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RIPPLE-LOADING EFFECTS ON STRESS-CORROSION CRACKING IN STEELS

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ABSTRACT

Stress-corrosion cracking (SCC) under ripple-loading conditions was investigated in three quenched-and-tempered steels ranging in yield strength from 860 to 1210 MPa (125 to 175 ksi). These studies involved precracked cantilever-beam specimens exposed to 3.5 percent NaCl aqueous solutions at room temperature and at two electrode potentials, freely corroding and -1.0 V versus Ag/AgCl. Ripple-loads were applied at a cyclic frequency of 0.1 Hz and load ratios ($R = \text{minimum load}/\text{maximum load}$) between 0.90 and 0.975. Measured in terms of time-to-failure as a function of initial Mode I crack-tip stress-intensity (K_I), the primary responses to ripple-loading were no effect in one instance and strongly detrimental in another. Where ripple-loading was observed to significantly affect SCC, threshold values under ripple-loading appeared to agree with the fatigue crack growth rate threshold (ΔK_{th}) for comparable loading and environmental conditions. These observations suggest that ripple-loading effects on SCC in steels may be primarily mechanical in origin.

INTRODUCTION

More than 20 years ago, B. F. Brown and coworkers at the Naval Research Laboratory began to study the stress-corrosion cracking (SCC) properties of high-strength alloys using precracked specimens. One enduring outcome of their work was the development of the fracture mechanics SCC threshold parameter, K_{Isc} [1]. In intervening years, laboratory methods for measuring K_{Isc} have been systematically examined by several organizations [2-4]. Also, the concept of an SCC threshold parameter which serves as a valid measure of a material's resistance to SCC has been sufficiently well accepted that K_{Isc} data appear in materials properties handbooks widely used by government agencies and their contractors [5].

The most common test methods for measuring K_{Isc} involve essentially static loading. Typically, precracked specimens are either dead-weight loaded or are loaded to a fixed crack-mouth-opening displacement [2-4].