Chapter 3
Treeing Characteristics in HTV Silicone Rubber

ABSTRACT

Silicone rubber (SiR) is widely used as the main insulating material in cable accessories and faces high temperature challenges during operation. Pulse overvoltages can threaten working state of the insulation. In order to understand electrical tree degradation process at high temperature under repeated pulse voltages, stress testing was performed in this experiment. The ambient temperature (Tamb) was set to 30, 60, 90, 120, and 150°C, and the frequencies of the pulses were set to 5, 20, 100, 200, and 1000 Hz, respectively. During operation, it is also threatened by mechanical stress, which is caused by the spring-clamping device and the expanded bundling force of the rubber stress cone, which will affect the electrical properties of the silicone rubber in the cable accessory. In this chapter, the growth characteristics of trees under tensile stress and compressive stress were studied by using the needle plane electrode system.

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INTRODUCTION

During abnormal operation, high temperature caused by overloaded load current of the conductor in cable can seriously threaten the stable operation of the insulation. The temperature gradually decreases. For inner conductor, the rated load temperature is about 90°C, and the operating temperature is usually designed to be 50 to 60°C, during the transient failure of the extruded XLPE cable system, the temperature during operation may rise to 150°C. In (Chen, 2015), the electric tree characteristics of XLPE cables at different temperatures were studied in detail. However, research on the insulation properties of cable accessories is currently less relevant at different high temperatures. Electrical trees are the phenomenon of the occurrence and propagation of electrically induced tubes, which are the main electro-degradation phenomena in dielectric insulation materials (Dissado, 2002). However, the degradation mechanism of cable accessories at different high temperatures has not been fully studied. Connector failures accounted for about 21% of the cable system. According to the statistical results of the national grid for 110 kV and above cable systems, more than 70% of cable faults originate from faults in cable accessory equipments. Therefore, based on the practical view, it is of extraordinary significance to explore the phenomenon of electric tree initiation and the propagation process in silicone rubber.

SiR is employed as the main insulating materials for the cable accessory and is main insulating materials for cable joints as well as the cable terminals. In order to ensure certain electrical strength of the interface, the cable attachment is coated to the main insulation layer under the certain amount of interference force which generated by the spring clamp device as well as the silicone rubber stress cone. However, mechanical stress can easily cause deformation of the material during installation of the cable attachment and during changes in the operating environment. Therefore, it is inevitably subjected to the varying mechanical stresses for the silicone rubber.

Mechanical stress and strain are relevant to the electrical property of polymer material, which affect the electrical breakdown strength of the materials. It shows that the breakdown field decreases when the strain is up to 30%, and increases when the strain is up to 160%. Electrical tree is the main cause of electrical dilapidation and breakdown of insulating materials. According to state grid statistics, more than 70 percent of cable failures were caused by failures of cable accessories in cable systems 110 kV and above. Electrical trees usually originate from electric field focus points, such as