Research and Application on the Power Transmission and Transformation Equipments’ Fault Diagnosis Method Based on Online Monitoring

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Abstract. How to ensure the safe and stable operation of power system is one of the key tasks that need to be solved urgently in power department at present, and the fault factors such as normal operation and condition maintenance of power transmission and transformation equipment determine the safety of power system. In order to solve the fault diagnosis method of transmission and transformation equipment, improving the efficiency of equipment condition maintenance and improving the ability of fault discrimination is one of the main solutions. In this paper, through the equipment state evaluation and fault early warning based on-line monitoring, a variety of inspection measures are fully considered through the model, so as to predict the equipment with hidden trouble and put forward the fault early warning.

1. Analysis of causes of failure of power transmission and transformation equipment

China's ministry of electronics industry has the following standards for the causes of failure of power transmission and transformation equipment: 1. Failure to complete the relevant specified working parameters within a fixed period of time and failure to maintain the specified upper and lower limits. 2. The equipment cannot be completed within the specified stress range, and its functions and related parts and components of structural parts are in a state of damage. Failure of power transmission and transformation equipment is defined uniformly as "a physical state resulting in failure of the device, component or component part to work in the prescribed way". According to the failure of its related transmission and transformation equipment, its related causes are different. Therefore, as shown in figure 1, it is classified according to the failure of its equipment, system and original parts to meet the specified requirements, as well as the reasons caused by component attributes and equipment failure. Details are as follows.

| The serial number | Classification standard | classification | The characteristics of |
|------------------|------------------------|----------------|-----------------------|
| 1                | Any state              | Progressive failure. | It is caused by the gradual deterioration of the initial parameters of the equipment, which is closely related to the wear and decay of materials and candle belt process. Produced by the combination of various adverse flash and accidental external interference. This is beyond the equipment can bear the maximum limit, resulting in equipment operation is not often successful is out of service. This kind of fault is usually sudden, without any warning, often occurs in the early use of equipment stage. |
The equipment loses some or all of its functions in a short period of time, but it can be restored after repair and debugging without replacement of parts. Some parts of the equipment are damaged, resulting in the loss of some or all functions of the equipment. Set up each safety protection system when no need to play the action, the flash fault occurs protection action, resulting in the equipment is not available.

| Nature of the fault | Permanent failure |
|---------------------|-------------------|
| The cause of the problem | Hazardous failure |
| How dangerous | Rules of the fault |
| Occurrence regularity | Functional failure |
| The fault results | Parametric fault |

1.1.  equipment failure rate modeling

The study of equipment failure rate is the premise to evaluate the equipment state and repair the equipment state. The failure time $T$ is defined to calculate the failure probability, and the distribution function and density function are used to solve the problem, and the dependence function $R(T)$ is obtained. Its expression is denoted as:

$$F(t) = p(T \leq t), t > 0$$  (1)

At this point, the density function is regarded as the derivative of the distribution function, and its expression is recorded as:

$$f(t) = \frac{d}{dt} F(t) = \lim_{\Delta t \to 0} \frac{F(t + \Delta t) - F(t)}{\Delta t}$$  (2)

If the reliability function is defined as a device, the probability that no failure occurs at a fixed time, the expression is recorded as:

$$R(t) = 1 - F(t) = p(T > t), t > 0$$  (3)

When the device is running properly, the probability of failure is expressed as follows:

$$P(t < T \leq t + \Delta t | T > t) = \frac{F(t + \Delta t) - F(t)}{R(t)}$$  (4)

According to the above function definition, the failure rate represents the probability of the occurrence of the failure in a fixed time. There are objective laws in its development and use. As shown in figure 1, it can be seen that the physical parameters of its equipment will change accordingly when it runs, from which the laws can be summarized.
It can be seen from the figure above that the performance of its equipment changes synchronously with time. When the performance of the equipment is located at point P, it presents the state of causing failure, which will be damaged at point F. Therefore, when the equipment is in p-f, it can avoid damage by searching for its potential fault parameters for maintenance.

The probability of equipment failure is closely related to time. The failure rate changes at any time according to the typical failure rate curve of equipment, also known as the bathtub curve, as shown in figure 2.

