ELSEVIER

Journal of Nuclear Materials 318 (2003) 368

journal of nuclear materials

www.elsevier.com/locate/jnucmat

Discussion session summary: corrosion

J.R. DiStefano *

Oak Ridge National Laboratory, Metals and Ceramics Division, P.O. Box 2008, Oak Ridge, TN 37831-6156, USA

Seven papers were presented in the Corrosion Session on a variety of issues ranging from development of facilities to compatibility of materials with Pb–Bi eutectic (LBE) or mercury. In addition, it was reported in other sessions that the Delta Loop at Los Alamos National Laboratory (LANL) is being readied for corrosion testing of materials in LBE as part of the Advanced Accelerator Applications (AAA) program, and the MEGAPIE target is being constructed at Paul Scherrer Institute (PSI) for evaluating materials cooled by LBE in a proton beam. Work was also reported on liquid metal embrittlement (LME) during low-cycle fatigue in LBE in the session on Cavitation Erosion and Fatigue.

The work reported in the various sessions is in support of several different accelerator programs such as the Spallation Neutron Source (SNS), European Spallation Source (ESS), AAA, High Intensity Proton Accelerator Project, and Accelerator Driven System (ADS). Liquid targets for these systems involve Hg and LBE. Ta-clad tungsten cooled by water is also being developed as a solid target. The mercury target system for the SNS will operate at <150 °C. Mass transfer rates of type 316 SS have been found to be very low up to 300 °C and not to be affected velocity up to 1 m/s. LME effects found in both tensile and fatigue tests thus far have been small to negligible. In laboratory tests, chemical wetting does not occur below approximately 250 °C. However, proton beam effects on all these above processes remain to be demonstrated. In addition, if a coating is required to reduce cavitation pitting, qualification tests will be required. Although the Hg-target system container of the SNS is type 316 SS, aluminum components of the maintenance system could possibly be exposed to Hg vapor or liquid droplets. Testing confirmed the susceptibility of 6061-T6 aluminum to pitting and cracking in liquid Hg, but the material was essentially immune to vapor phase corrosion from 0 to 160 °C after times up to 30 days.

LBE targets will likely operate at higher temperatures (400–550 °C). Formation of an oxide on the surface of austenitic or ferritic steel has been proposed to reduce wetting, dissolution, and LME. It was reported that with a surface oxide, temperatures up to 500 °C can be tolerated with type 316 SS and up to 550 °C with T-91. At 600 °C, the surface oxide was not stable and significant corrosion of both materials occurred. Even though corrosion mitigation by oxidation appears to be proven, experience in understanding and controlling oxidation in complex loop systems has not yet been gained outside of the former USSR. Thus, except for the DELTA loop at LANL, present tests planned for loops at PSI (LISOR) and ENEA (LECOR) will not involve surface oxide formation. Further work in this area is definitely recommended.

LME studies with the LBE have been initiated, but further testing will be required for better understanding. Low-cycle fatigue tests of T-91 in LBE did indicate a reduction in life compared with air, but the data are limited.

Experimental facilities to evaluate proton beam effects in LBE are being constructed. Effects on wetting mass transfer and LME will eventually be evaluated. Initial cavitation studies have indicated some surface modification could be required to reduce pitting. Any effect of a coating on corrosion or corrosion mitigation techniques must be quantified.

The stage is set for considerable progress in developing improved corrosion behavior of target system materials through surface modification, corrosion mitigation, or microstructural changes.

* Tel.: +1-423 574 4452; fax: +1-423 241 0215.
E-mail address: distefanojr@ornl.gov (J.R. DiStefano).

doi:10.1016/S0022-3115(03)00124-7