

Summary

The papers in this publication are divided into four sections based on their principal subject matter. First, papers are presented which deal primarily with the background and interpretation of the slow strain-rate test technique. Second, applications of the slow strain-rate test to specific environments and, in particular, industries are described. Third, application of the slow strain-rate test to specific metals and alloys are described, and fourth, slow strain-rate test equipment and procedures are discussed. Thus, the reader is guided from a general treatment of the theory and practice of the slow strain-rate test technique through specific applications, and finally to a description of the test method itself.

An excellent treatment of the role of strain in the stress corrosion cracking (SCC) process is presented by Parkins. The concept of critical strain rate is developed, and the contribution of plastic strain to SCC in constant load tests is recognized. The relationship between slow strain-rate tests and constant load tests is discussed. Papers by Diegle and Boyd, and Hishida et al discuss the role of two other principal phenomena in the SCC process, namely, film rupture and anodic dissolution at the crack tip. The evaluation and interpretation of slow strain-rate tests is discussed by Payer et al. Several parameters to quantify SCC susceptibility are presented.

Applications of slow strain-rate tests to SCC in specific environments and specific industries are presented in the second section. Theus and Cels discuss caustic SCC studies related to nuclear steam generator and fossil boiler materials. Favorable comparisons were found between slow strain-rate tests, U-bend tests, and service experience. Kim and Wilde discuss SCC of carbon steel in ammonia. Ugiansky and Johnson describe slow strain-rate tests in gaseous atmospheres at elevated temperatures from 450 to 600°C. Slow strain-rate tests of stainless steels in high temperature, high purity water are discussed by Solomon et al. Clarke et al discuss the slow strain-rate test for rapid screening of susceptibility to intergranular SCC in high purity, oxygenated water at 289°C. Slow strain-rate test results are correlated with long term, constant load test results. Indig presents slow strain rate results for Incoloy Alloy 800 and 21/4Cr-1Mo steel in 5 or 10 percent sodium hydroxide (NaOH) at 316°C. The results are applied to materials selection for liquid metal fast breeder reactor (LMFBR) steam generators. Ondrejcin presents results of slow strain-rate tests used to select temperature and composition limits for storage of nuclear wastes in carbon steel tanks. Payer et al

describe the extensive use of slow strain-rate tests to prevent and control SCC of carbon steel in gas transmission pipelines. The technique was used to evaluate the temperature and composition limits of SCC, and it contributed to the identification of SCC inhibitors and development of pipeline coatings for SCC control.

In the third section, papers deal primarily with applications to specific metals and alloys. A broad range of alloys were studied. Scully presents results for titanium, brass, and zircaloy. Ugiansky et al studied SCC of aluminum alloys and compared slow strain-rate results with more conventional constant load test results. The effects of oxyanions and chloride on SCC of admiralty brass were determined by Kawashima et al. The effects of strain rate, solution temperature, and solution composition on the SCC of nickel-base and cobalt-base alloys was determined by Asphahani. Abe et al applied slow strain-rate technique to the study of SCC of sensitized stainless steel in high temperature water. Mom et al studied the effect of solution parameters and inhibitors on the SCC of austenitic, martensitic, duplex ferritic-austenitic, and ferritic stainless steels. The effect of heat treatment on SCC of a cast, low carbon, martensitic stainless in 3 percent sodium chloride was determined by Suery. Buhl compared slow strain-rate test results with constant load test results for several alloys and found good agreement for titanium alloys, high alloyed chromium stainless steels, and chromium-nickel stainless steels. Daniels compared slow strain-rate test results with other SCC tests for austenitic stainless steel in chloride solutions. Andrew et al describe applications of the slow strain-rate test technique for 12 percent chromium precipitation hardening stainless steel and 70-30 brass.

Equipment for slow strain-rate testing is described in the final section. Multiple-specimen test equipment is described in papers by Nutter et al and Lyle and Norris. Hauser et al describe a portable slow strain rate test device for use in the laboratory or a plant. Poulson describes a bursting tube test technique.

Certain general remarks also seem appropriate. Perhaps the first thing to point out is that if there was a perfect test method for stress corrosion cracking, we would all be using it exclusively. The fact that we use a variety of testing methods indicates that there is not a single, perfect method. The slow strain-rate technique is not the answer to every SCC problem. It is, of course, really no greater in its impact than that of the effort that is put into it by the user.

Many of the problems associated with slow strain-rate testing are dealt with in several of the papers in this volume. It is worth reminding ourselves that many of the points made could be made equally well for many other methods of testing. The problems that we get into with slow strain-rate testing are not necessarily uniquely a function of that test method. There are other methods where essentially the same problems exist. This is pointed out here because there is always the chance with a new technique like slow strain-

rate testing that some people will expect too much of the test. We have gone through this exercise before in relation to, for example, the precracked, fracture mechanics type test for SCC. There are very obvious limitations on slow strain-rate testing as observed in practice. For example, it does not give a stress or stress intensity at least in simplest form that the engineer can use directly in design calculations. The very difficult problem that remains is that of trying to relate the slow strain-rate type of testing to practical or engineering decisions. This is obviously an area on which we will still have to continue to work.

In spite of the challenges present for improving the slow strain-rate technique, it is an extremely powerful technique as is attested to by the many papers in this volume. One of the major advantages of this test is the fact that results are obtained very quickly, in a matter of a couple of days. Certainly if progress continues with slow strain-rate testing as it has in the last few years, this technique will contribute greatly to our knowledge of the mechanisms for SCC and will give us a rapid test method for SCC testing.

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