

The analysis of overheat failure for 220 kV voltage transformer with live detection

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Abstract: Temperature measurement is critical for fault detection in electrical equipment. Non-contact infrared temperature measurement, with its fast, accurate, convenient, long life, and other advantages, has been widely used in the power grid. With the development of the times, infrared detection technology mature and increasingly sophisticated. Infrared detection technology not only has long-distance, non-contact, real-time and accurate features, but also in the non-power failure, no sampling, not disintegration of the case to achieve fault diagnosis and online testing. Here, examples of the use of infrared thermal imaging to detect abnormal heat generation method, which found that the defect and give the reasons for treatment recommendations and measures.

1 Introduction

In recent years, the development trend of infrared thermal imaging technology has increased rapidly. From the current development situation, the development trend of the infrared thermal imaging technology has the following three directions: (1) standardisation. At present, the main research direction of domestic scholars is theoretical research and laboratory quantitative research. However, qualitative analysis is more common in practical application, and it is influenced by human factors. Therefore, standardisation will become the development direction of infrared non-destructive testing. (2) phase information. Equipment defects can not only be reflected from the amplitude, a larger part can be reflected from the phase. (3) system portable integration [1]. In order to meet the requirements of online on-the-job testing, equipment portability, site adaptability should be increased, foreign infrared non-destructive testing equipment from the laboratory equipment for the development of products to market. China's development of non-destructive testing will be more mature and more to the application areas.

Infrared live detection work in Liaoning Province has been carried out for many years, the use of infrared temperature measurement technology to find and solve a lot of defects and failures for the safe and stable operation of the power grid to provide a guarantee. Here, a typical example of the existence of abnormal heat in the casing of a 220 kV voltage transformer is selected, which proves the effectiveness of the infrared charge detection technology.

2 Infrared detection principle

Many of the failure modes of the power plant in the substation are manifested in the thermal state of the equipment. The basic principle of infrared detection is by detecting the infrared radiation signal of the equipment being monitored, so as to obtain the thermal state characteristics of the equipment. According to this thermal state and the appropriate criteria, to make the equipment is

in a healthy state of discrimination. As shown in Fig. 1, the optical device aggregates the infrared radiation emitted by the object on the detector, and the detector converts the incident radiation into an electrical signal, which is then processed into a visible image in the monitor. Infrared thermal imaging testing of high-voltage live equipment in operation with non-power, non-contact, intuitive and accurate, safe and fast [2–6].

3 Examples

A province maintenance company found inside abnormal heat under the casing of the phase voltage transformer by infrared thermal imaging process in the fourth quarter of November 2013. The normal part of the temperature of 10.5°C, the heating site temperature of 14.9°C, the temperature difference of 4.4 K, as shown in Figs. 2 and 3 shows.

In accordance with DL/T 664-2008 “Application rules of infrared diagnosis for live electrical equipment”, such voltage-generating equipment, there is 2–3 K temperature difference when there is a critical flaw, which may endanger the safe operation of the equipment.

In order to prevent other factors interfering with other factors caused by misjudgement, the provincial maintenance company continuous infrared thermal imaging on November 2, November 3. The test results show that the normal temperature of the voltage transformer is 6.2°C, the heating part temperature is 12.6°C, the temperature difference is 6.4 K. It is confirmed that there is a serious overheating defect inside the voltage transformer.

Provincial maintenance company to the provincial control centre to apply for power replacement program. The device was replaced during a power outage, then complete the relevant tests of the old and new equipment.

3.1 Failure analysis

Comparison of the transfer test and abnormal after the test report, select the capacitor section C11 and C under the section of the dielectric loss test as shown in Tables 1 and 2. Through the comparison of the experimental results, the capacitance of the lower capacitor C1 (14070PF) of the transformer is obviously increased compared with the initial value (12724.2PF). The initial difference is 10.6%, which is far more than the capacitance of the travel value of not more than +2% of the standard. The dielectric loss factor increased from 0.063 to 0.249% of the initial value, although it did not reach the 0.25% attention value, but the growth rate was faster.

