

Influence factors and Countermeasures of breaker's shunt capacitor dielectric loss measurement

Influence factors and countermeasures of dielectric loss measurement of shunt capacitor of breaker

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Abstract.

Affected by various factors, the result of shunt capacitor of breaker dielectric loss measurement is easily misjudged. In order to avoid misjudgment, this paper analyzes the common three kinds of influence factors: interference signals in the site, Cardon effect and air humidity. Three methods were proposed to reduce these effects, they are frequency conversion and anti-jamming technology, increasing the test voltage and spraying RTV. The results show that these measures can effectively avoid the miscarriage of justice of the test results.

Introduction

Shunt capacitor of breaker can not only improve the voltage distribution of the circuit breaker and the overall breakdown voltage level, but also reduce the recovery voltage of the breaking time, meanwhile the breaking capacity could be improved[1]. So its working reliability is related to the safety and stability of breaker's operation. Measurement of high voltage circuit breaker's shunt capacitor dielectric loss is an important index of capacitor insulation performance. According to relevant regulations, the loss tangent value of breaker's shunt capacitor is not larger than 0.002 at 20°C under rated voltage and rated frequency[2]. In the site, 10kV test voltage and 50 Hz frequency were used according to relevant regulations[3]. There are two shortcomings of this method: First, 10 kV testing voltage can not eliminate the interference of Cardon effect which leads to measurement deviation; Second, high voltage and strong magnetic field disturbance in the site bring the measurement deviation when power frequency is used[5-7]. In addition, dielectric loss test result of Breaker's shunt capacitor is also affected by humidity, connection mode and so on, which lead to misjudgment of equipment's insulation status. Therefore, it is necessary to study the influence factors and countermeasures of breaker's shunt capacitor dielectric loss measurement.

Factors affecting field test results for dielectric loss of breaker's shunt capacitor

Interference of high voltage and magnetic field

There are stray capacitance between test object and the surrounding charged equipments, the stray capacitance is related to the distance and their shape. With the decrease of distance and the increase of the external voltage, external power source's impact through capacitance coupling is more significant. These interference signals are mainly caused by the high voltage of the adjacent equipment in the substation, and its frequency is always consistent with the system power.

Garton effect of breaker's shunt capacitor

In 1940, Professor M.Garton found that in the medium insulation containing paper (or plastic and oil), The measurement value of $\tan\delta$ at the lower voltage may be 1 ~ 10 times higher that of the measurement value at high voltage. This phenomenon is called Garton effect.

The reason of Garton effect is that the movement of gel type charged particles is blocked by the paper fiber in the oil under the effect of electric field. This resistance decreases with the increase of electric field intensity. Under low voltage, tiny particles are free in the insulating medium, so the dielectric loss is larger. While under high voltage, the tiny impurities distribute on both electrodes, and then dielectric loss value is reduced[8-9].

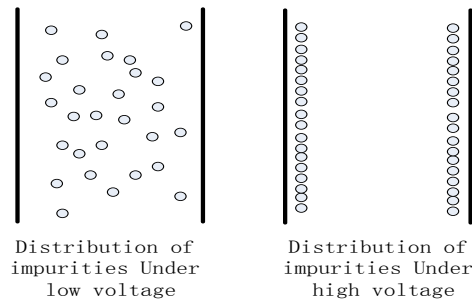


Fig.1 The principle diagram of the Cardon effect

The effect of humidity

When air humidity is high, the filth on the surface of the shunt capacitor of breaker is affected with damp and then there is leakage current on the surface. The higher humidity is, the bigger the leakage current is. When the air humidity of the environment is relatively high, the measurement results of dielectric loss will be higher than normal. For the smaller capacity capacitor, humidity plays a greater role.

How to reduce these effects

Frequency conversion and anti-jamming technology

Compared to 50Hz power frequency, the disturbance of electric field could be removed by using different frequency power measurement. Using frequency conversion anti-jamming technology in field practical measurement it also needs to combine the specific signal processing method. In this article, the Fourier transform and inverse Fourier transform are used to change the dielectric loss measured into dielectric loss under power frequency. The detail progress is shown in Fig.2.

