load tap changer vibrations can be included in vibration analysis (Antipov et al 1996- Patel 1973 – Holm et al 1985-Hiraishi et al 1971- Shengchang et al 2001- Kang & Birtwhistle 2001).

C. Dissolved Gas Analysis

Dissolved gas analysis is the one of chemical technique.[1] Since 1928 monitoring of transformer first effective test that was dissolved gas analysis technique. In last 25 years there is different different methods of analysis has been done for monitoring of transformer. Lot of important data expertise has been done.it has been done for analysis gas contain in transformer oil.

A cellulose which is made of transformer board,soild insulating matrial,pressboard,paper transformer oil they are make fault gases produced by mortification[1]. For the operation of transformer the gases which produced mainly they can be summarized as follow in table 1.

Table I Names of produced gases in operation of transformer

Name of Produced gases	***Key gases produced***
HYDROCARBONS	C_2H_4, C_2H_6,CH_4
CARBON WHICH INCLUDE OXIDES	CO_2,CO
ENVIRONMENTAL GASES	O_2, NO2

Uncommon gases can be divided into three types:

1) Partial discharge, corona

2) Heating of thermal

3) Arcing

Due to cause of corona cellulose and oil hydrogen gas is produced that is accepted everywhere. Low temperature occurs because of production of ethane and methane. Due to heating of oil thermal heating affected to temperature and it increases as well it will produce CH_4, C_2H_4, and H2. When increases tempeture, it go very high and presence of an arc at that time acetylene produced.

D. Partial discharge

Partial discharge is the local dialectical discharge of which particular area can be considered as liquid insulation system or solid insulation system .In Transformer partial discharge is responsible for failure of insulation. The magnitude of partial discharge generally less it is the reason of progressive collapse.

There are different techniques for detection partial discharge is the conventional method. According to standard IEC 270 partial discharge can be done in influence place because it cannot easy used in clangor atmosphere. [1] Cause of partial discharge TEM waves generated and it is picked up by broadband filter, antenna for satisfactory frequency area between 500MHZ to 1000MHZ [15].

Under research laboratory condition we got the major data about fault, partial discharge patterns and PD processes. because of complicated structure of transformers, exact location of PD is very difficult identification of fault region reduces the compensation costs. the importance of partial discharge method, many researches are done in this area[1]. Location methods are classified to acoustic and electrical method. There are mainly two types of PD patterns are determined in transformer:

1) Regular partial discharge pattern

Power transformer feature (characteristic) for pattern which in good shapes that can be called as regular partial discharge pattern.

2) Irregular partial discharge pattern

Power transformer feature for patterns which show the unsupportable partial discharge sources that can identify failure of insulation after ageing effects during life of equipment after construct.

E. Frequency Response Analysis

The methods that are analysis before such as vibration analysis, thermal analysis, dissolved gas analysis are relate for transformer condition monitoring and each has their own advantages. Frequency can be change due to vibration and network fault. In faulty condition high current flow after for that need test of frequency response analysis [12].

FRA is the sensitive and power full method. It is also called finger print method. It is used for core testing, winding press frames and mechanical integirity.At different frequencies, the terminals of winding of transformer apply the sinusoidal voltage to sweep generator by used of frequency response analysis method [12].

The Frequency response analysis contains number of resonant frequency. In winding each of resonant frequencies similarly to winding section in that they can be parallel or series resonant circuit. Identification of winding use

Frequency response analysis method can be igneous by comparing the fingerprints of a good condition winding [12].According to input signal frequency analysis can be classified in to two types:

1) Impulse Frequency Response Analysis

2) Sweep Frequency Response Analysis

By further Examination of response of dissimilarity signature of winding give the sign damage in transformer. It can reduce the accidental mainatnce cost .a specify phase winding can be repair when damage occurred it is main advantage of FRA analysis.

Table II Summary of Different Diagnostic Techniques Styles

Methods	**Different Diagnostic Techniques**	
	Test	***Use at:***
Thermal analysis	Continuously measured as a function of temperature	Manufactures
Vibration analysis	Health condition of core and windings	Many research labs
Dissolved Gas Analysis	Arcing, Ageing of oil & paper	Ttransported and used on site, laboratories
Partial Discharge	Identification of the insulation system	Mainly utilities
Frequency Response Analysis	The terminals of a transformer winding	Laboratories

References

[1] Dhingra Arvind , Singh Khushdeep , Kumar Deepak“ Condition Monitoring of Power Transformer: A Review’’2008 IEEE

[2] Zhang GuangMing1, Jiang GuoLian1, Xie ZhiXun1, ’’Techniques of On-line Monitoring and Diagnosis for Transformer, ’’ Transformer’’The International Conference on Advanced Power System Automation and Protection, vol. 2. , 2011, pp.68-73.

[3] D. H. Shroff and A. W. Stannett, “Review of paper aging in power transformers,” in Proc. Inst. Elect. Eng. C, vol. 132, no. 6, pp. 312–319, 1985.

[4] J. Fabre and A. Pichon, “Deteriorating processes and products of paper in oil,” in Proc. Cigré Conf, 1960.

[5] Mehdi Nafar,Bahamn Bahmanifirouzi and Masoud Jabbal“Transformer Monitoring by using Vibration Analysis”, Australian Journal of Basic and Applied Sciences,2011

[6] Sajidur Rahman, Shimanta Kumar Dey, Bikash Kumar Bhawmick and Nipu Kumar Das “Design and Implementation of Real Time Transformer Health Monitoring System Using GSM Technology” International Conference on Electrical, Computer and Communication Engineering (ECCE), February 16-18, 2017

[7] Ahmed E. B. Abu-Elanien, and M. M. A. Salama, Survey on the Transformer Condition Monitoring Fellow, IEEE

[8] Vadirajacharya.K,Harish Kulkarni,Ashish Karche “Transformer Health Condition Monitoring Through GSM Technology”international Journal of Scientific & Engineering Research December 2012

[9] T.S.Madhavrao, “Power System Protection-Static Relays” in TMH Publication ,1979

[10] Y. Han and Y. H. Song ‘’Condition Monitoring Techniques for Electrical Equipment—A Literature Survey’’2007 IEEE

[11] Ali Kazemi & Casper Labuschagne ,“Protecting Power Transformers From Common Adverse Conditions”,paper presented at the Ga-Tech and the Western Protective Relay Conferences, New Berlin” in 2005

[12] Ahmed E. B. Abu-Elanien, and M. M. A. Salama,’’ Survey on the Transformer Condition Monitoring,Fellow, IEEE

[13] P. M. Nirgude, B. Gunasekaran, Channakeshava, A. D. Rajkumar and B. P. Singh, “Frequency Response Analysis Approach for Condition Monitoring of Transformer,” in proc. Annual Report Conference on Electrical Insulation and Dielectric Phenomena, 2004

[14] Shayan Tariq Jan, Raheel Afzal, and Akif Zia Khan” Transformer Failures, Causes & Impact”International Conference Data Mining, Civil and Mechanical Engineering (ICDMCME’2015) Feb. 1-2, 2015 Bali (Indonesia)