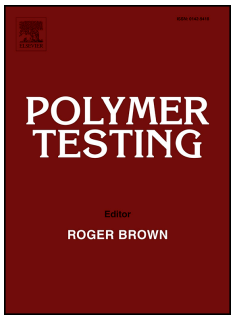
Accepted Manuscript



Aging studies on polymeric insulators under DC stress with controlled climatic conditions

Alok Ranjan Verma, B. Subba Reddy

PII: S0142-9418(18)30370-2

DOI: 10.1016/j.polymertesting.2018.04.014

Reference: POTE 5419

To appear in: *Polymer Testing*

Received Date: 4 March 2018

Revised Date: 6 April 2018

Accepted Date: 11 April 2018

Please cite this article as: A.R. Verma, B.S. Reddy, Aging studies on polymeric insulators under DC stress with controlled climatic conditions, *Polymer Testing* (2018), doi: 10.1016/j.polymertesting.2018.04.014.

Aging Studies on Polymeric Insulators under DC Stress with Controlled Climatic Conditions

Alok Ranjan Verma and **Subba Reddy B.**
High Voltage Laboratory,
Department of Electrical Engineering,
Indian Institute of Science, Bangalore 560012, India

ABSTRACT

In the present investigation, long term service performance of silicone rubber based polymeric insulators under DC stress with controlled climatic conditions is attempted. Simultaneous application of UV, thermal, humidity with DC electrical stress is applied to polymeric insulators enclosed in a specially fabricated climatic chamber. The stresses are applied for 1000 hours for an adopted cycle to simulate close service life conditions. The leakage current is regularly monitored and recorded. After the experimentation, samples of the aged specimen are subjected for post analysis and psycho-chemical analysis like Scanning Electron Microscope (SEM) to monitor morphological changes, Energy Dispersive X-Ray analysis (EDAX) to observe elemental presence over the surface, Fourier Transform Infra-Red (FTIR) spectroscopy to examine chemical changes in the material, Thermo-gravimetric analysis (TGA) to understand the role of filler in aged insulator specimen and loss of Loss of hydrophobicity was measured. Investigations with long duration DC stress reveal material degradation, depolymerization and loss of ATH; this could result in low thermal stability and accelerate the thermal erosion and early failures.

Index Terms — **Aging studies, multistress, degradation, polymer insulator, silicone rubber, FTIR, SEM, EDAX, TGA, wettability.**

1 INTRODUCTION

SILICONE rubber insulators are evolving as one of the most preferable insulation for overhead transmission lines. These insulators provide promising advantages over conventional porcelain and glass insulators such as light weight, slim design resistance to vandalism, hydrophobic, and better pollution performance. The major issue with the polymeric insulators is the long-term performance and deterioration of material properties due to aging. The polymeric insulators consist of three main components, Fiber Reinforced Plastic (FRP) as core material, metal end fittings, and silicone rubber as a housing material. The silicone rubber has polydimethylsiloxane as base polymeric compound added with some filler [1]. In the present composition of high temperature vulcanized (HTV) silicone rubber, Aluminum Trihydrate (ATH) is used as filler that works as the flame retardant and provides the thermal stability. The housing material is sensitive to its local environmental condition and degrades over a period of time, further deteriorates the material properties and temporary loss of hydrophobicity resulting in frequent flashover under fog/ moist conditions [2-3].

Therefore, long-term performance of such insulators is of importance in providing the utilities an uninterrupted and reliable electrical power supply. Effects of multistress with ac stress on the performance of polymeric insulators have been investigated by many researchers, however degradation of housing material under different environmental conditions with dc stress needs attention to evaluate long-term service life.

The effect of aging under UV and humidity on different insulating material is reported in [4-7] the researchers concluded that silicone rubber is comparatively stable as compared to other materials. The effect of aging on silicone rubber material results in a permanent loss of material properties but still can recover its temporary loss of hydrophobicity. Schneider et al [8] studied accelerated aging by simulating the coastal environment thereby compared to real service performance. Fourmigue et al [9] performed multistress studies on silicone rubber and EPDM insulators and reported the loss of material properties and increase in hardness due to exposure of UV and thermal stress.

The housing material of silicone rubber is used for insulator and surge arresters. The effect of simultaneous application of environmental stresses over polymeric housing is studied and reported, the adverse effects of environmental stresses on aging [10-13]. The accelerating aging is reported as loss of hydrophobicity, salt deposition and surface cracking. An increase in surface roughness and loss of hydrophobicity is reported due to multistress application. Zhu et al [14] simulated effect of UV and sandstorm and reported the degradation resulting from crosslinking and depolymerization. Nakeb et al [15] studied the effect of UV on leakage current of 11 kV polymeric insulators and reported the decrease in leakage current under the exposure of UV. The effect of thermal and UV with electrical stress on polymeric insulators resulted in loss of material properties is reported in [16-17].