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ONLINE INTERNAL FAULT IDENTIFICATION IN TRANSFORMERS BASED ON DIRECTION AND LOCATION OF MAGNETIZING SIGNATURE PATTERNS

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ABSTRACT

The transformers are designed to transmit and distribute electrical power. Depending on the size of the requirement, replacement costs will be more if any fault occurs. Performing offline and invasive test also added to the replacement cost. Hence there is an increasing need to move from traditional schedule based maintenance programs to condition based maintenance. A large number of techniques are available for transformer health monitoring however a focused approach is required for diagnostics. Considering the long service life of a power transformer and prevalent use of human judgment, there is a need to structure a knowledge base around expert knowledge while continuing to create new diagnostic capabilities which can be plugged in. A novel method of online detection of the faults in the transformer is done by using the spectral signature of the flux emitted by the transformer during the running condition. In the flux based transformed fault identification region based fault can be detected at the earlier stage. From the experimental result it has concluded that flux based fault detection is efficient method for prefault detection when compared to the existing method. The flux based fault discrimation in transformer is more efficient.

Keywords: *Electromagnetic Flux, Transformer Faults, Predictive Maintenance, Spectral Signature, Flux Sensor*

1. INTRODUCTION

In electrical power systems the transformer plays a vital role in the supply of power in quality. The internal faults may be considered as the major root cause for the quality less of power supply as well as the breakdown in the transformer. In electrical machines the condition monitoring has been done by using vibration techniques is the traditional method of online condition monitoring. In the vibration based condition monitoring of electrical machines there is a big disadvantage is that the mounting of the sensors and cost of the sensors. The sensor mounting on the transformer can able to detect only the fault occurred in the region where the sensor is mounted. The regions where the sensor cannot be mounted and their faults in those particular regions cannot be detected. In vibration based condition monitoring placing the sensor plays a vital role for the data acquisition of vibration signals, improper mounting of sensors will lead to the noise in acquired signals.

For reliable operation of the electrical machines initial depend on simple protection like over current, overvoltage, earth fault. The usage and efficiency of the electrical machines grows day by day. So the improvements in area of fault diagnosis also are more needed. Though there are potential measurement and diagnosis of fault diagnosis are available like speed fluctuations, current, electrical surge, temperatures, gas analysis, acoustic. These fault diagnosis are useful for offline fault detection and prefault detections cannot be identified. The flux based condition monitoring has potential information richness more when compared to the vibration. The flux measurement based online condition monitoring can be done in hourly based and the operator skill required for the flux based condition monitoring is less. The cost for the condition monitoring is less and the prefault

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detection in the machines can be done easily and efficiently with more accuracy. The flux based condition monitoring is done in electrical machines like linear Induction motors. In the linear induction motor the eddy current and secondary core flux density distribution are analyzed. The magnetic flux in the linear induction motor air gap reduces the various losses such as fringes effect. This was analyzed by using the COMSOL software[1].A new design of flux probe, installed on a stator tooth with new algorithms in the hardware and software with different load conditions, an efficient and reliable diagnostics was implemented in the generator rotors[2].Many researchers had done the fault detection of machines using the stray flux. In the leakage flux measurements are done by using probes. The flux leakages in motors were used for the fault identification of stator and rotor. In the power transformers the leakage flux is used for the insulation fault detection. In this paper transformer the stray flux are used for the internal faults identification. In the power transformers the leakage flux are curved at the winding ends and the flux flows through the air and parallel direction to the winding axes[3].The machine shield and coils distance affects the degree of curvature of the lines. The authors so far proposed the leakage flux for fault detection. The stray flux has its sources in transformers according to the ampere law. The stray flux is also due to the imperfection of the materials boundaries, internal faults like line to ground fault, turns to turn faults, fault due to the secondary short, and insulation failure. The authors proposed algorithms for protection in the three phase winding transformer using the increments of flux linkages. They suggested six detectors for fault identification and they also suggested the rule for the faulted phase and winding identification. The data shows the discrimination in the internal faults from normal operating condition and inrush, over excitation [4].The Researchers are simulating the flux saturation for inrush current in the transformers using electromagnetic transient program. The flux signal of the transformer are given as an input to the wavelet transforms and form the transformation results they were able to detect the inrush current from the transients. The simulation result proves that the flux is the suitable signature for the identification of the transformer faults [5].Still many new approaches are being done in the fault detection of the transformers. The relationship between integral values of voltage and current valves was proposed to discriminate inrush current with help of magnetization characteristics. They also validated the proposed method using the test data obtained. They also suggested that the transformer magnetizing character is the best approach and fast approach for the fault identification and it is also a fast protection system using this method of distribution system [6].A huge number of studies are done for detecting inrush currents were made and a methods like monitoring active flow of power in transformer [7], signatures of current and voltages similar features are used. By using the equivalent circuit of the transformer for detection the inrush current [9].Many new concept in fault detections and removing the fault in distribution systems are done by using FRIENDS- flexible reliable and intelligent electric energy delivery systems [10]. a new protection method was introduced to detect and identify transformer winding fault using principal component analysis and they also proved that the magnetizing property of the transformer were able to distinguish between the fault and magnetizing inrush current.[11].All the existing methods uses a Fast Fourier Transform (FFT) or a wavelet technique (WT) for analyzing dynamic and transient signals such as transformer incipient faults only by simulations or by the test signals collected from the line currents. This procedure is not suitable for analyzing transient signals obtained from power systems[12]. In [13], PCA technique was utilized for monitoring power transformers. They used the chronological data of distribution transformers to assess distribution transformer's most favorable operation is preprocessed by PCA.

