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NASA TECH BRIEF

A Rapid Stress-Corrosion Test for Aluminum Alloys

Alternate immersion in aqueous 3.5% NaCl solution has been an effective stress-corrosion cracking test for most aluminum alloys. Unfortunately, the alternate immersion test also promotes excessive general corrosion of those alloys which contain copper as a major alloy addition (2000- and copper-bearing 7000- series alloys). The general corrosion attack of these alloys can mask fine cracks and, therefore, materially increase the difficulty of determining the cause of failure. Supplemental metallographic examinations are often helpful in determining if stress-corrosion cracking did or did not occur, but these examinations are expensive and time consuming.

Continuous immersion in an aqueous (common salt–potassium dichromate) 1% NaCl–2% $K_2Cr_2O_7$ solution at pH 4 and temperature of 60°C has proved to be an effective stress-corrosion test for aluminum alloys such as 2024, 2014, 2219, and 7075, which are most prone to general corrosion in 3.5% NaCl alternate immersion testing. Because of the minimal general corrosion of these alloys in this salt-dichromate solution, stress corrosion failures are readily detected by low-power microscopic examination of the test specimen. The salt-dichromate solution test is particularly well-suited to the tesk of rapidly separating various tempers of 2024, 2219, and 7075 aluminum alloys on the basis of their relative susceptibilities to stress-corrosion cracking.

Stressed alloy specimens, e.g., C-rings, tensile rounds, etc., are immersed in the salt-dichromate solution at a temperature of 60°C. The solution is prepared on a weight basis (1% salt–2% dichromate) using reagent grade chemicals and distilled water. As prepared, the solution should exhibit a pH in the range of 3.7 to 4.0. If necessary, the pH should be brought within this range with additions of normal HCl or NaOH solution.

The test solution must be contained in an inert vessel, preferably glass, which will withstand the test temperature of 60°C. Provisions should be made for maintaining the temperature within ±1°C of 60°C for the best reproducibility of test results. It is not necessary to reflux the solution; but the vessel should be suitably covered to minimize evaporation losses. Distilled water must be added periodically to compensate for any evaporation losses.

The recommended immersion period in the salt-dichromate solution is seven days, but this period may be extended for several weeks without danger of excessive general corrosion attack of the specimens. Failure of highly stressed susceptible alloys and tempers generally occurs during the first few hours of testing. Therefore, specimens should be inspected at least once during the first four hours' exposure and twice a day thereafter.

Because of the minimal general corrosion attack in the salt-dichromate solution, chemical etching of the unstressed specimens is a necessary preliminary step for reproducible response in this test. Specimens should be immersed for 30 seconds in a 5% NaOH solution at 75°C, soaked in cold concentrated HNO_3 for 15 to 30 seconds to remove smut, and finally rinsed in hot tap water. The use of the etch does not complicate the test. In fact, it may reduce the variability associated with most stress-corrosion tests in assuring complete removal of oils, residual oxides, and smeared metal introduced during the machining of the specimens.

(continued overleaf)

Note:

Documentation is available from:

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Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

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