



Standard Specification for Pre-Treatments of Iron or Steel for Reducing Risk of Hydrogen Embrittlement¹

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INTRODUCTION

When atomic hydrogen enters steels and certain other metals, for example, aluminum and titanium alloys, it can cause a loss of ductility, load carrying ability, or cracking (usually as submicroscopic cracks) as well as catastrophic brittle failures at applied stresses well below the yield strength or even the normal design strength for the alloys. This phenomenon often occurs in alloys that show no significant loss in ductility, when measured by conventional tensile tests, and is referred to frequently as hydrogen-induced delayed brittle failure, hydrogen stress cracking, or hydrogen embrittlement. The hydrogen can be introduced during cleaning, pickling, phosphating, electroplating, autocatalytic processes, porcelain enameling, and in the service environment as a result of cathodic protection reactions or corrosion reactions. Hydrogen can also be introduced during fabrication, for example, during roll forming, machining, and drilling, due to the breakdown of unsuitable lubricants as well as during welding or brazing operations. Parts that have been machined, ground, cold-formed, or cold-straightened subsequent to hardening heat treatment are especially susceptible to hydrogen embrittlement damage.

The results of research work indicate that the susceptibility of any material to hydrogen embrittlement in a given test is related directly to its trap population. The time-temperature relationship of the heat treatment is therefore dependent on the composition and structure of steels as well as plating metals and plating procedures. Additionally, for most high-strength steels, the effectiveness of the heat treatment falls off rapidly with a reduction of time and temperature.

1. Scope

1.1 This specification covers procedures for reducing the susceptibility or degree of susceptibility to hydrogen embrittlement or degradation that may arise in electroplating, autocatalytic plating, porcelain enameling, chemical conversion coating, and phosphating and the associated pretreatment processes. This specification is applicable to those steels whose properties are not affected adversely by baking at 190 to 230°C or higher (see 6.1.1).

1.2 The heat treatment procedures established herein have been shown to be effective for reducing the susceptibility of steel parts of tensile strength 1000 MPa or greater that have been machined, ground, cold-formed, or cold-straightened subsequent to heat treatment. This heat-treatment procedure is used prior to any operation capable of hydrogen charging the

parts, such as the cleaning procedures prior to electroplating, autocatalytic plating, porcelain enameling, and other chemical coating operations.

NOTE 1—1 MPa = 145.1 psi.

1.3 This specification has been coordinated with ISO/DIS 9587 and is technically equivalent.

1.4 The values stated in SI units are to be regarded as the standard.

2. Referenced Documents

2.1 *ASTM Standards*:²

[A919 Terminology Relating to Heat Treatment of Metals \(Withdrawn 1999\)](#)³

[B242 Guide for Preparation of High-Carbon Steel for Electroplating](#)

¹ This specification is under the jurisdiction of ASTM Committee B08 on Metallic and Inorganic Coatings and is the direct responsibility of Subcommittee B08.02 on Pre Treatment.

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

³ The last approved version of this historical standard is referenced on www.astm.org.