2. METHODOLOGY

A Transformer of 3KVA is taken for the study purpose. The transformer when it is in normal condition without any fault, the stray flux is captured by using a simple air core coils. The sensor is able to provide electrical quality signals sensitive to the conditions which alter the electrical characteristics of the transformer, such as line to line faults etc. The voltage captured by the sensor is directly proportional to the rate of change of flux. The flux captured by a simple air core coil is then given to the Data acquisition system. The specification of the data acquisition is that of 2 channels, 16 bit, sampling rate is 22050Hz with block length 4096 samples. The refresh rate is of 5.38per second. The decimation used for the data acquisition is of 1:1 ratio the data acquisition captures the amplitude of five volt signal. The capture signal of flux form sensor coil to data acquisition and then flux is analyzed using matlab software for the spectrum analysis. In the transformer the various faults like line to ground

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faults, turns to turn faults are made for the study purpose and those faults and these flux signals are been captured for individual faults. Then the flux signals also captured for the combination of two or more various faults in the transformer. From the flux signals due to different faults occurred, individual and combined faults and without faults, a database has been created for the specific location of the sensor. Then the next database of flux signals for the normal transformer and the faults are created in the same transformer with individual faults and combination of the faults with different location of the sensor over the transformer is collected. Then the third databases of the flux signals are collected when the normal transformer is changed from normal condition to fault condition during the load condition. These flux signals I called as the on line condition flux signals. Then the fourth database of the flux signals is that the fault transformers and good transformers with different combination of the faults, captured by moving the flux sensor from specific direction over the transformer and then the signals from the sensor without any specific direction the signals are been collected. All these signal database are then analyzed through the flux spectrum of the signals and the each spectrum of flux signals are categorized by the fault location , state and cause are noted down. The qualities of the database of the signals are also verified by comparing the some test flux signals from the new transformer with same rating and same manufacturer. Then flux signals from the different manufacturer with same transformer rating are also compared for the quality of database. Figure. 1 explains the real time data acquisition of the system setup with transformer and digital storage oscilloscope.

Figure.1 Complete setup

3. EXPERIMENTAL RESULTS

The signal of normal transformer is captured in the Digital Oscilloscope as in the Figure 2.

Figure 2.Normal wave

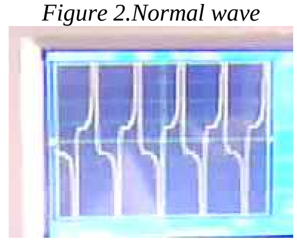

Figure 3.Turn to turn short circuit fault

The Figure 3. is the Turn to turn short circuit fault. and in the Figure 4. Starting inrush current signals are displayed.

Figure 4 Starting inrush current

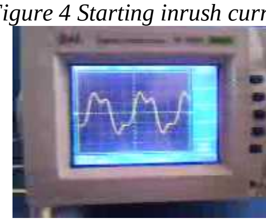

Figure 5.Line to ground fault

In Figure 5 the Line to ground fault and the signal pattern is captured.The Figure 6 shows the Measuring probe and Flux sensor which used for the signal pattern collections.

In Figure 6.Measuring probe and Flux sensor

4. CONCLUSION

From the experimental results it has been confirmed that the flux signature changes according to the internal faults and combining different internal faults is also shows a different signatures. Then the database of different flux spectrum and its statistical values are used for the fault identification of different manufacturers with same rating. However the prefault identification and online defect of the transformers where able to detect more

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efficiently than other existing method. The database accuracy for the fault identification is about 85% is achieved. Further it can be extended for many more faults and different rating of the transformer can be executed with more efficient decision making tools

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