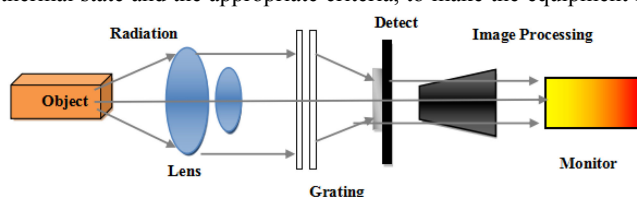


Fig. 1 Infrared monitoring principle

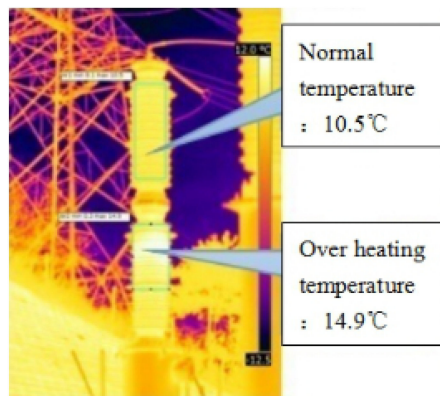


Fig. 2 Test result of Nov.1

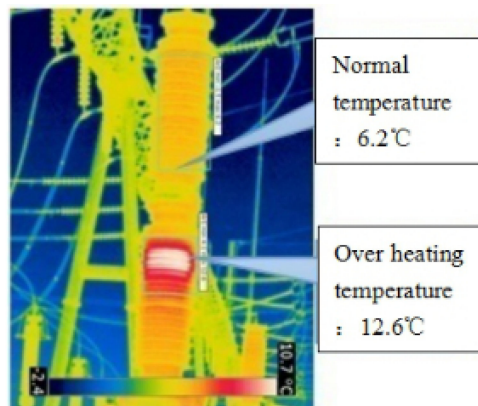


Fig. 3 Test result of Nov.3

Table 1 A-phase dielectric loss tangent

Capacitor section	CX, nF	Tg δ, %	CO, nF	Capacitance error, %
C11	9.945	0.046	9.9811	-0.4
Lower capacitor C	10.09	0.139	10.0254	0.6

Table 2 A-phase test data after defective

Test content	C11	C12 + C2	C1	C2
Capacitance, pF	9978	10,150	14,070	52,720
nameplate value, pF	9981.4	10,025.7	12,724.2	—
last test capacity pF	9990	10,150	12,850	52,680
Error	—	1.20%	10.60%	—
dielectric loss, %	0.072	0.359	0.249	0.027
last test dielectric loss, %	0.068	0.181	0.063	0.055

As shown in Table 3, the rise of CO, CO₂, H₂ content in the oil is due to local temperature rise, solid insulation materials, and insulating oil decomposition. A small amount of acetylene dissolved in the oil may be due to the breakdown of the high-energy partial discharge of the capacitor unit. The experimental results in Table 4 show that the dielectric loss factor of the insulating oil is excessive.

3.2 Cause analysis

Analysis of Local Overheating: Inspection found Medium pressure which immersed in the tank section into casing with rubber gasket by four fixed screws to achieve partial isolation with the next part of the capacitor. The rubber gasket has no special fixing groove. If the four screws are uneven, resulting in gasket displacement, and the pressure in the casing is not close, will damage the sealing

Table 3 Oil Chromatographic test after failure

CO	358
CO ₂	831
H ₂	381
CH ₄	30.4
C ₂ H ₆	5.4
C ₂ H ₄	3.2
C ₂ H ₂	1.58
total hydrocarbon	40.58

Table 4 Insulating oil performance test

Breakdown voltage	Dielectric loss factor	Water content
46 kV	0.53%	13 mg/L

effect. It will cause in the lower section of porcelain sets of insulating oil into the electromagnetic unit of the tank. The oil level rises in the electromagnetic unit and the lower section divides the upper part of the capacitor lack of oil. Part of the oil shortage unit is exposed to air which leads to surface flashover, internal heat, insulation breakdown, and increased capacitance.

Analysis of Cracking of Medium Pressure Casing: During the assembly process, the bushing is subjected to mechanical stress to bend deformation that results in poor contact with the gasket. After the operation is put on, the bad condition of the seal is aggravated. The upper high-voltage capacitor strikes through the heat to melt the solder that connects the capacitor. Then falls on the medium voltage capacitor. The medium voltage capacitor appears short circuit. This process produces a transient overvoltage at the intermediate voltage terminal and breaks in the pressure casing.

3.3 Maintenance recommendations and measures

As the maintenance base exists different capacitor unit and medium pressure small casing, it is decided on the upper and lower parts of the overall replacement of voltage divider and keep the electromagnetic part and re-inject the qualified insulating oil. The next step: Strengthen the infrared thermal image detection, detection, and processing timely; Increase the daily inspection with the same type of product to strengthen surveillance. Recommend equipment manufacturer to strengthen the process and quality, improve the sealing of product sealing components.

4 Conclusions and prospects

Infrared live detection by virtue of its unique advantages in the application of the grid more and more widely. As evidenced by this example. Infrared detection can effectively detect defects, solve problems timely, eliminate hidden dangers, ensure the safe and reliable operation of the power grid, to avoid the defects caused by large-scale power outages caused by economic losses [7, 8].

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