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Analysis of Power Transformer On-line Monitoring and Fault Diagnosis Technology

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Abstract

With the development of power system automation, the requirements for power supply reliability are getting higher and higher, so fault detection of electrical equipment has become the focus of research in power systems. With the increasing importance of condition detection, mature online monitoring and fault detection technology for electrical equipment becomes more and more important. It is not only the basis for condition maintenance, but also can help us achieve smooth operation of electrical equipment and extend the power equipment's life. This paper analyzes the common faults in transformer operation, and then studies and analyzes the theory and practice of online detection technology. Finally, the development trend of detection technology is pointed out.

Keywords

Power transformer; Fault detection; Online monitoring; Technical analysis.

1. Introduction

In modern life, electricity has become an indispensable part of life. As an important part of the power system, the safe operation of a transformer is directly related to the stable operation level and economic benefits of the power grid. When the transformer fails, it will not only lead to regional power outages, but also cause the failure of other power equipment [1]. After a long-term test of production practice, there are some problems with regular maintenance, mainly due to excessive or untimely maintenance. Therefore, with the continuous upgrading of power system equipment maintenance technology, condition maintenance is gradually moving towards people's attention, and it is also a detection trend of whether the power system equipment is in a normal state in the future [2].

According to the working environment of the condition detection, it can be divided into online monitoring and offline detection. Off-line detection is to disconnect the transformer from the operating state, compare and analyze the key mellow and normal operating oil samples of the equipment, and judge the normal operating state or fault according to the change of oil sample chromatogram [3]. Off-line detection is now common, but due to the difference between normal and offline oil samples, there are certain errors in the results, leading to some potential failures, which is not conducive to the stable operation of the equipment. The on-line detection technology uses sensor devices to continuously detect faults and notify them at the first time. It does not need to be powered off, can perform continuous detection, and can detect problems in a timely and effective manner during operation. Danger from accidents. Therefore, online monitoring is an important guarantee to ensure that the transformer can remove faults in time to ensure the stable operation of the power system [4].

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2. Introduction Common faults of power transformers

During the operation of the power transformer, some abnormal situations occur due to its external or internal reasons, which affect the normal work of the power transformer and cause an accident [5].

It is mainly due to the deterioration of insulating materials, including thermal degradation due to normal and overload, the degradation of electric fields causes by overvoltage such as shock, and mechanical degradation caused by external mechanical short-circuit electromagnetic forces and vibration. Common faults are the following.

2.1 Transformer oil leakage fault

Oil seepage fault is the most common fault in transformer failure. Oil-immersed transformers are widely used because of their good insulation performance and strong thermal conductivity, which can solve the problems of large-capacity heat dissipation and high-voltage insulation, but also cause the problem of oil leakage [6].

2.2 Circuit fault

Transformer circuit failure is mainly due to a short circuit in the operation of the power system, mainly a short circuit at the outlet, and a short to ground between the internal leads or windings. Short-circuit fault is the most common and common fault. It cannot be measured with a multimeter, and the inspectors need to rely on their own experience to judge. If the short-circuit at the outlet is small, the faulty windings need to be replaced. If the faulty range is wide, all the internal windings may need to be replaced, which will cause a large economic loss.

2.3 Winding fault

When the transformer insulation is damaged, the windings have sundries entering, and the insulation is aging, it is easy to produce winding fault. It may also be caused by the long-term operation of the winding that causes its temperature to rise and the transformer to deform. Winding faults are relatively complicated. The main realizations are short circuits and cracked interfaces. If a winding fault occurs, the windings need to be replaced, which will cause greater damage to the transformer.

2.4 Connector overheating fault

The current-carrying joint is a bridge connecting the transformer and other parts. The operation of the current-carrying joint directly affects the operating efficiency of the transformer. The overheating of the joint is caused by the long-term operation of the transformer, which causes the temperature at the joint to rise dramatically. Overheating of the connector may cause the electric wire to blow, affect the normal operation of the transformer, and easily cause major safety accidents [7].

2.5 Transformer damp

The damp of the transformer may be due to the leakage of moisture from the internal components, or the external moisture entering the interior with the pipeline. The damp of the transformer will affect its insulation and affect the safe operation of the transformer.

2.6 Multi-point grounding

The transformer can mainly adopt one point grounding and multi-point grounding. The multi-point grounding of the transformer will generate a current loop when it is actually used, which will cause the iron core to malfunction, and cause local heating, transformer oil decomposition and iron core silicon steel sheet deformation. This makes it difficult for the transformer to run normally and safely.

