Topic：E (Magnets and power supplies)

HEAT EXCHANGER CFD ANALYSIS FOR THE W7-X HIGH TEMPERATURE SUPERCONDUCTOR CURRENT LEAD PROTOTYPE

E. Rizzo [1, 2], R. Heller [2], L. Savoldi Richard [1], R. Zanino [1]

[1] *Dipartimento di Energetica, Politecnico di Torino , I-10129 Torino, Italy*

[2] *Karlsruhe Institute of Technology (KIT), D-76344 Eggenstein-Leopoldshafen, Germany*

Corresponding author: laura.savoldi@polito.it

The Wendelstein 7-X (W7-X) stellarator is presently under construction at IPP Greifswald, Germany [1]. For its superconducting coils, High Temperature Superconductor (HTS) current leads will be used consisting of two main parts: an HTS module and a Cu meander-flow (MF) type heat exchanger (HX), covering the temperature range from 60 K to room temperature and actively cooled by He at 50 K inlet temperature [2]. Two prototypes of the W7-X current leads were extensively tested in relevant operating conditions during the past months at the TOSKA facility at KIT.

A strategy for the computational thermal-hydraulic analysis of this type of HX has been recently proposed and applied to a sub-size HX mock-up with shorter length and smaller temperature range compared to the forthcoming prototypes [3]. The strategy is based on a detailed 3D Computational Fluid Dynamics (CFD) model of a single module (period) of the HX, from which the thermal-hydraulic behavior of the entire HX could be deduced.

In this paper we apply the same strategy to the simulation of heat transfer in the HX of the above-mentioned current lead prototypes. The Nusselt number resulting from the 3D CFD analysis is then fed into a simplified 1D model [4], aimed at the computation of the Cu and He temperature profile along the device. A comparison will be presented with the temperature values measured at different locations during the prototype test, in order to validate the model in this full-size geometry.

[1] L. Wegener, *Fusion Engineering and Design,* vol. 84, 2009, pp. 106-112

[2] W.H. Fietz, et al., *IEEE Trans. on Appl. Supercond.,* vol. 19, 2009, pp. 2202-2205

[3] L. Savoldi Richard, et al., *IEEE Trans. Appl. Supercond.*, vol. 20, 2010, to appear

[4] R. Heller, “Numerical calculation of current leads for fusion magnets”, KfK Report 4608, 1989