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Experimental Assessment of Erosion Corrosion Parameters of Copper Alloys and Copper to Steel Joints at ITER Operational Conditions

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The ITER In-Vessel design includes coolant water interfaces with the copper alloy CuCrZr exposed to high water velocities. For reasons of structural integrity, the formation of activated corrosion products as well as the need for water purification, it is important to assess the erosion corrosion susceptibility of CuCrZr. In ITER, the materials will be subjected to different water chemistry conditions depending on whether the plasma is active or not. The present work, organized by F4E via a task agreement with ITER IO, was performed at Studsvik. Experimental studies at oxidizing conditions were recently finished, while a similar test at reducing condition is ongoing. Exposure of CuCrZr and CuCrZr/316L(N)-IG specimens was performed in two consecutive autoclaves, operating at different temperatures, where the specimens were subjected to impinging coolant water flow. Each campaign was divided into four exposure periods allowing for specimens to be taken out for intermediate inspections. The first test campaign was performed under oxidizing conditions in order to simulate operational conditions during plasma burn. Specimens weight were measured after each exposure period. Specimen surfaces and oxide cross sections were analyzed by HR-SEM after the final period after which erosion corrosion and release rates were calculated. The corrosion rates at oxidizing conditions were 25 and 37 micrometer per year at 110°C and 150°C respectively. The rates were constant with exposure time. At 250°C the rate was much higher, 1600 micrometer per year. Erosion corrosion rates recorded for CuCrZr under simulated ITER coolant water conditions are disturbingly high. For comparison it can be mentioned that corrosion rates of structural materials in LWR reactors generally are considerably lower than 1 micrometer/year. The ongoing test campaign comprises exposure under reducing conditions representing nominal off-plasma operational condition. Although preliminary results indicate much lower corrosion rates, the effect of alternating corrosion potential may be destructive. Erosion corrosion of CuCrZr can thus potentially cause serious problems for the ITER coolant systems.

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