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Condition Monitoring Of Transformers by Incipient Fault Diagnosis –An Overview

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Abstract:-*In the changing Global Scenario of Power sector reorganisation Incipient faults of power transformers are of great concern as initially they may not present themselves but with passage of time they become a major reason behind malfunctioning of power system, Right from simulation and application of artificial intelligence techniques up to Dissolved gas analysis various approaches have been made to handle the situation*

Keywords:- *Incipient faults, Condition Monitoring, Frequency response analysis*

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I. Introduction:-

A transformer is a static electrical device used in electric power systems to transfer power between circuits through the use of electromagnetic induction. Transformers are devices that transfer energy from one circuit to another by means of a common magnetic field. When an alternating current flows in a conductor, a magnetic field exists around the conductor. If another conductor is placed in the field created by the first conductor such

that the flux lines link the second conductor,then a voltage is induced into the second conductor.The use of a magnetic field from one coil to induce a voltage into a second coil is the principle on which transformer theory and application is based. Transformers range in size from thumbnail-sized used in microphones to units weighing hundreds of tons interconnecting the power grid. A wide range of transformer designs are used in electronic and electric power applications. Transformers are essential for the transmission, distribution and utilization of electrical energy.

The term power transformer is used to refer to those transformers used in the generator and the distribution circuits, and these are usually rated at 500 KVA and above. Power systems typically consist of a large number of generation locations, distribution points, and interconnections within the system or with nearby systems, such as a neighbouring utility. The complexity of the system leads to a variety of transmission and distribution voltages. Power transformers must be used at each of these points where there is a transition between voltage levels.

II. Transformer Faults:-

Transformers are prone to variety of faults :

1. The most common type of fault being the winding to core faults because of weakening of insulation. Phase faults inside the transformers are rare. However, such faults may occur on terminals, which fall within the transformer protection zone.
2. Power transformers are generally provided with on-line tap changing (OLTC) gear. This is another major area of occurrence of fault.
3. All large transformers are oil immersed type. There is a possibility of oil leakage.
4. Transformers experience large inrush currents that are rich in harmonic content at the time of switching if they happen to be unloaded.
5. A transformer may develop inter turn faults giving rise to local hot spots within the winding.
6. Transformers may suffer from over fluxing due to under frequency operation at rated voltage. Over fluxing may also be caused when the transformer is subjected to over voltage at the rated frequency.
7. In case of sustained overload conditions, the transformer should not be allowed to operate for long duration. [1,2,3]

Condition Monitoring:- Condition-based maintenance (CBM) is a maintenance strategy that monitors the actual **condition** of the transformer to decide what maintenance needs to be done. CBM dictates that

maintenance should only be performed when certain indicators show signs of decreasing performance or upcoming failure. Machine condition monitoring is important because it provides information about the health of a machine. We can use this information to detect warning signs early and help your organization stop unscheduled outages, optimize machine performance, and reduce repair time and maintenance costs.

Traditional Techniques:-

1. Percentage differential protection
2. Restricted earth fault protection
3. Over current protection
4. Protection against over fluxing
5. Protection against overheating
6. Protection against incipient faults

Approaches for diagnosis of incipient faults :-

Traditionally the Bucholz`s Relay has been raising the alarm by sensing the incipient faults but restructuring of power markets has brought to the forefront the need for condition based maintenance in place of scheduled maintenance in order to ensure operating the transformer close to its rated parameters , prevention of forced outages with the related consequential costs (3)

Mirrasoul J. Mousavi et.al have Indicated the use of primary and secondary voltages and currents, during such faults. Unique characteristics derived from this data would be then used as the basis in developing a transformer incipient fault detection method. the models proposed in [4] were utilized to simulate various incipient fault scenarios at different degradation levels of the transformer winding insulation. The models were implemented using commercially available software called Ansoft SIMPLORER® (version 6.0) [5]. This software package provides appropriate tools and features to simulate and analyze complex systems.

The transformer internal incipient fault computer model[3] is a combination of a two-dimensional nonlinear finite element analysis internal short circuit fault model and deteriorating insulation model consisting of an aging and an arcing component.[4,6] results of simulations of various incipient fault case using SIMPLORER® software have been analysed and conclusions indicate fast diagnosis of results.

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.[7].

Since the past, there have been many works conducted on the applications of artificial intelligence and optimisation in condition monitoring on power system component s and fault diagnosis, including transformer incipient fault diagnosis [8–12].These include artificial neural network (ANN), fuzzy logic, rough set theory, support vector machine(SVM) and genetic programming. One of the most widely used artificial intelligence methods in transformer fault prediction is artificial neural network (ANN) [13,14,15].ANN is widely used due to it can learn from the training data directly and th complexity of computation in ANN is less. It is also adaptive, able to handle various nonlinear relationships and can generalize solutions for a new data set [16].ANN directly implements the association process of inputs ,where for transformer incipient fault prediction ,it is the gas concentration and the outputs or fault type. Hence, physical model and a predefined correspondence function are not required[17] .

Frequency response analysis (FRA) is also proved to be one of the successful diagnostic in transformer fault diagnosis. In FRA the admittance is measured over a wide range of frequencies and the results are compared with a reference set. Any deviation in these two sets of measurements indicates a fault in the transformer winding. In general this method is adopted to assess the mechanical deformation of transformer winding under the influence of short circuits. Although it is a popular method, it requires additional instruments for fault detection and also it always needs an evidential reasoning (ER) approach [14].

Combined Artificial Intelligent (AI) techniques with wavelet transforms is proposed in [18-19] for power transformer fault diagnosis. However these methods need much computation and more memory requirement and hence they require large number of processors and instruments.

III. Conclusions:

From above brief review it can be concluded that simulation techniques are faster but at times may lead to near correct results which may be insufficient to initiate protection gear on the other hand artificial intelligence techniques are still in the developmental stages Dissolved gas analysis gives results but generation of gases can be triggered by other real time situations also. In the long run a combination of all the three techniques may prove to be an important tool in incipient fault diagnosis of power transformers

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