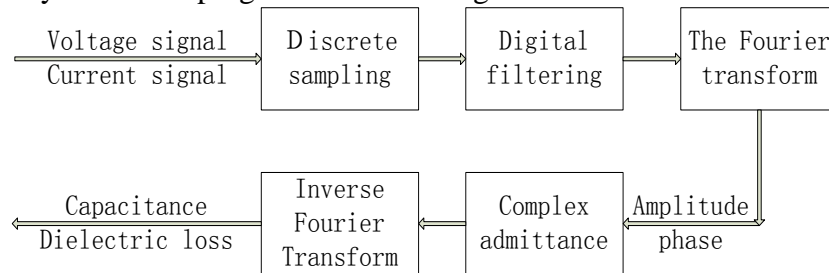


Fig.2 Schematic diagram of Fourier transform frequency spectrum analysis

Increasing test voltage

In high voltage dielectric loss test, using frequency conversion power source, by the serial harmonic of excitation transformer, reactor and capacitor, high voltage could be get. The principle diagram of the high voltage dielectric loss test is shown in Fig.3

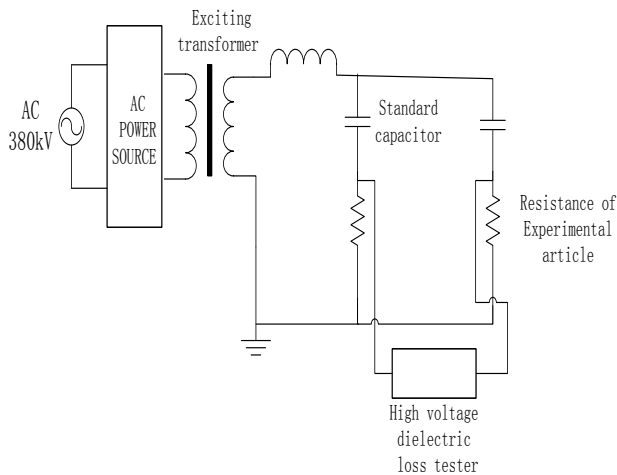


Fig.3 The principle diagram of the high voltage dielectric loss test

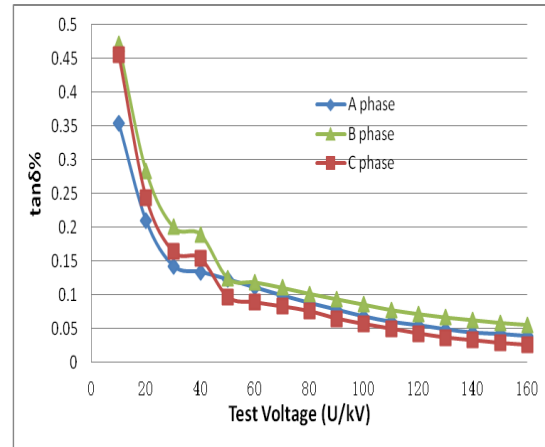


Fig.4 The relationship between dielectric loss test results and test voltage of shunt capacitor

By the series resonance loss method, test voltage raise from 10 kV to 160 kV, record dielectric loss value every 10 kV. Fig.4 shows the relationship between dielectric loss test results and test voltage of shunt capacitor. Experiment results show that, for breaker's shunt capacitor of A, B, C phase, the dielectric loss under 10kV voltage is clearly beyond the regulations. But before the exclusion of Carton effect , it is not sure that the testing equipments have insulation defect. As shown in Figure 4, when the test voltage is raised, the dielectric loss of breaker's shunt capacitor returns to normal. This shows that Carton effect happens in the film and paper composite insulation of capacitor.

Spraying RTV

Because of the good hydrophobic property and hydrophobic migration of RTV itself, RTV can moisture and reduce the effect of humidity. Spraying RTV on the surface of shunt capacitor of breaker plays an important role in decreasing the dielectric loss.

Summary

The results show that, by Frequency conversion and anti-jamming technology, the electromagnetic interference can be effectively reduced; By high voltage dielectric loss measurement, carton effect can be excluded, insulation performance of equipment can be correctly judged; And the influence of humidity on the results of the test can be reduced by spraying RTV.

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