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Electrochemical Conditions to Evaluate the Corrosion Fatigue Behavior of Friction-Welded Stainless and Carbon Steel

Stefano Rossi, Luca Benedetti, Matteo Benedetti and Vigilio Fontanari

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Abstract

The aggressive environment significantly influences fatigue-corrosion behavior, reducing material resistance. Welding materials with different electrochemical nobilities proves even more critical due to their particular geometry and the establishment of galvanic couplings. However, the use of joining of dissimilar steels is increasingly necessary to satisfy both corrosion resistance and mechanical properties. The behavior of components and structures working under fatigue in an aggressive environment such as the marine one can be critical.

This study characterized the friction junction between a stainless steel 304L and a carbon steel ASTM A105. A specially designed and constructed electrochemical cell allowed evaluating the fatigue-corrosion behavior of the junction in a 3.5 wt.% NaCl solution, simulating the marine environment, at different electrochemical potentials. To simulate and verify the influence of cathodic protection and overprotection, fatigue-corrosion tests were conducted both in free immersion conditions and at two cathodic potentials equal to -850 mV and -1300 mV Ag/AgCl. The negative role of the aggressive environment and the positive role of cathodic protection were highlighted. The effect of hydrogen developed by the cathodic reduction reaction in overprotection was also evaluated. Failure analyses allowed identifying different degradation mechanisms depending on the different testing conditions.

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