TRANSFORMER MONITORING IN VIBRATION ANALYSER USING CORRELATION TECHNIQUE

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ABSTRACT

The vibration of power transformer windings is studied with the aim of identifying the winding structural condition. The preliminary study shows that it is feasible to predict the mechanical faults of transformer windings with the vibration method. Power transformer is a critical component in energy transmission, and its failure can cause catastrophic social loss. Among many techniques to prevent the transformer failures, ones using vibration signals show good capability of detecting the mechanical faults. Condition monitoring techniques are illustrated in this paper and then the transformer oil-tank vibration is investigated as a main technique for transformer condition monitoring. There are known methods to measure transformer oil-tank vibration, but without measuring the current simultaneously with vibration, the decision can be false. To reach this goal two main parts must be examined (windings and core) by making tests on the site. Vibration analysis extended with the measurement of currents and voltages offers a robust method to plan maintenance. The aim is to find correlation between current and vibration which represents correctly the state of the transformer winding. While vibration is caused by the windings the electrodynamic forces, the magnetostriction effect makes the core to vibrate. Separation of these sources would be advantageous, but it is essential to find out if they are correlated or not? This method hopefully gives an important benefit, after an accurate state estimation the transformer may be repaired on site if it is needed. With more than one accelerometer, it is possible to predict which winding should be repaired in case of three phase transformer.

KEYWORDS; Power transformer, vibration method, winding deformation, condition assessment, correlation analysis

INTRODUCTION

Power transformer asset management has been generally considered to be one of the most important power system apparatus asset management’s. The major factors that affect the system reliability. Since large power transformers are the most expensive and strategically important components of any power generator and transmission system, their reliability is crucially important for the energy system operation. Thus the number of maintenances should be the possible minimal over its lifetime. It is highly desirable to develop methods that allow diagnosis failures in the transformers when they are in an incipient stage, that’s the reason why in the last years power transformer monitoring and diagnosis techniques have increased their popularity.

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RELATED WORKS

In [1] Zhejiang University et al presents Condition monitoring and fault diagnosis of power transformer using vibration analysis method has attracted great attention. This paper presents a transformer vibration model under short-circuit condition, which consists of two sub-models. One is a vibration model of internal windings, and the other is a signal transmission model. In the laboratory tests, the parameters in the model is measured using data set sampled in single phase short-circuit tests. Then with this model, the estimated vibration signals of the same point can be calculated by employing the input current only. In order to validate the whole model, three phase short-circuit tests are taken, and the results show a good agreement between estimated signals and measured signals.

In [2] Henryk Herman GnoSys UK Ltd Guildford, UK et al presents The residual lifetime of primary and secondary insulation materials is a critical parameter for many electrical materials, especially when in service. The analysis of epoxy impregnated materials with conventional techniques is a particularly difficult one, as this often requires removal and repair of at least part of the insulation. We have investigated methods based on reflectance spectroscopy that demonstrate the ability to predict the temperature to which carefully air-aged epoxy-impregnated glass mats have been subjected. The resulting calibrations also provide excellent predictions of the exposure time at a known temperature. Using a time-temperature superposition function based on first-order kinetics to rationalize the widely different temperatures and exposure times examined in our samples, we found that the correlation of this combined function with the reflectance spectra was much better than with temperature or exposure time on their own. The calibrations are constructed using multivariate statistical methods, and one of the outputs is a spectral regression coefficient that shows which chemical components are correlated with the cumulative ageing metrics, and so give insight into the strengths and weaknesses of the resin composition under conditions of use.

