Chapter 7
Treeing Property In Polypropylene Under Various Temperature and Electrical Field

ABSTRACT

Polypropylene (PP) has no cross-linking process and environmentally friendly properties and is considered to be a replacement for cross-linked polyethylene (xlpe) for high voltage direct current (HVDC) cable insulation. High-voltage DC cable systems generate repetitive pulse voltages during operation and may encounter different temperature environmental challenges. This chapter discusses the effects of pulse amplitude and frequency on PP trees at different temperatures. A higher pulse frequency accelerates the propagation of the tree. Higher amplitudes accelerate tree growth and fractal dimensions. In addition, the effects of DC voltage, pulse voltage, and pulse frequency on the tree characteristics of PP at DC voltage and pulse combination voltage are also studied.

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INTRODUCTION

HVDC transmission has been rapidly developed due to its large capacity and low loss. Therefore, there is an urgent need to develop high voltage DC plastic cables (Murata, 2006; Chen, 2015). During the operation of HVDC transmission cables, space charge accumulates, causing local electric field deformation of polymer insulators, accelerating the aging process, posing a great threat to safe operation (lan, 2014; Suzuki, 2013). Due to the decomposition of the crosslinking agent and the oxidizing agent, XLPE is defective as a high-voltage DC cable insulating material. These defects capture and accumulate more space costs (Han, 2011; Campus, 2002). Compared to crosslinked polyethylene, space charge is more difficult to accumulate in polypropylene due to the absence of cross-linking. Due to the non-crosslinking, recyclable environmental characteristics and excellent electrical and thermal properties of polypropylene, some researchers have suggested replacing polypropylene with polypropylene (Zhou, 2015; Holto, 2010).

Due to the on-off state and polarity reversal of the thyristor, the working pulse voltage is an overvoltage that often occurs in high-voltage DC converter transformers (Gao, 2013; He, 2013). The impact of the combination of surge voltage or DC voltage and surge voltage on the insulation of high voltage DC cables cannot be ignored. The high temperatures generated by the current flowing through the cable conductors will threaten the insulation operation of the cable. The design temperature of a power cable at rated load is typically 90°C, but typically up to 50-60°C (Clean Water, 2000). However, during a power outage, the temperature can reach 150°C in a short time (Bono, 1995). High temperature superconducting insulation is also facing the huge challenge of low temperature. At low temperatures, the mechanical properties of crosslinked polyethylene and polypropylene change. As the temperature decreases, the mechanical properties of the crosslinked polyethylene deteriorate. Therefore, it is important to study the resistance of polypropylene to repetitive pulse voltage and different temperatures.

The study found that voltage, temperature, frequency and other factors will affect the growth of trees. Chen et al. studied the effects of frequency and applied AC voltage on the characteristics of XLPE electrical trees. It is found that the higher the frequency, the faster the insulation strikes (Chen, 2011). The aging phenomenon of epoxy resin under positive and negative pulse voltage was studied. One is a simple straight tree - once a branch reaches the ground electrode and breaks. The other is a multi-branch tree -