Abstract

Ceramic materials are commonly used as outdoor insulator for high voltage power transmission line. Presently these ceramic insulators are replaced by composite polymeric insulators with silicone rubber (PDMS) housing, especially in industrial area with pollution. Silicone rubber is chosen for housing material because of their excellent aging resistance, electrical property, tracking resistance, stable hydrophobicity which in turn controls the tracking resistance. Unlike inorganic ceramic insulators, organic polymeric insulators have relatively shorter life. In fact, these outdoor insulators are subjected to variety of electrical, mechanical, chemical, thermal and ultra violet (UV) stresses during their service under open atmosphere. The most important issue for consideration here is the long-term service performance of polymeric insulators and estimation of their probable service life. However, the determination of service life is complicated and time consuming process. The main objective of this investigation is to check the property deterioration with natural aging followed by probable lifetime prediction from aging properties. The working silicone insulator samples (not failed) with different age life were collected and the changes in mechanical, electrical and hydrophobic properties with time were measured. Further, the service life was estimated from the change in mechanical property (elongation at break) and surface hydrophobicity and these results were compared with results obtained from standard insulator compound subjected to accelerated aging tests. Thus comparative study was made between natural aging and accelerated aging process. Prediction of service life will be helpful in replacing the aged insulator before failure without abrupt interruption of power transmission. However, insulator compounds based on PDMS have deficiencies like poor mechanical strength and high cost. To improve mechanical properties and reduce cost, silicone rubber is blended with ethylene vinyl acetate copolymer (EVA). The optimum blend composition is found to be PDMS/EVA 60/40 (w/w). But in doing so there is some reduction in hydrophobicity is observed, thus adversely affecting the tracking resistance. To improve hydrophobicity, the addition of nanosilica in the level of 6 phr is found to be the optimum. Thus high performance outdoor insulator can be produced from PDMS-EVA blend containing 6 phr nanosilica. Different types of accelerated aging test were performed on insulator samples to simulate their aging behaviour under different real life aging process. Aging studies under different conditions reveal that the failure of polymeric insulator is mainly due to UV radiation from sunlight which adversely affects surface hydrophobicity and increases the probability of failure by electrical tracking. To improve aging resistance against UV radiation some nanoparticles like MnO_2, TiO_2 and hybrid nanoparticles TiO_2-MnO_2 were added to the developed insulator compounds. These nanofillers MnO_2, TiO_2 and hybrid nanofiller TiO_2-MnO_2 were also synthesized in laboratory. Effects of addition of these nanofillers on different properties of insulator compounds were investigated.

Key words: Insulator; High voltage; Polymer nanocomposite; Polymer blend; Nanoparticles; Hydrophobicity; Natural, thermal and UV aging.