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Metallic materials — Tensile testing — Method for evaluating the susceptibility of materials to the effects of high-pressure gas within hollow test pieces

Matériaux métalliques — Essais de traction — Méthode d'évaluation des changements de propriétés dans un environnement gazeux à haute pression en utilisant une pièce d'essai creuse

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Introduction

Hollow test pieces have been occasionally used for the evaluation of influence of hydrogen[~~1~~][1] since the 1950's. But those hollow test pieces were mostly shaped with thin walls or in a tubular form, and the deformation behaviour was different from that of solid test piece; as a result, neither the percentage elongation after fracture (the elongation) nor the percentage reduction of area (the reduction of area) can be accurately obtained. ~~-~~The influence of a high-pressure hydrogen gas environment has been conventionally evaluated using a solid test piece within a gas-filled cylinder or vessel with the tensile force applied from outside the vessel to evaluate the influence of the hydrogen gas on the material under test as described in ASTM G 142[~~2~~][2] or ISO 11114-4.[~~3~~][3].

Since 2005, the use of a hydrogen gas filled hollow test piece has been utilized as a method to evaluate changes in tensile properties of metallic materials due to concurrent exposure to gaseous hydrogen. It was found in previous studies[~~4~~] [~~9~~][4]-[9] that testing of a hollow test piece with a small diameter axial hole pressurized with gaseous hydrogen yielded similar trends for both the elongation and the reduction of area to testing of solid test pieces stored in a similar gaseous environment. For this reason, this method has been considered a material screening test method for evaluation of metallic materials in gaseous hydrogen and the resulting data are not suitable for design.

This document does not address the determination of entirely the same values of mechanical properties for design purposes as specified by the ISO 6892 series but is suitable as a screening or first selection method for metallic materials in a gaseous or liquid media. The hollow test piece is suitable for the evaluation of materials used for high-pressure pipe or vessels, and can be used not only for hydrogen gas, but also for other gaseous or corrosive media. However, the major concerns for the hollow test piece are the hoop stress and the roughness of inner surface. In this document, the hollow test piece method is regarded for tests filled with various media and the required preparation of the test piece, such as an inner surface finish, is also described.

The type of the pressurized gas in the hollow test piece ~~could~~can affect the tensile properties in the test. Also, the specific test conditions, e.g., test speed, test gas, internal pressure, temperature, and gas purity, can affect the outcome. As this document describes in general the test procedure for the hollow test piece, it does not describe the most suitable test conditions for all possible variations of the test parameters. Preliminary tests should be conducted to identify technical relevant test conditions. Test conditions in this document will be revised with the increase of test results.