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Stress Corrosion Crackings Test of Candidate Materials in Support of the Development of the European Small Modular Supercritical Water Cooled Rector Concept

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Abstract : This research has been conducted within the European HORIZON 2020 project ECC-SMART. The main objective is to assess whether it is feasible to design and develop a small modular reactor (SMR) that would be cooled by supercritical water (SCW). One of the main objectives for material research concerns the corrosion of the candidate cladding materials. The experimental part has been conducted in support of the qualification procedure of the future SCW-SMR constructional materials. The last objective was to identify the gaps in current norms and guidelines. Apart from corrosion, resistance testing of candidate materials stresses corrosion cracking susceptibility tests have been performed in supercritical water. This paper describes part of these tests, in particular, those slow strain rate tensile loading applied for tangential ring shape specimens of two candidate materials, Alloy 800H and 310S stainless steel. These ring tensile tests are one the methods used for tensile testing of nuclear cladding. Here full circular heads with dimensions roughly equal to the inner diameter of the sample and the gage sections are placed in the parallel direction to the applied load. Slow strain rate tensile tests have been conducted in 380 or 500oC supercritical water applying two different elongation rates, 1x10-6 and 1x10-7 s-1. The effect of temperature and dissolved oxygen content on the SCC susceptibility of Alloy 800H and 310S stainless steel was investigated when two different temperatures and concentrations of dissolved oxygen were applied in supercritical water. The post-fracture analysis includes fractographic analysis of the fracture surfaces using SEM as well as cross-sectional analysis on the occurrence of secondary cracks. Assessment of the effect of environment and dissolved oxygen content was by comparing to the results of the reference tests performed in air and N2 gas overpressure. The effect of high temperature on creep and its role in the initiation of SCC was assessed as well. It has been concluded that the applied test method could be very useful for the investigation of stress corrosion cracking susceptibility of candidate cladding materials in supercritical water.

Keywords : stress corrosion cracking, ring tensile tests, super-critical water, alloy 800H, 310S stainless steel
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