Research of Composite Insulator Detection Device Based on Electric Field Method and Resistance Method

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ABSTRACT

Detecting the low value insulator in the insulator string on-line is of great significance to the safe and stable operation of power system. It is one of the most important technical problems in the construction of HVDC transmission project in our country. At present, there are many researches on HV AC insulator strings both at home and abroad, but HVDC is the only mode of transmission recently used, and there are few researches on this kind of transmission lines. In view of this new problem, after a number of our research design, invented a DC insulator for high voltage zero line detection device, the detection device can effectively detect low and zero value insulators, and through the wireless data transmission system for real-time measurement of insulator shows low value zero data, then the data can be playback and the backup test results.

INTRODUCTION

The development of UHV DC transmission technology in China rapidly, has been built and put into operation of HVDC transmission lines, a plurality of different voltage levels in June 2009, by the China Southern Power Grid built Yunnan Guangdong DC transmission line is the world's first 800kV UHV DC transmission line.

Insulators are the most important and important power equipment in power transmission lines. Its purpose is to connect the conductors with different potentials
mechanically, while electrically insulating each other. At present, domestic insulators in overhead transmission lines in the form of the structure of a disk type suspension and rod type suspension two categories, according to the dielectric material commonly used in three - insulator porcelain insulator, glass insulator and composite insulators. The main research object of this paper is the porcelain suspension insulators on transmission lines. The porcelain insulator in China is the earliest, is currently the application of a kind of insulator widely, has good insulation properties, anticlimate change performance and heat resistance, but also has the creepage distance of effective coefficient, simple manufacturing process, low cost. Although the transmission line is more and more widely used glass insulators and composite insulators, but porcelain insulators cannot be completely replaced in the short term.

Insulator in power system quantity, wide distribution, in the tens of thousands of insulators as long as a string, a number of burst off or insulator allowed faulty insulator flashover and exceeding the prescribed number, will lead to accidents. Therefore, insulator fault diagnosis is an important subject, and has been paid attention to for many years. Must be on the transmission line for regular inspection, to grasp and understand the change of the operation of transmission line and the line of the surrounding environment and the line protection zones at any time, in order to discover and eliminate hidden dangers and prevent the occurrence of accidents, ensure the safety of power supply.

The Factor of Insulator Performance Degradation

Suspension insulators are usually made of steel caps, steel feet and other hardware and insulation medium, filling and so on. An on-line operation after a certain age, because of the influence of various factors inevitable deterioration caused by insulator insulation performance loss, low or zero explosive.

Problems Arising in the Manufacturing Process

Insulator manufacturing is a process, followed by a process, each link in the manufacture has an important impact on the quality and performance of the product. The manufacturing process of ceramic insulators by milling machine milling, gas phase reaction and solid phase reaction, thermal decomposition, molding, injection molding, dry pressing molding, static pressure sintering hot isostatic pressing sintering and reaction sintering and microwave sintering and machining processes, in different processes may introduce defects.

Problems Arising During Operation

Due to the influence of various external factors, insulation in the operation will gradually appear the aging phenomenon of the insulation level. For porcelain insulators, that is to say, the insulation performance is reduced to zero or the
The insulation resistance value is very low, which is usually called zero value or low value insulators.

The effect of Lightning Overvoltage on the normal insulators and zero insulators is quite different. When the lightning overvoltage in the normal insulator, due to the solid breakdown voltage of porcelain insulator below the surface flashover voltage, so it may have insulator surface flashover accident. When the Lightning Overvoltage on zero insulators, insulator breakdown is completely, freewheeling from the head of the porcelain insulator through the gap of lightning current and power strong, will cause overheating below zero insulator.

**Disrepair is A Problem Arising from Maintenance**

Insulator in the long run will inevitably occur a variety of physical and chemical changes, so that the electrical properties and mechanical strength with time increases gradually deteriorated, this phenomenon is called the aging of insulators. There are many reasons for the aging of insulators, mainly the role of electricity, the role of mechanical forces, and the impact of the surrounding environment, such as sun, wind and rain and the role of various rays. Often a variety of factors that cause ageing act simultaneously and often interact with each other and contribute to accelerated ageing processes.

In summary, the cause of insulator deterioration is in many aspects, in order to avoid the zero insulator to continue running in power system, reduce the malignant accidents occurred at home and abroad have been trying to explore the online detection method of insulator, and has achieved certain achievement. To find a convenient, economical, accurate and effective insulator on-line detection method has been a problem that the power department at home and abroad needs to solve.

**Electric Field Analysis of DC Insulators**

Because the voltage waveform on the AC side of the converter station in the DC transmission line is not entirely sinusoidal, the voltage on the DC side is neither smooth nor constant DC, but voltage with a variety of harmonic components. It can be considered that the converter is a harmonic source, and it has characteristic harmonic and none characteristic harmonic components at the DC side. The characteristic harmonic components are related to the working conditions of the converter, including the valve side voltage, arc extinction angle, arc angle and the change of tap position. Non characteristic harmonics are usually caused by the asymmetry of the power system and the equipment. Therefore, the voltage of insulators of DC transmission lines can be expressed as the electric field in the DC insulator string. Accordingly, there is a DC component, an electric field and a harmonic component field.

Using the differential equation method analysis and calculation of the voltage distribution along insulator strings with an overhead high-voltage transmission line to ground voltage is V, insulator, insulator strings in each insulator except the partial
capacitance between electrodes, and the capacitance of the part. And the partial capacitance of the high voltage wire. If the influence of leakage conductance is not taken into account, the equivalent circuit diagram of the whole suspension insulator string is shown.

