



IAEA FEC 201

Contribution ID: 295

Type: **Poster**

Assessment of corrosion behavior of reduced activation ferritic/martensitic steel, F82H in high temperature water

Thursday, 20 October 2016 08:30 (4 hours)

Water cooled ceramic breeder concept is a primary candidates for ITER and DEMO blankets of Japan. In this blanket, the pressurized water of 15 MPa between 558 K to 598 K is used as the coolant. In such blanket, the structural material is required to be as thin as possible for tritium breeding. However, the pressure tightness is required to withstand 15 MPa of internal pressure. Therefore one of possible issues of such blanket concept is to understand the corrosion mechanism of structure materials in high temperature pressurized water in the operating temperature range. However, available data on the corrosion of reduced activation ferritic/martensitic steel (RAFMs) in simulated PWR environment are limited. In this study, the temperature and DO dependencies of corrosion properties of RAFM, F82H were investigated using rotating disk specimen in autoclave. Based on the results obtained from corrosion test, all of the static corrosion test specimens demonstrate weight gain after the corrosion test in any temperature. The all of the rotated disk specimens of DO 0.02 mg/L showed weight loss after the corrosion test. In contrast, the results of rotated disk specimen tested at DO 8 mg/L were almost same as the static specimen. Additionally, the weight changes of static and rotated disk specimen tested at DO 8 mg/L were smaller than those of DO 0.02 mg/L specimen in any temperature. Based on the results of SEM observation and XRD measurement, the oxide particles were not observed on the surface of rotated disk specimen tested at DO 0.02 mg/L in any temperatures. On the other hand, the oxide particles were still observed on the DO 8 mg/L specimen even if the temperature changes. Based on the results of XRD measurement, the dominant oxides of static specimen in DO 0.02 mg/L condition and DO 8 mg/L condition were magnetite and hematite respectively. Considering these results, it can be concluded that the inhibition of flow accelerated corrosion at DO 8 mg/L was caused by the surface oxide which act as the diffusion barrier of Fe ion transport. In any events, it was desirable to control the DO concentration up to 8 mg/L, because the effects of temperature and water flow on corrosion behavior were significantly suppressed. Based on these results, it was revealed that the high-DO operation is necessary to suppress the flow accelerated corrosion in the blanket system.

Paper Number

MPT/P5-16

Country or International Organization

Japan

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Session Classification: Poster 5

Track Classification: MPT - Materials Physics and Technology