Contribution ID: **25** Type: **not specified**

Performance assessment of multi-tube He II/He II heat exchanger using a single tube sample

Friday, September 24, 2021 12:50 PM (25 minutes)

Superconducting high-field magnets working in He II are usually immersed in a pressurized static He II bath. This pressurized He II bath is then connected through a heat exchanger to a saturated He II bath acting as a cold source. Due to the peculiar He II properties (very high heat conductivity), the conventional heat exchanger designs are not suitable here. In addition, a compact design is often mandatory, as space inside cryostats is always an issue.
In a recent paper, we presented different configurations of optimized multi tube heat exchangers depending on the available horizontal or vertical space. Such an optimized compact heat exchanger prototype has been built to fulfill the cooling needs and the integration constraints of the HL-LHC superconducting D2 recombination dipole. The chosen design with hundred oxygen-free high-purity copper horizontal tubes penetrating inside the extremity of the D2 cold mass vessel is an efficient solution offering significant operating margins.
From the thermal analysis, it appears that the profile and value of the temperature difference across the heat exchanger really depends on the ratio of the transverse conductance to the longitudinal conductance, the former being determined by the conductivity of the copper and the Kapitza conductance. Therefore, optimization and prediction of the thermal performance of such a heat exchanger is only possible when these thermal properties (i.e., the conductivity and Kapitza conductance of the copper tubes) are well known. For that purpose, we built a dedicated test bench to perform these Kapitza resistance measurements on a single pipe, while the thermal conductivity and RRR measurement were measured independently in laboratory apparatus. The experimental results obtained on a single pipe were then used to infer the behavior of the overall heat exchanger.
The comparison of the predictive code and the cryogenic measurements shows excellent agreement over a wide range of cryogenic operating conditions (temperatures, pressures, heating powers).
This paper presents guidelines for designing compact and efficient He II/He II heat exchanger as well as a method to predict the performance of such heat exchanger accurately.

Keywords

Superfluid, Heat exchanger

Category

Tools to support commissioning and operation phases of superconducting magnet systems

Primary author: ROUSSET, Bernard (CEA - Commissariat à l'énergie atomique et aux énergies alternatives)

Co-author: MILLET, Francois (CEA - Commissariat à l'énergie atomique et aux énergies alternatives)

Session Classification: Tools D5