

Inspection, Assessment, and Repair of Heavy Wall Reactor Vessels in High-temperature High-pressure Hydrogen Service

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Inspection, Assessment, and Repair of Heavy Wall Reactor Vessels in High-temperature High-pressure Hydrogen Service

1 Scope

This TR documents guidance for the inspection, assessment, and repair of heavy wall reactor vessels (nominally considered a wall thickness of 50 mm (2 in.) and greater) in high-pressure hydrogen service operating at temperatures below 455 °C (850 °F). It provides industry practices dealing with reactor vessels after construction and exposure to operating conditions. It focuses on reactor vessels fabricated from 2¼Cr-1Mo, 3Cr-1Mo, 2¼Cr-1Mo-¼V, and 3Cr-1Mo-¼V steels. It also offers some guidance for heavy wall reactor vessels fabricated from 1Cr-½Mo and 1¼Cr-½Mo steels, but specifically does not pertain to C-½Mo steel vessels. However, guidance included in this document can be used for C-½Mo steel reactor vessels at the owner's discretion and with modifications as appropriate.

This document does not address damage found in hot wall catalytic reforming reactors, fluid catalytic cracking unit (FCCU) reactors, and delayed coking drums as they generally operate at higher temperatures and have thinner walls.

Since this is a technical report, it does not provide recommendations, but instead presents industry experience with case histories of repairs and recognized practices, much of which was documented as part of a Joint Industry Program (JIP) on Aging Reactor Vessels, conducted in two phases between 1995 and 2004.

2 Normative References

There are no normative references in this document.

3 Terms, Definitions, Abbreviations, and Acronyms

3.1 Terms and Definitions

For this report, the following terms and definitions apply in addition to those given in API Recommended Practices 934-A and 934-C.

3.1.1

cladding

Internal integrally bonded corrosion-resistant lining applied as a wrought product to the internal surface of a vessel, i.e. the vessel is constructed from clad plate. Clad plate is fabricated using a hot roll bonding process or an explosive bonding process and is mostly used for thinner wall reactor vessels. See also lining, overlay, and loose lining.

3.1.2

disbonding

Areas of cladding or overlay that do not have a metallurgical bond to the base metal. Disbonding can occur during fabrication, and testing is typically done to detect and repair any locations. It can also occur due to high-temperature high-pressure hydrogen service depending on the characteristics of the bond areas. Testing of cladding and overlay procedures are done before fabrication to minimize the susceptibility to disbonding.

3.1.3

J-factor

An empirical relationship used to predict temper embrittlement susceptibility of some low alloy steel grade base materials

$$\text{J-factor} = (Si + Mn) \times (P + Sn) \times 10,000$$