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Component Test of Martensitic/Ferritic Steels and Nickel-Based Alloys and Their Welded Joints under Creep and Thermo-Mechanical Fatigue Loading

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Abstract : Future power plants currently face high design requirements due to worsening climate change and environmental restrictions, which demand high operational flexibility, superior thermal performance, minimal emissions, and higher cyclic capability. The aim of the paper is, therefore, to investigate the creep and thermo-mechanical material behavior of improved materials experimentally and welded joints at component scale under near-to-service operating conditions, which are promising for application in highly efficient and flexible future power plants. These materials promise an increase in flexibility and a reduction in manufacturing costs by providing enhanced creep strength and, therefore, the possibility for wall thickness reduction. At the temperature range between 550°C and 625°C, the investigation focuses on the in-phase thermo-mechanical fatigue behavior of dissimilar welded joints of conventional materials (ferritic and martensitic material T24 and T92) to nickel-based alloys (A617B and HR6W) by means of membrane test panels. The temperature and external load are varied in phase during the test, while the internal pressure remains constant. At the temperature range between 650°C and 750°C, it focuses on the creep behavior under multiaxial stress loading of similar and dissimilar welded joints of high temperature resistant nickel-based alloys (A740H, A617B, and HR6W) by means of a thick-walled-component test. In this case, the temperature, the external axial load, and the internal pressure remain constant during testing. Numerical simulations are used for the estimation of the axial component load in order to induce a meaningful damage evolution without causing a total component failure. Metallographic investigations after testing will provide support for understanding the damage mechanism and the influence of the thermo-mechanical load and multiaxiality on the microstructure change and on the creep and TMF- strength.

Keywords : creep, creep-fatigue, component behaviour, weld joints, high temperature material behaviour, nickel-alloys, high temperature resistant steels
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