World Academy of Science, Engineering and Technology
International Journal of Materials and Metallurgical Engineering
Vol:19, No:01, 2025

Corrosion Analysis of Brazed Copper-Based Conducts in Particle Accelerator Water Cooling Circuits

Authors : A. T. Perez Fontenla, S. Sgobba, A. Bartkowska, Y. Askar, M. Dalemir Celuch, A. Newborough, M. Karppinen, H. Haalien, S. Deleval, S. Larcher, C. Charvet, L. Bruno, R. Trant

Abstract : The present study investigates the corrosion behavior of copper (Cu) based conducts predominantly brazed with Sil-Fos (self-fluxing copper-based filler with silver and phosphorus) within various cooling circuits of demineralized water across different particle accelerator components at CERN. The study covers a range of sample service time, from a few months to fifty years, and includes various accelerator components such as quadrupoles, dipoles, and bending magnets. The investigation comprises the established sample extraction procedure, examination methodology including non-destructive testing, evaluation of the corrosion phenomena, and identification of commonalities across the studied components as well as analysis of the environmental influence. The systematic analysis included computed microtomography (CT) of the joints that revealed distributed defects across all brazing interfaces. Some defects appeared to result from areas not wetted by the filler during the brazing operation, displaying round shapes, while others exhibited irregular contours and radial alignment, indicative of a network or interconnection. The subsequent dry cutting performed facilitated access to the conduct's inner surface and the brazed joints for further inspection through light and electron microscopy (SEM) and chemical analysis via Energy Dispersive X-ray spectroscopy (EDS). Brazing analysis away from affected areas identified the expected phases for a Sil-Fos alloy. In contrast, the affected locations displayed micrometric cavities propagating into the material, along with selective corrosion of the bulk Cu initiated at the conductor-braze interface. Corrosion product analysis highlighted the consistent presence of sulfur (up to 6 % in weight), whose origin and role in the corrosion initiation and extension is being further investigated. The importance of this study is paramount as it plays a crucial role in comprehending the underlying factors contributing to recently identified water leaks and evaluating the extent of the issue. Its primary objective is to provide essential insights for the repair of impacted brazed joints when accessibility permits. Moreover, the study seeks to contribute to the improvement of design and manufacturing practices for future components, ultimately enhancing the overall reliability and performance of magnet systems within CERN accelerator facilities.

Keywords : accelerator facilities, brazed copper conducts, demineralized water, magnets
Conference Title : ICCMDS 2025 : International Conference on Corrosion and Materials Degradation Studies
Conference Location : Zurich, Switzerland
Conference Dates : January 14-15, 2025