Monitoring of Power Transformer Incipient Fault

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Abstract

Power transformers are expensive and important component in power system. Insulation behavior, loads tap changer performance, temperature and load condition is the knowledge of actual status of the transformer. This is necessary in order to evaluate the service performance concerning reliability, safety and availability. System abnormalities, switching, loading, ambient condition are contribute to aging and failure. In this paper present the causes in the power transformer. Monitoring system will be valuable for preventing damage to the transformer. The faults and online monitoring are also analyzed.
Keywords: monitoring, power transformer, fault, failure, and aging

I. INTRODUCTION

Power transformers are ones of the most important components of power system. These devices are used in service under different conditions such as mechanical, electrical and environmental etc.
These devices are very costly therefore monitoring systems are valuable to stop the damage of transformers.
The shutdown of the attached generation unit is cause by the fault of step-up transformer in a power generation plant. The thousands of homes are leave without heat and light because the fault of a distribution transformers.
The Speaking and monitoring is the observation of transformers condition. There are two types of monitoring such as offline monitoring and online monitoring. In offline monitoring, the transformer are switched off in order to measure data. And in online monitoring, the dada can be obtained while the transformer is operating.
The incipient fault diagnosis in power transformers are starting from the new research outcomes. The aim of this paper is to study different methodologies of incipient fault monitoring. To develop a new monitoring procedure for power transformer.

II. TYPES OF FAULTS

There are two types of faults
1) External fault
2) Internal fault
The faults that occur within the transformer protection zone are internal fault.
Internal faults transformer can be divided into two types. Internal short circuit faults and internal incipient faults. Internal short circuit faults are generally turn-to-turn short circuit or turn to earth short circuits in transformer windings.

Transformer faults are cause is show that the winding failures most frequently. During transformer through faults are created insulation deterioration, often the result of moisture, overheating, voltage surges, vibration, and mechanical stress. This is also the major reason for winding failure.

The cause of transformer fault is voltage regulating load tap changers, when supplied, rank as the second most likely. Mechanical switching mechanism, high resistance load contacts, insulation tracking, contamination of the insulating oil or overheating is the causes of tap changer failures.

Bushing is the third most likely cause of failure, contamination, cracking, general aging, internal moisture and loss of oil is the all cause a bushing to fail.

The another reasons of the bushing are vandalism and animals that externally flash over.

Transformer core problems are caused by core insulation failure, an open ground strap or shorted laminators. Other consisting of different types of failures are caused by current transformers, oil leakage due to inadequate tank welds, oil contamination from metal particles, overloads and overvoltage.

For failures and accelerated deterioration some factors are responsible which is given below:

- operating electrical environment: load current, lightening, short circuits and switching surges.
- operating physical environment: wind, rain, pollution, temperature.
- operation of tap changer
- operating time: time under abnormal conditions, time in service.
- contaminants: presence of oxygen, moisture and particles in oil.
- effect of vibration: material fatigue and sound.

Table 1. shows the correlation between the causes and faults [2], [4-6]

One fault type is more than one cause. For example: arching and overheating of cellulose is the cause of winding turn-to-turn short circuit; arching and corona discharges is the cause free water or excessive moisture in oil, etc. This makes fault location very difficult.

Table 1:
Correlation between Internal Faults And Causes

Causes	*Faults*
Winding open circuit	*Arcing, overheating of cellulose*
Winding turn to turn short circuit	*Arcing, overheating of cellulose*
Operation of build in LTC	*Arcing*
Free water or excessive moisture in oil	*Arcing, corona*
Floating metal particles	*Arcing, corona*
Overheating	*Overheating of cellulose, Overheating of oil*

III. METHODOLOGY

Dissolved gas analysis are become a very popular technique for monitoring. As various Faults developed, it is known that the different gases are generated. When we take sample of mineral oil in transformer, then it can determine which gases are present & their levels of concentration.

By theoretically, Researches have been done for gaseous hydrocarbon formation mechanism with the thermodynamic equilibrium.

It indicates that the hydrocarbon gases with the fastest rate of evolution are methane, ethylene & ethane & acetylene.
Some studies focused on key gases & then they can identify the faults.
In table 2. shows the relationship between key gases & types of fault.

In case of key gases analysis, a Fault condition is indicated. When excessive generation in there any of these gases.
For this effective, some expert experience is needed.

Table 2:
Relationship Between The Fault Type And Key Gases

Key gas and chemical symbol	*Fault type*
Hydrogen(H_2)	*Corona*
Carbon monoxide(CO) & Carbon dioxide(CO_2)	*Cellulose insulation Breakdown*
Methane(CH_4) & ethane(C_2H_6)	*Low temperature oil breakdown*
Acetylene(C_2H_2)	*Arcing*
Ethylene(C_2H_4)	*High temperature oil breakdown*

For example: Acetylene concentrations that more the ethylene concentrations. It indicates that arcing is occurring in the transformer which is extensive. Hence, arcing is produces acetylene.

