Tensile and fatigue crack growth properties of high strength stainless steel with high resistance to hydrogen embrittlement in 100 MPa hydrogen gas

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Abstract

The sensitivity of high strength austenitic stainless steel HP160 to hydrogen was investigated by conducting tensile tests and fatigue crack growth tests in hydrogen gas with a pressure of about 100 MPa. Tests for Type316L and Type304 austenitic stainless steels were also carried out to compare with HP160. The tensile strength was 919 MPa for HP160, 561 MPa for Type316L and 715 MPa for Type304. Type316L (12.1 mass %Ni) is a stable austenitic stainless steel, and Type304 (8.07 mass %Ni) is a meta-stable austenitic stainless steel. HP160 has 9.71 mass % Ni and small amounts of N, Mn, Nb, Mo and Cu. For Type304, the tensile strength (σ_B) and reduction of area (ϕ) in hydrogen gas were much lower than those in air. In contrast, decrease in σ_B and ϕ in hydrogen gas of Type316L was small. HP160 also showed only a slight decrease in σ_B and ϕ in hydrogen gas, regardless of low content of Ni, 9.71 mass %. The fatigue crack growth rate (da/dN) for Type304 was more than 10 times faster in hydrogen gas than that in air, while the acceleration of da/dN in hydrogen gas for HP160 and Type316L was very small. It is presumed that a small addition of nitrogen increased the strength properties and stabilized the austenitic phase of HP160 resulting in high strength and high resistance against hydrogen embrittlement.