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# NASA TECH BRIEF

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## Evaluation of Test Procedures for Hydrogen Environment Embrittlement

The capacity of an engineering structure to withstand an applied load is often degraded severely by the presence of hydrogen because it influences fracture behavior. The most extensively studied form of hydrogen embrittlement is that which results when hydrogen is introduced into the metal lattice by fabrication processes such as pickling or electroplating. Recently, however, technological advances in the use of gaseous hydrogen for propulsion systems or fuel-cell generation of electricity have required that detailed studies be made of the factors which produce embrittlement when clean metal surfaces are directly exposed to gaseous hydrogen.

A review has been made of available literature on hydrogen embrittlement in order to define the parameters which must be considered in the selection of a standardized test method that provides test data meaningfully related to real engineering structures. A detailed report presents a discussion of the three common and primary influences on the embrittlement process, i.e., the original location and form of the hydrogen, the reactions involved in the transport of hydrogen from its origin to some point in the metal lattice, and the embrittlement interaction itself; the influences of secondary processes are also discussed, such as impurity species in the environment, surface hydride films, and surface oxide films. A variety of test procedures are discussed.

The application of theoretical considerations to the design of test coupons and methods is illustrated for both internal (processing) and external (environment) hydrogen embrittlement. For example, design parameters for internal embrittlement must include presence, location, and severity of a stress concentrator as well as level and form of loading; test coupons must exactly duplicate processing conditions or be carried along in actual processing. For external embrittlement testing, the influence of each species in the environment must be understood, or the environment must be exactly duplicated; coupons must either contain a preexisting crack or must involve the crack-initiation stage in the fracture process. Acceptable designs and methods are indicated.

**Reference:**

Nelson, H. G.: Testing for Hydrogen Environment Embrittlement: Primary and Secondary Influences. American Society for Testing and Materials, Special Technical Publication 543, p. 152, 1974.

**Note:**

No additional documentation is available. Specific questions, however, may be directed to:

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