In addition to gas in oil, the fact is an accepted that the presence of water is not healthy to power transformers. Water is oil is indicates that the paper aging. When the cellulose insulation used in power transformers then it is known to produce water. When it degrades the water & oxygen in the mineral oil it further increases the rate of insulation. It means that the higher concentration of water in oil not only indicates that the insulation is degrading but also it degrade more quickly in the Future, water in the oil is mention the sign of the mineral oil when it is deteriorating.
When the mineral oil deteriorates, it decreases the dielectric constant of the oil.

The method of key gas is identifies the types of Faults & uses he percent of this gas for diagnose the fault. The results of dissolved gas analysis is interprets the simple set of Facts. In table 3. Shows that the diagnostic criteria of key gas method.

Table 3:
Diagnostic Criteria Of Key Gas Method

Key gas	*Criteria*
Acetylene(C_2H_2)	*Minor quantities of CH_4 & C_2H_4 & large amount of H_2 & C_2H_2. CO & CO_2 may also exist if cellulose is involved.*
Hydrogen(H_2)	*Some CH_4, large amount of H_2, with small quantities of C_2H_6 and C_2H_4. CO &CO_2 may be comparable if cellulose is involved.*
Ethylene(C_2H_4)	*Less amount of C_2H_6, large amount of C_2H_4, some quantities of CH_4 and H_2.Traces of CO.*
Carbon monoxide(CO)	*Large amount of CO and CO_2 . Hydrogen gases may exist.*

Moisture and dissolved gas analysis are the one of the method of monitoring. It is helpful for detecting types of failures that can occur in transformer. Partial discharge is also most effective method to detect the failure in the electric system. It is used for to measurement the pending failure in the system. In the transformer, electrical insulation is degraded and breakdown, it localized discharges within the insulation in electrical.

Every discharge deteriorates the insulation material by the high impact of electrons, it causing chemical reactions. It occur only right before failure high occurrence of partial discharges are indicate voids, cracking, contamination or abnormal electrical stress in insulation [2],[4-6].

For on-line detection, a partial discharge is the use of acoustical sensors mounted external to the transformer. The difficulty by using acoustical sensors in the field .however, the difference between internal transformers is partial discharges & external partial discharges source. It discharges from the surrounding of power equipment. Another method is recently proposed by the differentiate between internal & external partial discharges. It is based on the use of signals from capacitive tap &inductive coil fitted around the bushing.

The advantage of partial discharges, sensors is the most important to detect the actual location of insulation deterioration, otherwise the dissolved gas sensors.

The Disadvantage of partial discharge, sensor is greatly affected in the substation environment by the electromagnetic interference.

One simplest & most effective way to monitor the transformer externally. Temperature sensors are used to detect the Fault. Temperature readings always indicate type of failure in the transformer. The transformer begins to heat up & the winding insulation begins to deteriorate. The dielectric constant of mineral oil begins to degrade.

In this way on-line monitoring possible, thermocouples are placed externally in the transformer. It provides real –time data at various locations on the transformer. In lot of applications, temperature sensors have been placed externally in order to estimate the internal state of the transformer.

The breakdowns of the insulation are the cause catastrophic failure. The life of a transformer is predominantly shortened by its accessories. These include the accessories. These include the bushings, load tap chargers &cooling system.

The causes of bushing Failures include charging dielectric properties. It contains age, oil, leaks, design or manufacturing Flaws, or the presence of moisture, sensors are created to monitor health of bushings. Busting has a Finite life.

Overhead load tap changers are one of most important method of monitoring of power transformer. The results of overheated load tap changers are the different phenomena. These causes include misalignment, coking & loss of spring pressure. The temperature cannot measure easily; the overheating will generally result in increase in load tap changer oil temperature. By monitoring of load tap changer, the flashover between the contacts can be avoided. Results in the shorts circuit regulating winding and sub sequent failure of the transformer [2].

Vibration analysis is the method to predict many faults associated with transformers. Another useful to help determine the condition of transformer. Core segments, loose winding, shield problems, loose parts or bad bearings on oil cooling pumps or fans are the result of vibration from loose transformer. All are the different transformer; therefore, to detect the vibration test should be run. Then data recorded for comparison with future tests.

Vibration analyzers are used for measure and to detect the vibration. From this information the test may indicate maintenance is needed for the pump or fans mounted external to the tank. This test gained the ultrasonic and sonic faults detection tests and dissolved gas analysis. It may also show the internal transformer inspection is necessary. If wedging is displaced due to paper deterioration, faults and vibration will increase.

IV. CONCLUSIONS

Power transformers are the major device in power system. Their reliability not only affects to the availability of supplied area, but also affects the operation of utility. To determining the condition of transformer is useful for making short –term decisions regarding operation and maintenance.

The power transformer incipient fault is that they decrease the electrical and mechanical integrity of the insulation system. Incipient faults are classified in major categories which are as follows: electrical corona, electrical arcing, overheating of cellulose, overheating of oil. These faults are caused by many causes.

A monitoring system is used to identify the faults which appear in the transformer. This allows establishing a strategy of monitoring regarding the diagnosis of the power transformer faults.

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