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The Effect of Radiation Environment on Electrical Insulation Materials

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Due to recent renewed interest in reactor safety and many reactors approaching end of useful lifetime, emphasis on durability of power and instrumentation electrical Insulating Materials is growing. While current materials have shown suitable radiation tolerance in lab testing, combined effects of radiation, temperature, and water at normal or abnormal conditions have led to cable failures. Effects of radiation types and dose rates on selected cable insulating materials have been studied. Effects of dose-rate temperature during radiation on service endurance are considered.

Dielectric materials used to fabricate various parts of electrical equipment systems, nuclear and electronic devices often operate in ionizing radiation fluxes, problems of radiation resistance and changing of insulating materials and devices are urgent. It is necessary to develop ways to improve the radiation resistance. Radiation damage to dielectric and insulating materials is a function of temperature and atmospheric conditions as well as the radiation environment. Many materials are more resistant to radiation in the absence of oxygen or moisture and at lower temperatures. Because of this influence of environmental conditions it is impractical to attempt to compile detailed information that would be directly applicable to all circuit requirements and environmental conditions. The fabrication method used by the manufacturer can also be a factor in the amount of damage that occurs from radiation. Both temporary and permanent changes occur in the characteristics of organic insulating and dielectric materials as a result of exposure to a radiation environment. Enhancement of the electrical conductivity is the most important of the temporary effects with increases of several orders of magnitude being observed. The conductivity increases exponentially in response to ionizing radiation until it reaches equilibrium at a value that is determined by the rate of exposure and ambient temperature for a specific material. Following the termination of the irradiation the induced conductivity gradually decreases. Other temporary effects, in addition to the enhanced conductivity, are a reduction in breakdown and flashover voltages, increases in AC loss characteristics, and variations in dielectric constants. These changes in electrical characteristics, however, are often not large enough to prevent the use of the insulators in a radiation environment, particularly if allowances are made to minimize their effect on the circuits'performance.

Permanent effects of radiation on organic insulating materials are normally associated with physical changes, including decreases in hardness, tensile strength and melting point, and greater solubility. This physical degradation in the advanced stages is disastrous in that the insulating material breaks, crumbles, or powders thus losing structural integrity and causing failure. Changes in dissipation factor and insulation resistance have also occurred as permanent effects, but they are normally quite small and offer few problems except in the most uncommon applications. A comparison of the relative radiation resistance of organic insulating materials to permanent effects is presented. Gas evolution, a secondary reaction that occurs when organic insulators are irradiated, is a problem because of pressure build up in confined enclosures.

Country/Organization invited to participate

Egypt

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