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Research on On-line Monitoring Technology of Partial Discharge of High Voltage Electrical Equipment

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Abstract

At present, China's electricity industry is developing rapidly, and the demand for electric energy is increasing. The problem with it is the maintenance of high-voltage electrical equipment. Among the many maintenance problems, the electrical discharge maintenance is becoming more common. One of the outstanding issues. In order to ensure the safe and reliable operation of high-voltage equipment, on the one hand, it is necessary to use good insulation materials and improve the manufacturing process to improve the insulation strength of the equipment. On the other hand, it is necessary to check the insulation condition of the high-voltage equipment in operation and keep abreast of it. Partial discharge operation of the equipment. However, the detection technology of partial discharge of electrical equipment is difficult, and there are many interference factors. It is very difficult to realize online monitoring. This thesis focuses on the partial discharge phenomenon of high-voltage electrical equipment, and designs a partial discharge online monitoring system for high-voltage equipment to realize online insulation management of high-voltage electrical equipment.

Keywords

High voltage equipment; partial discharge; online monitoring.

1. INTRODUCTION

The so-called partial discharge refers to the discharge of the electrical equipment in a localized range under the action of a sufficiently strong electric field. This discharge is limited to only causing local shorting of the insulation between the conductors without forming a conductive path. Each partial discharge will have some influence on the insulating medium. The slight partial discharge has less influence on the insulation of the power equipment, and the insulation strength decreases slowly. The strong partial discharge will cause the insulation strength to drop rapidly. This is an important factor in the insulation damage of high voltage power equipment. Therefore, when designing high-voltage power equipment insulation, it should be considered that under the action of long-term working voltage, a strong partial discharge in the insulation structure is not allowed. It is necessary to strengthen the monitoring of the equipment in operation. When the partial discharge exceeds a certain level, the equipment should be taken out of operation and repaired or replaced. Since the electrical equipment transmitted by the electrical system is high-voltage transmission, the charge on the surface area is often very large, so the voltage formed by the partial discharge is also high, and the existence of the high-voltage discharge will affect the working state and performance of the electrical equipment itself. Status and other electrical equipment have an impact, so it is necessary to perform on-line monitoring and maintenance of high-voltage and high-voltage partial discharge of electrical equipment.

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At present, foreign research on on-line monitoring of high-voltage partial discharges of high-voltage electrical equipment is mainly focused on the research of new monitoring sensors. This is mainly due to the fact that in order to achieve on-line monitoring of partial discharge of electrical equipment, it is necessary to detect the presence of discharge charge on the surface of the electrical equipment by a highly sensitive sensor to enable on-line monitoring. At present, the research on the partial discharge phenomenon of high voltage and high voltage in China, in addition to focusing on the detection sensor, also conducts relatively independent research on some large-scale substation equipment, because in China's power system, due to technical strength Restricted, there are many applications of traditional high-voltage electrical equipment such as large transformers, transformers, and coupling capacitors, and the quality of its operation is not high enough, and related technical protection and maintenance measures are not fully in place, so once these high-voltage electrical equipment Partial discharge is formed, which tends to form a high discharge voltage, which will cause certain damage to the electrical equipment itself. It is also not conducive to the stable operation of the electrical equipment, and thus cannot guarantee the normal maintenance of the power system. Therefore, for domestic use, high voltage On-line monitoring of partial discharge of electrical equipment requires online discharge monitoring of the above-mentioned high-voltage electrical equipment. In addition to studying online monitoring sensors, it is necessary to study new online monitoring techniques and methods.

