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FRETTING CORROSION OF STEELS FOR LEAD ALLOY COOLED ADS

Mattia Del Giacco, Alfons Weisenburger, Georg Müller
Institute for Pulsed Power and Microwave Technology
Karlsruhe Institute of Technology, Hermann-von-Helmholtz-Platz1, 76344 Eggenstein-Leopoldshafen

The development of structural materials able to withstand the operating conditions is one of the main issues for the realization of Accelerator Driven Systems (ADSs). Steels exposed to liquid lead alloys (foreseen as coolant and spallation target for ADSs) are affected by different corrosion mechanisms (i.e. oxidation and dissolution) so that corrosion barriers for the candidate materials are required.

One specific challenge for fuel claddings and heat exchanger tubes is fretting by flow induced vibrations. This particular type of wear can interact with the corrosion mechanisms (fretting corrosion) and weaken or damage the corrosion barriers reducing the components lifetime. Thus, investigation, assessment and prediction of the fretting corrosion damage are relevant for economics and safety related considerations.

A dedicated facility named FRETHME (FREtting corrosion Test in Heavy liquid MEtals) was designed and realized to simulate, under reactor relevant conditions, the fretting wear/corrosion of possible friction contacts. For this purpose, several fretting test were performed varying the main affecting parameters in range of interests. The materials investigated were selected among the main candidates steels, namely: f/m T91 steel, austenitic 15-15 Ti steel and Al surface alloyed T91 (GESA-T91).

The experimental outcomes indicate that fretting damage generally increases with number of cycles/time, temperature and sliding amplitude. Besides, for reason related to the concept of fretting regimes, the fretting damage increases with the applied load up to a turning point and then decreases.

The fretting tests highlighted that the fretting action destabilizes the corrosion barriers favoring e.g. dissolution attacks. However, liquid lead, acting as a lubricant, slows down the wear process compared to the case in air.

On the other side, the fretting wear process is enhanced by the corrosion mechanisms (fretting corrosion). Dissolution enhanced fretting affects 15-15Ti steel (due to its high Ni content); while oxidation enhanced fretting characterizes T91 steel at temperatures higher than 500°C. From this point of view, the experimental results suggested that pre-formed oxide scales and Ni-enriched liquid Pb are possible countermeasures to mitigate fretting enhancement by dissolution and oxidation.

Due to the favorable wear and corrosion resistance properties of the surface alloyed layer, GESA-T91 steel showed the best fretting corrosion behavior among the tested steels.

The results of the experimental campaign were used to create preliminary fretting maps, which are useful tools to predict fretting corrosion damage and to provide relevant design indications. Combinations of high applied loads and short sliding amplitude, together with appropriate corrosion countermeasures, were identified in this work as conditions to meet the operating requirement in terms of maximum allowed fretting damage.

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