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M2Po2D-04 [46]: Liquid Nitrogen Cooled Superconducting Power Cable with No Solid Insulation

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Dielectric insulation systems pose a design and material selection challenges for high temperature superconducting (HTS) power cables. Cryogenic operating conditions cause mechanical stresses and the resulting cracks and voids degrade the performance of electrical insulation systems. Superconducting power cable designs that do not use solid insulation are attractive for low and medium voltage applications. The possibility to utilize the dielectric strength of liquid nitrogen (LN2) in the dielectric design of HTS cables is worth exploring because the idea offers designs that are efficient in cryogenic heat transfer. Liquid hydrogen (LH2) is being considered as cryogen for electric aircraft applications. Both LN2 and LH2 have significant dielectric strength if bubble formation can be avoided by subcooling and pressurizing the cryogenic circulation system. Elimination of solid insulation enhances both the volumetric and gravimetric power density of HTS devices. Considering all the advantages, we have explored HTS cable deigns that use liquid cryogens as sole dielectric media. This paper describes the concept of HTS cables without any solid insulation, electric field analysis, and experimental characterization of HTS test cable. Comparison of the estimated breakdown voltage based on the design and dielectric strength of LN2 with that of the experimentally obtained values will be discussed.

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