2. ON-LINE MONITORING TECHNOLOGY OF PARTIAL DISCHARGE IN HIGH VOLTAGE EQUIPMENT

2.1. Design of Online Monitoring Scheme

At present, the on-line monitoring of partial discharge in insulating layer of electrical equipment is mainly based on the principle of partial discharge. With partial discharge, electric pulse, electric radiation, ultrasonic wave and light will be generated in transformer, and local overheating will be caused. Discharge in oil will also decompose into gases, resulting in energy loss and so on. Accordingly, there are some measurement methods, such as electric pulse measurement, ultrasonic measurement, optical measurement, infrared measurement, chemical measurement, dielectric loss rate measurement, ultra-high frequency measurement and so on. Some of these detection methods are direct detection of partial discharge, and some are indirect detection of partial discharge. Considering the implementation requirements of on-line monitoring, ultrasonic positioning measurement method can be used to realize on-line measurement of partial discharge. The location of discharge point by ultrasonic positioning has the advantages of strong anti-interference and high positioning accuracy. The on-line monitoring steps of partial discharge in high voltage equipment are as follows: (1)ultrasound signal from discharge point was collected by ultrasonic sensor (2)The collected ultrasonic signals are processed by filtering and analog-to-digital conversion (3)Discharge type and discharge quantity are judged by pattern recognition of the converted ultrasonic signal (4)Calculate the time delay of the converted ultrasonic signal, and calculate the time difference between the ultrasonic signal arriving at different sensors (5)According to the calculated time difference and the spatial coordinates of the sensor, the location of the discharge point is calculated by using the location algorithm (6)The calculated discharge point position is displayed in the corresponding high voltage equipment model by using three-dimensional image.

2.2. Measures for Interference Signal Suppression

In high voltage electrical equipment, it is not easy to realize reliable on-line partial discharge monitoring. Because of the high voltage discharge of the electrical equipment itself, it is very

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easy to form electrical noise interference. Additionally, other unknown factors make the on-line monitoring of partial discharge charge in a strong noise and interference environment. Therefore, how to suppress the interference signal in the process of on-line monitoring partial discharge is also a key problem. In the partial discharge charge of high voltage electrical equipment, there are a lot of harmonic voltage, harmonic current and other noise signals, which constitute a certain obstacle to the on-line monitoring of sensors. Generally speaking, the interference signals of high voltage partial discharge mainly come from the following aspects: Rectifier, Inverter and Frequency Converter; Transformer Group in Power Grid; Larger Single-Phase Power Electronics Device; Controllable Reactor and Saturated Reactor in Static Compensation Device; Components in High-Tech Products, such as Sensitive Electronic Devices, etc. The above-mentioned power electronic devices will generate charge discharge or high-order harmonic current in actual operation, and these factors will interfere with the sensor on-line monitoring of partial discharge of high-voltage equipment, especially inductance power devices, which are prone to produce high-order harmonic current, which will interfere with the normal work of electrical lines. It is easy to cause additional loss of electrical equipment such as motor and transformer, increase heat loss of electrical equipment, decrease rated output power and reduce efficiency. It is also easy to cause accelerated aging of insulation of electrical equipment, shorten the service life of equipment, and then trigger discharge of surface insulation layer of electrical equipment, and often easy to form. High discharge voltage causes damage to electrical equipment. In addition to harmonic current, there are other types of interference, mainly power interference grounding system interference, electromagnetic radiation interference and so on. In a specific test environment, how to distinguish interference signals and what measures to take to ensure the correctness of the test has become a more important issue. The method that can be adopted is to improve the ability of the tester to distinguish the discharge signal waveform from the interference signal waveform, so that the tester can correctly grasp the discharge characteristics of high voltage equipment, the rules of applying voltage and time, and the characteristics of time, position, scanning direction and the relationship curve between voltage and time when discharging.

3. CONCLUSION

The insulation condition of high voltage electrical equipment plays an important role in the stable operation of power system. Therefore, on-line partial discharge monitoring of high voltage equipment can not only ensure the stable and reliable operation of the power system, but also have high research value for prolonging the service life of high voltage electrical equipment itself. The key technologies of on-line monitoring include anti-interference technology, sensor technology, signal transmission technology, data analysis, processing and diagnosis technology. In each link of on-line insulation testing of high voltage electrical equipment, the ability of identifying the waveform of discharge signal and the waveform of interference signal is improved, so that the tester can correctly grasp the characteristics of discharge of high voltage equipment, the rule of applying voltage and time, and the time, position, scanning direction and voltage and time of various types of discharge. The relationship curve and other characteristics can effectively help to distinguish the normal signal from the interference signal. The principle of partial discharge is used to realize on-line monitoring. With partial discharge in transformer, electric pulse, electric radiation, ultrasonic wave and light will be generated, and local overheating will occur. Considering the implementation requirements of on-line monitoring, the over-voltage can be selected. The acoustic positioning method is used to measure partial discharge on-line. The location of discharge point by ultrasonic positioning has the advantages of strong anti-interference and high positioning accuracy.

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