Synergistic Effects of a Sulfate-Reducing Bacteria and an Applied Stress on the Corrosion Behavior of 17-4 PH Stainless Steel After Different Heat Treatments

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The individual and synergistic effects of sulfate-reducing bacteria (SRB) and an applied stress on the corrosion behavior of 17-4 precipitation-hardened (PH) stainless steel in sterile and SRB-inoculated solutions were investigated by electrochemical impedance spectroscopy and fractographic observation. Different heat treatments were applied to the 17-4 PH stainless steel, including single-stage aging, double-stage aging, and an intermediate treatment. The microstructures of the 17-4 PH stainless steels were mainly composed of lath martensite. However, the samples subjected to an intermediate treatment showed improved toughness as a result of the uniform and fine lath martensite. Among the samples considered in this study, the double-stage aged samples exhibited the highest yield strength and maximum stress corrosion cracking (SCC) susceptibility (I_{sc}) of 43.2% in the sterile solution. In the SRB-inoculated solution, the impedance values of all samples were reduced, and the production of harmful metabolites, such as FeS and H₂S, occurred, indicating that SRB promoted corrosion of the stainless steel. The double-stage aged samples were the most sensitive to the SRB among the samples considered herein, where the I_{sc} was 52.8%. The SCC mechanism for single-stage aged and intermediate-treated samples was anodic dissolution (AD), and that for the double-stage aged samples was hydrogen induced cracking (HIC).

Keywords: 17-4 PH stainless steel, applied stress, sulfate-reducing bacteria, stress corrosion cracking

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