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Commentary on Standards Development for Selection and Qualification of HSC-Resistant Materials in Subsea Service with Cathodic Protection

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Document History

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Foreword

AMPP technical reports are intended to convey technical information or state-of-the-art knowledge regarding corrosion. In many cases, they discuss specific applications of corrosion mitigation technology, whether considered successful or not. Statements used to convey this information are factual and are provided to the reader as input and guidance for consideration when applying this technology in the future. However, these statements are not intended to be recommendations for general application of this technology and must not be construed as such.

A major standard in the oil and gas industry for material selection today is ANSI[1]/NACE MR0175/ISO[2] 15156 Parts 1-3. It deals extensively with environmental cracking and its mitigation through material selection for equipment handling sour production environments containing H_2S, CO_2, chlorides, and/or sulfur. Unfortunately, it does not include material requirements for resistance to hydrogen stress cracking (HSC) for subsea applications and conditions that may involve exposure to seawater with cathodic protection (CP). There are several other standards that identify corrosion mechanisms and parameters for evaluation when selecting materials for pipelines, piping and equipment related to hydrocarbon production, transportation and processing, including utility and injection systems; however, they do not address detailed aspects of materials selection to avoid HSC in subsea applications under CP.

The above-mentioned lack of in-depth industry standards is somewhat surprising since exposure of materials to subsea conditions with CP and risks of HSC, as shown herein, have been documented in the literature for over 50 years. Risks associated with HSC have been elevated because of several component failures in high strength materials and recent near-miss, in-service incidents in bolting/fasteners/studs in drill-through equipment operating subsea under cathodic protection. The findings in this Technical Report (TR21524) were developed to support member-driven standardization activities that were initiated in AMPP to better define material requirements for HSC-resistant metallic materials for subsea service with cathodic protection.

This Technical Report is intended as a companion document to the AMPP standard MR21525 (Hydrogen Stress Cracking Resistant Metallic Materials for Use in Subsea Oil and Gas Production with Cathodic Protection), which is in development. It provides results, review and commentary on many investigations and includes important literature data, references, background information, service experience and related standards that were utilized in the development of the AMPP MR21525. Most of the information in this Technical Report covers findings from HSC field experience and HSC data from CP exposure tests or from cathodic charging experiments. It is important to note in the use of MR21525 and in the review of data contained herein that HSC can also be induced from hydrogenating environments and conditions other than from just from CP exposure. A non-exhaustive list of such conditions is presented later in this Technical Report.

Scope

As a companion document to MR21525, this Technical Report provides results, review and commentary on many investigations of HSC and includes important literature data, references, background information, service experience and related standards that were utilized in the development of the AMPP MR21525. Most of the information in this Technical Report covers findings from HSC field experience and HSC data from brine/CP exposure tests or from other cathodic charging experiments. It is important to note, in the use of MR21525 and in the review of data contained herein, that HSC can also be induced from hydrogenating environments and conditions other than from just from CP exposure alone. A non-exhaustive list of such conditions is presented later in this Technical Report.

Rationale

This report is important as a reference guide for those wishing to understand the background information and experience used in the development of the MR21525 standard and its elevated importance because of several component failures in high strength materials and recent near-miss, in-service incidents associated with HSC. These recent events were primarily in bolting/fasteners/studs in drill-through equipment operating subsea under cathodic protection, but as shown herein, HSC failures have also occurred in other subsea materials and components over decades of subsea service experience. The findings presented in this Technical Report were developed to support member-driven standardization activities that were initiated in AMPP to better define material requirements for HSC-resistant metallic materials for subsea service with cathodic protection.

[1] American National Standards Institute (ANSI), 25 West 43rd Street, 4th Floor, New York, NY 10036, www.ansi.org.
[2] International Organization for Standardization (ISO), Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, www.iso.org.