In [3] Yuanhong Wu, Yonglong Yan, Tianyan Jiang State Key Laboratory et al presents In order to assess and improve the reliability of wind turbine generators (WTG), and to optimize the maintenance strategy, it is necessary to use online monitoring data acquired from supervisory control and data acquisition (SCADA) system to assess the real-time operational conditions of WTG. Because the determination of fuzzy membership function is subjective and fails to take randomness into account in traditional fuzzy synthetic condition assessment, this paper presents a method for real-time condition assessment of WTG based on fuzzy cloud theory. The cloud model is used to describe the fuzziness and randomness in the fuzzy synthetic condition assessment process of WTG. Based on the actual monitoring data of a 1.5 MW wind turbine generator system within a period of time, the operational conditions are evaluated by using the improved method and the case study indicates the proposed assessment method are reasonable and effective.
In [4] Qingdong Feng and YongLiang Liang et al presents Study on method of condition assessment of substation equipment is the key subject in condition maintenance. This article introduced the application of artificial intelligence methods in the substation equipment condition assessment and different artificial intelligence methods, such as artificial neural network (ANN), fuzzy theory and expert system, are introduced respectively, and their advantages and disadvantages are analyzed in detail; in accordance with feature of multi-sensor information in online monitoring, the application of information fusion in condition assessment gained an important introduction; The assessment method based on intelligence information fusion is recommended to solve the deficiency of single assessment method .. Key words--artificial intelligence; artificial neural network; condition assessment; expert system; fuzzy theory; information fusion

In [5] Hong Hai Huang, Jianping Zhou et al presents In this paper, the vibration of power transformer windings is studied with the aim of identifying the winding structural condition. A winding vibration model coupled with electromagnetic force analysis is proposed to obtain the steady-state vibration distribution along the axial direction. During the experiment, the model was validated on a full size, 50 MVA, three phase power transformer. Good agreement was found between the measured vibrations and the vibrations that were calculated from the model developed in this study for a healthy winding. The effect of the winding clamping force on vibration is studied to assess the winding clamping state, and different types of winding deformations were simulated to extract diagnostic information. The preliminary study shows that it is feasible to predict the mechanical faults of transformer windings with the vibration method

PROPOSED SYSTEM

Many advanced signal processing techniques have been introduced; a good winding condition assessment model using vibration analysis should have a close connection with the vibration mechanism. Then, a reference is needed to judge whether the winding under test is normal. The transformer vibration is so complicated that the individual differences are large for different transformers. So the best way to solve the reference problem is to compare the vibrations collected from different places of one transformer. In this paper, the vibrations from multi-sensors located at different positions on the tank are sampled synchronously. According to the mechanism, a novel method is proposed to extract the winding vibration form the tank vibration. The relation among the winding vibrations from different sensors is studied to obtain the assessment model.

BLOCK DIAGRAM

POWER SUPPLY UNIT

The ac voltage, normally 220V rms, is coupled to a transformer, which steps that ac voltage down to the level of the preferred dc output. A diode rectifier then provides a full-wave rectified voltage that is originally filtered by an easy capacitor filter to produce a dc voltage. This resulting dc voltage frequently has a few ripple or ac voltage variations. A regulator circuit removes the ripples and also remainders the similar dc worth even if the input dc voltage varies, or the load linked to the output dc voltage changes. This voltage regulation is typically obtained by one of the accepted voltage regulator IC units.

BRIDGE RECTIFIER

When four diodes are associated as exposed in figure, the circuit is called as bridge rectifier. The contribution to the circuit is practical to the diagonally differing corners of the network, and the output is taken from the residual two corners.
IC VOLTAGE REGULATORS

Voltage regulators include a class of widely used ICs. Regulator IC units hold the circuitry for reference source, comparator amplifier, control machine, and overload protection all in a single IC. IC units give regulation of also a set positive voltage, a fixed negative voltage, or an adjustably set voltage. The regulators can be chosen for operation with load currents from hundreds of milli amperes to tens of amperes, equivalent to power ratings from milli watts to tens of watts.