1.2. Equipment fault diagnosis
Equipment fault diagnosis is to point to in the process of equipment operation, or does not remove all the parts, according to the process data of the equipment operation, master the equipment running status, to determine whether the whole or partial is normal, for equipment fault detection, isolation and identification were found equipment failure and its reason, fault location and the severity and predict the development trend. The amount of data in the process of equipment operation is very large, and it is necessary to extract the feature amount of equipment operation according to its fault feature information, so as to carry out fault diagnosis. The failure symptom of the equipment is the change of state caused by a certain fault. The process of fault diagnosis is to judge the failure symptom of the equipment according to the characteristic quantity of the equipment running fault, and judge the type and position of the fault according to the fault symptom. Equipment fault diagnosis mainly includes equipment condition monitoring, equipment condition analysis and fault prediction. In the specific implementation process, it can be divided into the following five processes, as shown in the figure.
2. Fault diagnosis method of power transmission and transformation equipment based on online monitoring

The main advantage of the data-driven fault diagnosis theory is that it utilizes a large number of real-time data and historical data, and extracts useful information by sample training or mathematical methods, so as to provide useful statistical data and computational reasoning information for equipment fault diagnosis and improve the accuracy and timeliness of fault diagnosis. Data-driven technique is an effective method of high-dimensional data processing, usually adopted method is to put the high dimensional feature space projection data through some method of transform to the low dimensional feature space, so as to get a new convenient to handle the characteristics of the data collection, and keep the useful information of original data, the requirements in the process of data dimension reduction maximize the removal of the redundant information of original data, the commonly used methods mainly include fault diagnosis method based on statistical analysis, fault diagnosis method based on signal analysis and fault diagnosis method based on quantitative knowledge, as shown in figure 4.

![Figure 4](image-url)
power3. Business integration application platform based on standard, structure and component architecture technology. The technical implementation architecture of the system is shown in figure 5.

Fig. 5 Multi-tier design diagram of the system

3. Fault diagnosis and Analysis of Transformer in Transmission and Transformation equipment

With the rapid development of information computer technology, there are corresponding records for a large number of off-line transformers and related historical online monitoring data, and the establishment of other factors, such as temperature and humidity, can also be fully covered. The relevant power grid enterprises can sum up the important information of transmission and transformation equipment operation through the above data, can diagnose the uncertain fault factors according to its on-line monitoring, improve the running speed and reliability through the equipment fault diagnosis information system, and can further provide intelligent decision support for equipment maintenance.

3.1. Classification of transformer fault diagnosis

Nowadays, large power transformers have been used for insulation and heat dissipation. Oil is discharged and heated by combining with solid organic insulating materials under the voltage of the transformer. As equipment ages, carbon monoxide and related gases such as carbon dioxide appear. At present, the relevant methods of transformer fault diagnosis are used to check the content of carbon monoxide, carbon dioxide and other gases as well as the relationship between them. H2, CH4, C2H6, C2H4, TOTLE, C2H2, C2H4, C2H6 and other gases are called the main components in the content of fault gas. In order to diagnose the fault type of transformer, the relevant content of gas in transformer insulation oil is detected. The concentration of gas and the proportion relationship between gas are different according to the state of transformer. Through online monitoring and analysis, based on the dissolution of the gas in the transformer insulation oil, according to the key gas and the relative ratio of a certain gas, the important characteristic quantity of the characteristics of the fault equipment was carried out, and the transformer was combined with relevant factors to form the transformer. For details, please see the transformer fault diagnosis classification in Table 2 below.

| order number | Field name | type   | attribute                  |
|--------------|------------|--------|----------------------------|
| 1            | H2         | FLOAT  | H2 concentration           |
| 2            | CH4        | FLOAT  | CH4 concentration          |
| 3            | C2H6       | FLOAT  | C2H6 concentration         |
| 4            | C2H4       | FLOAT  | C2H4 concentration         |
| 5            | TOTLE      | FLOAT  | total concentration        |
| 6            | C2H2       | FLOAT  | C2H2 concentration         |
| 7            | C2H4       | FLOAT  | C2H4 concentration         |
4. Conclusion

The various types of power transmission and transformation equipment, the complexity of equipment structure, the diversity of fault causes, the randomness of fault phenomena and the fuzziness of fault causes make the fault diagnosis of equipment difficult. On the other hand, the technology and equipment of on-line monitoring of power transmission and transformation equipment are in a development stage, and all kinds of diagnostic methods are still in the theoretical test stage. In order to correctly diagnose the faults of power transmission and transformation equipment, an online monitoring system for the condition of power transmission and transformation equipment based on online monitoring technology is established based on the research and application of the fault diagnosis method of power transmission and transformation equipment based on online monitoring technology, which can effectively solve the above problems.

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