

Seminar

Institute for Plasma Research

Title: High Temperature Superconductor based Current Leads for large scale fusion devices

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Abstract

In superconducting (SC) magnets based fusion devices, current leads (CL) electrically connect the magnets at low-temperature to the power supply at room temperature. CL experience an internal heat generation owing to Joule heat and conduction heat leak because of temperature gradient from 300 K to 5 K, which directly affects the heat loads on cryogenic system. Therefore, an effective yet efficient cooling of CL is a design prerequisite to minimize the heat leaks to the cold end.

High Temperature Superconductor (HTS) CL comprises of a resistive heat exchanger (HX), HTS module with suitable transitions and bottom joint connecting with SC magnet. The resistive part is cooled by cold helium to mitigate heat loads. This cooling process needs to be optimized based on the geometry of HX and operating conditions of helium. This optimization requires complex analysis of multifaceted aspects like Joule heating, fluid flow and heat transfer considering the temperature dependent properties of both copper and helium along with the HX geometry. A comprehensive numerical approach can effectively address these aforementioned issues and will be useful in the design of HTS CL.

In this work, a 3D numerical analysis is performed for the resistive part of CL in ANSYS fluent. A meander type HX having central conductor with fins to increase flow path as well as convective heat transfer surface is adopted for the resistive part of lead. The HX is cooled by forced flow helium at 50 K, 5 bar (a). The effect of turbulence induced by the zig-zag pattern of flow in between the fins is realized. Additionally, the pressure drop and heat transfer characteristics for this intricate geometry are analyzed. The results are benchmarked with 10 kA rated HTS CL for the ITER correction coils.