PIC 16F877A:

This influential yet easy-to-program CMOS FLASH-based 8-bit microcontroller PIC16F877A packs Microchip’s powerful PIC® architecture into a 40- or 44-pin package and is upwards well-suited with the PIC16C5X, PIC12CXXX and PIC16C7X devices. The PIC16F877A features 256 bytes of EEPROM data memory, self programming, an ICD, 2 Comparators, 8 channels of 10-bit Analog-to-Digital converter, 2 capture/compare/PWM functions, the synchronous sequential port can be configured as also 3-wire Serial Peripheral Interface or the 2-wire Inter-Integrated Circuit bus and a Universal Asynchronous Receiver Transmitter. All of these features make the PIC16F877A ideal for additional superior level A/D applications in automotive, industrial, appliances and consumer applications. The 16F877A is one of the most accepted PIC microcontrollers and it’s easy to see why - it come in a 40 pin DIP pin out and it has a lot of interior peripherals. The 40 pins create it easier to use the peripherals as the functions are spread out over the pins. This makes it easier to choose what outside devices to fasten lacking worrying too much if there sufficient pins to do the job.

RELAY:

A relay is an electrically operated switch. Many relays utilize an electromagnet to function a switching apparatus automatically, but other operating principles are also used. Relays are used where it is required to manage a circuit by a low-power signal with absolute electrical isolation among control and controlled circuits or where numerous circuits must be controlled by one signal. The primary relays were old in long detachment telegraph circuits, repeating the signal coming in from one circuit and re-transmitting it to another. Relays were used lengthily in phone interactions and early computers to do logical operations.

BASIC DESIGN AND OPERATION:

A easy electromagnetic relay consists of a coil of wire wrapped approximately a soft iron core, an iron yoke which provides a low reluctance pathway for magnetic flux, a movable iron armature, and one or more sets of contacts. The framework is hinged to the yoke and mechanically connected to one or additional sets of touching contacts. It is detained in place by a spring so that when the relay is de-energized there is an air gap in the attractive route. In this state, one of the two sets of associates in the relay pictured is congested, and the other put is open. Other relays may have more or fewer sets of associates depending on their purpose. The relay in the picture also has a wire between the armatures to the yoke. This ensures continuity of the circuit between the touching contacts on the armature, and the circuit track on the printed circuit board via the yoke, which is soldered to the PCB.

ALARM

An alarm apparatus or classification of alarm devices gives an audible, illustration or other form of alarm signal about a quandary or condition.

LCD:

A liquid crystal display is a flat panel display, electronic visual display, or video display that uses the light modulating properties of liquid crystals. Liquid crystals do not produce light honestly. LCDs are obtainable to display arbitrary images or fixed images which can be displayed or concealed, such as set words, digits, and 7-segment displays as in a digital clock. They use the identical basic technology, excluding that subjective images are made up of a bulky amount of small pixels, while other displays have better elements. LCDs are used in a wide range of applications counting computer monitors, televisions, instrument panels, aircraft cockpit
displays, and signage. They are ordinary in consumer devices such as video players, betting strategy clocks, watches, calculators, and telephones, and have replace cathode ray tube display in most applications. They are obtainable in a wider range of screen sizes than CRT and plasma displays, and since they do not use phosphors, they do not experience image burn-in. LCDs are, however, vulnerable to image persistence.

SIMULATION OUTPUT

FAULT ANALYSIS

PERFORMANCE ANALYSIS

TRAINING DATA
CONCLUSION

Extracting the characteristic parameters of suitable is therefore has become a common method to analysis of various power equipment vibration signal. On load tap vibration switches and circuit breakers are non-stationary signal in the transient of transformer, so not many methods of rotating equipment to apply, to a certain extent also limits the application of vibration analysis and development in these two areas, the focus of future research is still looking for a suitable signal processing method. Then, the PCA theory is used to analyze the correlation of winding vibrations from different sensors. Two health parameters are proposed in the model, one is MPC, which shows the degree of the vibration correlation, and the other is VHI, which indicates the fault locations if the transformer condition is suspicious. In laboratory tests, the vibrations are compared between a new transformer and the same transformer with man-made winding deformations. The result shows that the fundamental frequency vibration is related to the winding condition. The correlation among different sensors is low for the transformers with deformed winding. The MPC value reflects the winding condition correctly, and the VHI value indicates the fault location accurately.

REFERENCE


[4] Qingdong Feng and YongLiang Liang, “Condition Assessment of Substation Equipment Based on Intelligence Information Fusion”, Innovative Smart Grid Technologies - Asia (ISGT Asia), IEEE 2012


