



Contribution ID: 607

Type: **Poster Presentation of 1h45m**

Determination of Threshold Electric Field for PPLP Specimen in Liquid Nitrogen Based on the Measurement of Electrical Conductivity

Tuesday 29 August 2017 13:15 (1h 45m)

AC electric field distribution in composite insulation materials is mainly determined by their permittivity. However, DC electric field distribution highly depends on the electrical conductivity of the insulating materials, and this electrical conductivity exponentially increases with externally applied electric field in cryogenic environment. Therefore, we should not only obtain the accurate electrical conductivity according to externally applied electric field but also necessary to find out the threshold electric field of each insulation material for the desirable insulation design of dc power apparatuses. Accurate determination of the threshold electric field at which charge injection from the electrodes increases is the important matter for the reliable electric field analysis. Due to the presence of space charge in the insulation material, it could lead to the electric field enhancement, resulting in degradation and early failures of the insulation material. Therefore, in this paper, we tried to measure the electrical conductivity of the Polypropylene Laminated Paper (PPLP) specimen in liquid nitrogen (LN₂) and find out the threshold electric field. PPLP was widely known as insulating layer for dc High Temperature Superconducting (HTS) Power cable and the examination of the electric field characteristics of PPLP is very important for the reliable insulation design of dc HTS power cable. For the verification of the experimental results, the simulation works were performed using COMSOL Multiphysics in HTS cable model for the comparison of the electric field distribution depending on whether the threshold electric field were considered or not. Consequently, it was possible to deduce the threshold electric field for PPLP was around 10.34 kV/mm, and this value could vary the dc electric field distribution of HTS cable.

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Session Classification: Tue-Af-Po2.12

Track Classification: H3 - Other Associated Technologies