Overview: Section 6

The following is an overview of papers concerned with the effects of hydrogen embrittlement on manufactured parts. Some present case histories of embrittled parts while others deal with coatings, shortened destructive testing, and a proof test logic for nondestructive testing.

Since all of the case histories presented here involve parts which were either plated or coated, we devote the beginning of this overview to coatings themselves. Although applied to a product to protect it (for example, to prevent corrosion), many coatings also provide the hydrogen needed to embrittle the parts. Most of today's hardware needs some type of coating protection, making this a large-scale problem. G. T. Murray presents a view of several coatings shown to be very effective in prevention of hydrogen embrittlement in stainless steel as well as a review of current prevention and control methods.

Gerry Voorhis presents a specific example of hydrogen embrittlement caused by coating. The products are high-strength steel artillery submunitions coated with zinc phosphate. Testing for embrittlement was accomplished by stressing ring specimens at 65% of the normal breaking load for 200 h. Relief procedures consisted of thermal bake-out or storage at room temperature.

A more aggressive source of hydrogen embrittlement than zinc phosphating is cadmium plating. Milton Levy and Gordon Bruggeman present a situation dealing with cadmium-plated 4340 steel fasteners used in helicopters. Failure of these parts was determined by a 200-h test and found to be caused by brightener solution additives to the cadmium-plating bath. Filtration of the bath proved successful in rectifying the problem. Suspect parts were relieved by thermal bake-out.

Regardless of the source of the embrittling hydrogen, rejection of large numbers of manufactured parts because of failed test coupons can be costly. Nondestructive tests are needed to salvage good parts from failure-dominated lots. W. E. Krams presents a proof test logic based on fracture mechanics that is designed to provide the required margins of safety and reliability without damaging the hardware.

These papers demonstrate the difficulties with hydrogen embrittlement presently encountered. Protective coatings are the source of hydrogen in many of the current embrittlement situations. Shortened destructive testing and eventually nondestructive testing will afford manufacturers better control in combatting this problem.

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