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Standard Guide for Post-Coating Treatments of Steel for Reducing Risk of Hydrogen Embrittlement[1]

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INTRODUCTION

When atomic hydrogen enters steel, 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.

1. Scope

1.1 This guide covers procedures for reducing the susceptibility in some steels to hydrogen embrittlement or degradation that may arise in the finishing processes.

1.2 The heat treatment procedures established herein may be effective for reducing susceptibility to hydrogen embrittlement. This heat-treatment procedure shall be used after plating operations but prior to any secondary conversion coating operation.

1.3 This guide has been coordinated with ISO/DIS 9588 and is technically equivalent.

NOTE 1—The heat treatment does not guarantee complete freedom from the adverse effects of hydrogen degradation.

2. Referenced Documents

2.1 *ASTM Standards:*

A 919 Terminology Relating to Heat Treatment of Metals[2]

B 374 Terminology Relating to Electroplating[3]

B 851 Specification for Automated Controlled Shot Peening of Metallic Articles Prior to Nickel, Autocatalytic Nickel, or Chromium Plating, or as Final Finish[3]

2.2 *ISO Standards:*

ISO 2080 Electroplating and Related Processes—Vocabulary[4]

ISO DIS 9588 Post-Coating Treatments of Iron or Steel for Reducing the Risk of Hydrogen Embrittlement[4]

2.3 *Federal Standard:*

QQ-C-320 Chromium Plating (Electrodeposited)[5]

3. Terminology

3.1 *Definitions*—Many of the terms used in this guide can be found in Terminology B 374, A 919, or ISO 2080.

4. Requirements

4.1 Heat treatment may be performed on coated metals to reduce the risk of hydrogen embrittlement. The duration of heat treatment in all cases shall commence from the time at which the whole of each part attains the specified temperature.

4.2 Parts made from steel with actual tensile strengths ≥1000 MPa (with corresponding hardness values of 300 HV_{10kgf}, 303 HB, or 31 HR_C) and surface-hardened parts may require heat treatment unless Class ER-0 is specified. Preparation involving cathodic treatments in alkaline or acid solutions shall be avoided. Additionally, the selection of electroplating solutions with high cathodic efficiencies is recommended for steel components with tensile strengths above 1400 MPa (with corresponding hardness values of 425 HV_{10kgf}, 401 HB, or 43 HR_C).

[1] This specification is under the jurisdiction of ASTM Committee B-8 on Metallic and Inorganic Coatings and is the direct responsibility of Subcommittee B08.02 on Substrate Preparation.

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[2] *Annual Book of ASTM Standards*, Vol 01.02.

[3] *Annual Book of ASTM Standards*, Vol 02.05.

[4] Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

[5] Available from DODSSP, Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111.