LOW CYCLE FATIGUE TESTING IN HIGH PRESSURE GASEOUS HYDROGEN USING TUBULAR SPECIMENS

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Fatigue life testing in autoclaves containing high pressure gaseous hydrogen atmospheres using conventional solid specimens is difficult to perform. One reason is that the high hydrogen pressure must be held constant over a long testing time of several days which is experimentally challenging. The second challenge is the precise operation of strain gauges within a high pressure hydrogen atmosphere to perform strain controlled fatigue tests. Both issues are circumvented when using tubular specimens for strain controlled fatigue testing. A tubular specimen contains an axial hole where the hydrogen pressure is applied. Due to the small volume of the hole, the volume of hydrogen is small and the pressure is easy to control even over long testing times. Strains applied in low cycle fatigue tests are typically lower than about 2%. That is, the strain gauge can be installed on the outer gauge surface which has no contact with the high pressure hydrogen.
This study presents the results of low cycle fatigue tests in high pressure hydrogen using tubular specimens. Various structural alloys were investigated. The results are directly compared to those of conventional solid specimens tested in an autoclave. The influence of the surface quality as well as the influence of the specimen dimensions (ratio of gauge inner to outer diameter) of the tubular specimens are investigated. Results are interpreted and explained by finite element simulations.