A POST-MORTEM INVESTIGATION OF ELECTRON BEAM WELDS AND OTHER MIRCO-STRUCTURAL FEATURES OF JET HYPERVAPOTRONS

M. B. Olsson Robbie[1], N. Hamilton[1], J. Wood[1], A. M. Galloway[1], J. Milnes[2], I. Katramados[2]

[1] *University of Strathclyde, Department of Mechanical Engineeing, Glasgow, G1 1XJ, UK*
[2] *EURATOM/CCFE Fusion Association, Culham Science Centre, Oxfordshire, OX14 3DB, UK*

Corresponding author: mikael.olsson-robbie@strath.ac.uk

An inherent characteristic of tokamak fusion reactors are large heat fluxes on internal components that can exceed 5-10 MW/m^2. The beam scrapers and ion dump assemblies in the neutral beam injection heating (NBI) system of the Joint European Tokamak (JET) routinely handles such high heat flux (HHF) loads. These heat fluxes are accommodated using the Hypervapotron[1] heat sink design [1] which has proven to be very reliable. To date not a single Hypervapotron on JET has failed whilst subjected to normal operating conditions. Due to the excellent service history of the Hypervapotron design, in JET and on other experimental fusion reactors, it is a possible candidate for use in HHF applications in future fusion devices (such as ITER [2] and beyond).

In this work Hypervapotron specimens that were previously used in the JET NBI ion dump assemblies have undergone metallurgical investigation. The study has focused on the electron beam (EB) welds between CuCrZr main body and back panels as well as dissimilar transition welds between the CuCrZr and Ni support bracket. Porosity was found at the tips of the EB welds and it is postulated that these defects were caused by weld spiking. In addition, the brazed joint between the CuCrZr main body and stainless steel water manifolds (used to supply the coolant via flexible bellows) has been studied. It has been found that Ni braze filler had contaminated the internal surfaces of the Hypervapotron during the vacuum brazing process and became incorporated into the EB welds used to secure the end pieces. The increased concentration of Cr precipitates in the vicinity of welds suggests a heat affect zone even though it is not visually evident.

A number of techniques have been used in this study including; optical microscopy, scanning electron microscopy, energy dispersive X-ray spectroscopy, X-ray radiography and Vickers micro hardness testing. Findings will be discussed with a view to improving the mechanical design of future Hypervapotrons.

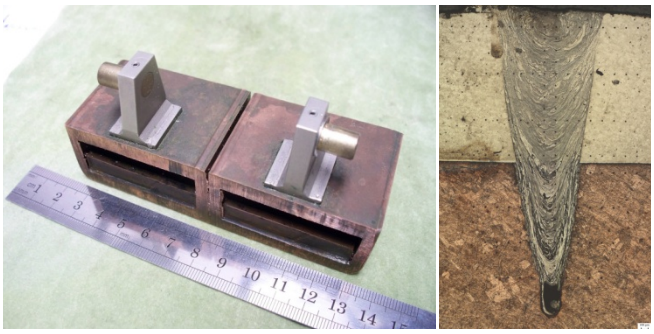

Figure 1: Left; Hypervapotron specimen. Right; CuCrZr - Ni electron beam weld

[1] J. Milnes et al, Fusion Engineering and Design 84 (2009) 1305–1312
[2] F. Escourbiac et al, Fusion Engineering and Design 75–79 (2005) 387–390

[1] Hypervapotron technology is patented by Thomas CFS