Seminar

Institute for Plasma Research

Title : Design aspects of High-Temperature Superconducting (HTS) power cables

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Time : 03.30 PM

Venue : Online - Join the talk: https://lobby.ipr.res.in/Dr.IpsitaDas_PDFTalk

Abstract :

High Temperature Superconducting (HTS) cables can transmit huge electrical power in compact size with minimum Joule loss. The design procedure of HTS cable mainly involves an understating of three different aspects other than electrical one e.g., structural aspect (electro-mechanical behaviour of HTS tape and cable), hydraulic and thermal aspects (cooling of cable using LN2 flow).

The HTS tapes are helically wound around a circular former and undergoes different types of mechanical loadings during cable production, transportation and installation. The strains developed in the YBCO layer of tape because of mechanical loadings need to be understood. A finite element investigation shows that the strain behaviour of HTS tape during production and post production processes with different winding pitches which affects the critical current of HTS tape.

Liquid nitrogen flows continuously through the cable to maintain the superconductivity of cable. Therefore, the flow behaviour and convective heat transfer enhancement of LN2 flow are studied. In cable, LN2 flow experiences a bilaterally heated annulus with uniform but unequal heat fluxes, whereas the annulus is having two different walls i.e., inner smooth and outer corrugated wall. The corrugations in outer wall of annulus increase the heat transfer area, but responsible for increase in flow friction. Therefore, to realize the effect of corrugation pitch and depth on flow friction, nine different corrugation geometries are studied. This analysis results a combination of pitch and depth (i.e.,10,5mm) having minimum flow friction. Thereafter, to realize the effect of corrugation shape on hydraulic and heat transfer performances, this particular combination is considered with four corrugation shapes i.e., curved, rectangular, trapezoidal and triangular. The nature of LN2 flow is turbulent and the numerical modelling carried out using k-ϵ model in ANSYS FLUENT.

A 22kV/3kA HTS cable is designed based on the Indian power grid scenario, considering all the afore-mentioned design aspects and safety measures into account.