3. On-line monitoring technology and fault diagnosis of power transformer

The online monitoring technology of power transformers is to obtain various early warning information of early failures in time, analyze and process the information, judge the change trend based on the comparison of the values, give a judgment conclusion on the operating status of the equipment and issue an early warning signal. The on-line detection technology effectively prevents

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the development of the fault to a serious degree, and minimizes the serious consequences that the fault may cause. The main components of on-line transformer monitoring include the use of sensor technology to collect equipment status information when the transformer is energized, which mainly includes the collection of characteristic gases and contents in the transformer oil that are related to the occurrence of faults, the application of intelligent algorithms for data processing and analyze and apply the expert system to diagnose the status [8]. The diagnosis results include three aspects, whether there is a fault, the severity of the fault, and the type of the fault. The final decision is made based on the diagnosis [9]. Figure 3-1 is a model diagram of the transformer online monitoring system.

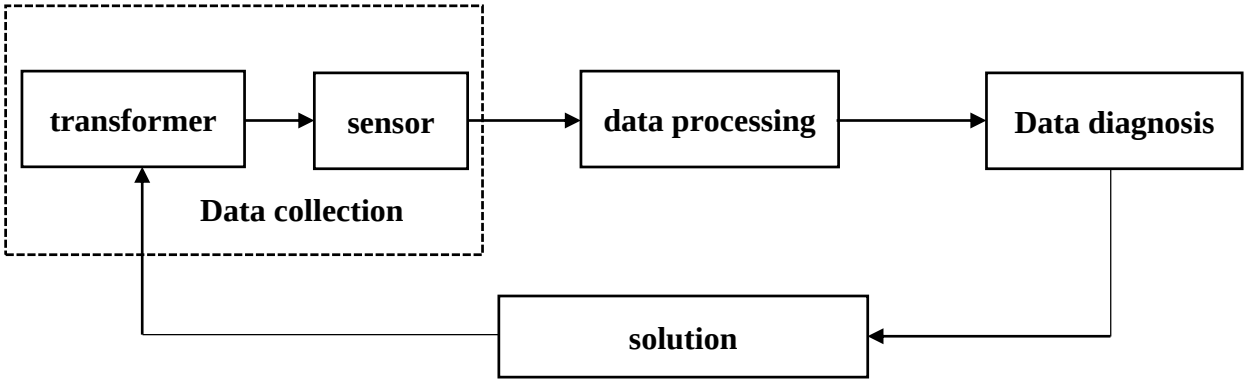

Figure 3-1. Transformer online monitoring system model

As can be seen from Figure 3-1, the online monitoring system is mainly composed of three parts: data processing, data acquisition system, and data diagnosis system. The content of online monitoring is mainly divided into five aspects, monitoring of dissolved gas in oil, partial discharge monitoring, core grounding current detection, micro-water content in oil monitoring, and oil temperature hot spot monitoring [10].

4. Development and future prospects of online detection technology

With the rapid development of artificial intelligence technology, the on-line transformer fault detection technology has also been greatly developed and achieved some results. At present, the main research directions are divided into the design of sensor circuits and the research of artificial intelligence algorithms to achieve detection purposes, such as neural networks, fuzzy theory, expert systems, genetic algorithms, and so on. Each algorithm has its advantages and disadvantages, so various methods are often used in combination. At the same time, On the other hand, the comprehensive intelligent platform for power equipment testing has also been greatly developed [11]. It is composed of a detector part that is responsible for online monitoring and raw data collection and signal processing, a server part that is responsible for managing transmission signals and fault diagnosis alarms, and a server Part, responsible for data storage and export and trend analysis. With the development of science and technology, online detection technology is constantly updated and mature. The addition of artificial intelligence makes the online detection technology more accurate and convenient, but there are still some limitations. For example, the expert system is very useful for the general fault of the power transformer, but the knowledge acquisition ability is weak, and the knowledge base cannot be updated in real time. There is no way to deal with the new faults of the transformer. Neural networks can process quickly, but they cannot explain the conclusions and processes [12]. Therefore, each intelligent technology is not omnipotent and has certain limitations. Only by optimizing these methods, establishing a new type of algorithm with multiple algorithms and fault detection methods, and improving the accuracy and efficiency of diagnosis, can the transformer be better Perform fault detection.

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5. Summary

The instant detection and repair of transformer failures not only affect the safety and reliability of equipment operation, but also affect the operation and management of power companies. Therefore, the development and application of on-line monitoring and fault diagnosis technology of transformer operating status is of great significance. With the development and maturity of detection technology, the combination of online fault detection technology and conventional detection technology will become a trend, and a variety of artificial intelligence technologies will also be combined to monitor and complement each other through data fusion for better detection effect, and ultimately reduce the transformer failure rate.

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