

Design and Manufacturing of a Multistage Cooled Current Lead for Superconducting High Current DC Busbars in Industrial Applications

Florian Schreiner¹, Bernd Gutheil¹, Mathias Noe², Wolfgang Reiser³, Stefan Huwer³, Claus Hanebeck³, Carsten Räch⁴, Marcus Röhrenbeck¹, and Fabian Schreiner¹

¹The University of Kaiserslautern, 67663 Kaiserslautern, Germany

²The Institute of Technical Physics at Karlsruhe Institute of Technology, 76344 Eggenstein-Leopoldshafen, Germany

³Vision Electric Super Conductors Ltd., 67663 Kaiserslautern, Germany

⁴The University of Applied Sciences Kaiserslautern, 67657 Kaiserslautern, Germany

Email: schreiner@eit.uni-kl.de

Abstract— There is a high potential to use high-temperature superconductors instead of conventional busbars in high direct current industrial applications. Since current leads are typically the major source of losses in these applications, we introduce and investigate the concept of a multistage cooled current lead for an operating current of 20 kA to minimize current lead losses. The design is based on the idea to realize an efficient and at the same time economic current lead that consists of components which are market proven and reliable. The current lead is down to 77 K and is cooled with two intermediate cooling stages at 240 K and 150 K. One key component is the joint between the resistive copper part and the YBCO high-temperature superconductor tapes, which is manufactured by a new soldering process. Moreover, electromagnetic Finite Element Analyses of a high-temperature superconductor stack design have been done to optimize the current carrying capacity of the current lead. As a result, the multistage cooled current lead is designed to cryogenic losses of 22.4 W/kA at 77 K.

Keywords (Index Terms)— Cryogenics, current leads, high-temperature superconductors, low heat leakage, multistage current lead.

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