When there is internal conduction fault or zero value insulator insulators, electric field generated by the DC voltage and harmonic voltage will produce distortion occurred in the fault. Theoretically, the DC insulators can be detected on-line by measuring the DC electric field distribution of DC insulators (hereinafter called DC electric field method) or harmonic electric field distribution (hereinafter called harmonic field method).

**Composition of Testing Instruments**

According to the above second criterions, the detector can design the relevant system software. When the system is online, the detection result is less than that of the detector. But when it is larger than that, it is judged to be a low value insulator. When the detection result is smaller than the service, it is judged to be a zero value insulator, and an alarm prompt will appear. Principle of the detecting instrument this project research using boost circuit module to the DC voltage to the DC voltage detection, detection of the metal detection directly under the original ARM hardware to be tested on the role in insulators in the insulator on the AC voltage by high voltage capacitor in parallel with the detection instrument inside the basic bypass off system the frequency of the voltage detection circuit to detect the whole collection only on the DC component and is partially bypassed the resulting current on the insulator, and through the calculation to determine the central processor, and the final detection result by the wireless data transmission module is sent back to the ground station and computer related faulty alarm. The purpose of this method is to see the result in real time and to replay and save the relevant data through the ground station computer. Because of the complicated electromagnetic environment on the high voltage line, there are various leakage currents on insulators, so it is necessary to deal with the filtering of clutter.

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The 770V AC harmonic voltage is applied to the electric field measurement of composite insulators and porcelain insulator strings by means of an experimental circuit. Insulator No. 1~4 is the same type of insulator. High end No. 2 test of semiconductor short defects (between the outer cladding and core embedded semiconductor pencil core, 16cm long and high pressure metal joints); 3 samples are suspended between the central defect (outer cladding and core rod embedded with 15cm long distance high voltage side of fine copper, gold a joint 9cm); used in the test and porcelain insulators in section third. The test voltage is 770V the tested insulator length of the DC insulator string 1/5, the Southbridge DC transmission line Gezhouba Dam - Shanghai as a model for harmonic simulation, the simulation results show that the harmonic component contains rich DC transmission lines, each harmonic voltage effective value reached 3.36kV.

According to the electric field distribution data, the curves corresponding to the test items of No. 1 and No. 2 are obviously decreased at the high pressure end, and the descent process is basically the same. The location of the curve slope is the end of the defect. It can judge out No. 1 and No. 2 sample has high voltage side short-circuit defect; 3 and 4 samples of corresponding curves are relatively smooth, no obvious subsidence, but compared 3 samples corresponding to the curve in the nineteenth, twentieth and 4 umbrella samples corresponding to the curve dropped a little, so no. 3 the sample in the Department of defective, No. 4 samples for good insulators. The experimental results show that the harmonic electric field method can detect the DC composite insulators on line, and can give the internal insulation fault information effectively.

A good porcelain insulator string and a porcelain insulator string have an electric field distribution curve at the third, fifth, sixth and seventh umbrella groups. The shape of the electric field distribution curve of a good porcelain insulator string is similar to that of the theoretical calculation curve, but the electric field at the eighth umbrella group is less than the electric field at the seventh umbrella group. This is because the detector only measures the longitudinal electric field, and the diameter of the porcelain insulator is much larger than that of the composite insulator. The electric field at the edge of the eighth umbrella group is larger along the radial direction of the insulator, and the longitudinal component of the insulator is weaker. There are some distances between the seventh umbrella group and the high voltage electrode. The electric field at the edge of the insulator is mainly longitudinal component, so the curve shape shown in the diagram is formed. When there is a zero resistance insulator, harmonic electric field at a corresponding position have obvious distortion.
The harmonic electric field distribution of a good porcelain insulator string is very different from that of a porcelain insulator string containing a zero value insulator, that is, the harmonic electric field distribution curve can clearly give the information of insulators.

This is because in the porcelain insulators under AC high voltage on capacitor circuit can be equivalent to the pure air, the capacitance between the electric field distribution of insulator strings by air capacitor, between insulator and insulator, insulator and conductor self-capacitance is determined. The equivalent parameters of porcelain insulator under AC voltage are less affected by external factors such as temperature, space charge and wind direction, and the parameters are relatively stable, so the harmonic electric field distribution of porcelain insulator is relatively stable. The harmonic electric field distribution can be used for online detection of DC insulators, when zero insulators exist in insulator strings, harmonic electric field distribution curve can give fault insulator information.

**Measurement Results and Discussion and Analysis**

From the experimental data can be seen that with the increase of voltage, the insulator in resistance is reduced slightly and the possible reason is because with high pressure, small air gap insulator internal or bubble breakdown, thereby reducing the resistance.

Because the capacitor bypass AC voltage can not bypass completely, then a scene with complex electromagnetic environment, has certain interference, so when the charged measurement will be much larger than the error of the charged case. Charged measurement, detector and detection of the metal arm near the insulator electric field distribution near the side will produce certain influence, resulting in some of the smaller discharge gap, thereby changing the voltage distribution of insulator.

**Conclusion and Prospect**

In this paper, the on-line detection of insulator resistance is studied. The test results show that the measurement system can operate stably and the detection accuracy meets the requirements of Engineering design.

**REFERENCES**

