NACE MR0103 & MR0175: A Brief History and Latest Requirements

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NACE MR0175 & MR0103

Overview

• NACE – A Look Back
• Benefits to end-user
• MR0103 & MR0175 Material Requirements, Limitations & Service Restrictions
Current NACE Specifications

• NACE MR0175/ISO 15156 – 2009 *Petroleum and natural gas industries — Materials for use in H2S-containing environments in oil and gas Production*
  - PART 1 - General principles for selection of cracking-resistant materials
  - PART 2 - Cracking-resistant carbon and low-alloy steels, and the use of cast irons
  - PART 3 - Cracking-resistant CRAs (corrosion resistant alloys) and other alloys
    - currently set to be revised again (2014 version)

• NACE MR0103 – 2012 *Materials Resistant to Sulfide Stress Cracking in Corrosive Petroleum Refining Environments*
NACE – A Look Back

Highlights

1930’s

- Focus was on cathodic protection for underground pipes
- The Mid-Continent Cathodic Protection Association (MCPA) held its first meeting on March 9, 1936 and met again on April 27, 1938
- Up until 1939, the MCPA operated separately, when they joined API as the Cathodic Protection Subcommittee
NACE – A Look Back

Highlights

➢ 1940’s

➢ In 1940 the MCPA became affiliated with the Petroleum Industry Electronic Association (PIEA)

➢ In 1942, MCPA attempted to revise the bylaws, which were rejected by PIEA. This drove members of MCPA to consider forming an independent group, specifically addressing corrosion.

➢ Several meetings over the summer of 1943 were held and on October 10 & 11, 1943 the National Association of Corrosion Engineers (NACE) was formed.

➢ Sour gas and affects of the gas were experienced in the oil & gas industries starting in West Texas, Ginger Field in the late 1940’s to early 1950’s.
NACE – A Look Back

Highlights, Con’t

➢ Early 1950’s

▪ The Canadian Jumping Pound and Pincher Fields came on experiencing similar issues with sour gas

▪ The Canadian failures were attributed to Sulfide Stress Cracking (SSC).
  ○ Considerable effort was put forth to understand and solve the Canadian failures, which would ultimately lead to safe and reliable production

▪ NACE formed the T-1G committee

▪ The purpose of the committee was to gather data and attempt to solve the H₂S cracking failures
  ○ NOTE: Many on the committee feared that if there was a disastrous event that the government would step in and require its own controls. The government standard could also hinder discussions and developments which encouraged fluid and technical discussions.
NACE – A Look Back

Highlights, Con’t

1952
- The T-1G committee held a SSC Symposium
- Multiple papers were presented discussing ten (10) failures seen in the field.
- They concluded that the failures resulted from improper material selection and how the material was processed, both of which made the materials vulnerable to $\text{H}_2\text{S}$.

1962
- The early committee work occurred in a Canada industry group that became T-1B
- The T-1B section released a report that addressed material recommendations for sour gas service in well equipment

1963
- NACE formed task group T-1F, which combined the activities of other task group activities
- They began to write valve document 1F166
NACE – A Look Back

Highlights, Con’t

1966

- T-1F issued 1F166 – “Sulfide Cracking Resistant Materials for Valves for Production and Pipeline Service”
- 1F166 consisted of
  - Production and pipeline valve document for wellhead valves up to 15,000 psi service
  - Consistent manufacturing methods
  - Gate valve materials

1975

- 1F166 was transitioned into a Materials Requirement for Valves and issued as MR0175, which became an industry standard for Christmas tree valves
NACE – A Look Back

Highlights, Con’t

- **Between 1975 and 1978**
  - Several SSC failures were experienced by the Texas Railroad Commission, which lead them to require MR0175 for all production equipment
    - This became common throughout the refining industry up until MR0103 was issued

- **1978**
  - Scope of MR0175 was expanded to include all equipment

- **1984**
  - MR0175 stopped using material trade names and referenced UNS or SAE numbers (concerned with liable action if they limited the approved materials to the trade names)

- **Late 1990’s**
  - The scope of MR0175 was expanded to include SSC cracking caused by chlorides
  - NACE approached ISO to create a global standard addressing sour environments combining the work done by NACE and European Federation of Corrosion (EFC)
NACE – A Look Back

Highlights, Con’t

2000
- NACE task group 231 was formed to create a refinery standard for sour gas
  - Would later become MR0103

2002
- By this time issues with MR0175 had accumulated since 1975
  - High temperature SSC of the corrosion resistant alloy
  - Inconsistent alloy requirements
  - Unclear rules for alloys
  - Differing interpretations
NACE – A Look Back

Highlights, Con’t

➢ Early 2003 MR0175 splits into MR0175 & MR0103
  ▪ MR0175-2003
    o Intended for oilfield production where H₂S and saltwater/brine was present
    o Many materials previously allowed were either discontinued or heavily restricted
      – Updated austenitic stainless steel requirements, which meant 300 series stainless steels may not meet the environmental requirements it once may have met
    o Clarified welding requirements for carbon steels
  ▪ MR0103-2003
    o Intended for sour refinery applications or other sour services but without saltwater/brine
    o Very similar to MR0175 pre-2003
NACE – A Look Back

Highlights, Con’t

- December 2003
  - NACE MR0175/ISO 15156 1\textsuperscript{st} Edition is issued

- 2004 to Present
  - Updates to MR0103 & MR0175/ISO15156 have consisted of adding or removing material requirements
NACE – A Look Back
Highlights, Con’t: MR0175-2003 vs MR0103-2003

MR0175 2003
Addressed fact that oilfield applications tend to contain both Hydrogen Sulfide & Chlorides
Old materials either removed or severely restricted

MR0103 2003
Refinery applications do not need protection from Chlorides
No change in allowed materials from old MR0175

Oilfield Applications
Prior to 2003
Recommended materials for Hydrogen Sulfide services

Refinery Applications

MR0175
Prior to 2003
Recommended materials for Hydrogen Sulfide services

MR0103
2003
Refinery applications do not need protection from Chlorides
No change in allowed materials from old MR0175
NACE MR0175 & MR0103

Benefit to the end-user

• Per MR0175/ISO 15156 the purpose is to provide “general principles and gives requirements and recommendations for the selection and qualification of metallic materials for service in equipment used in oil and gas production and in natural-gas sweetening plants in \( \text{H}_2\text{S} \)-containing environments . . . .”

• Per MR0103, the purpose is to “establishes material requirements for resistance to SSC in sour petroleum refining and related processing environments containing \( \text{H}_2\text{S} \) either as a gas or dissolved in an aqueous (liquid water) phase with or without the presence of hydrocarbon . . . .”

• In short, these standards reduce the risk of \( \text{H}_2\text{S} \) related cracking failures in equipment

• Benefits
  - Material requirements and recommendations for intended service
  - Minimizes health and safety accidents
  - Avoids equipment failures
  - Can extend the life of equipment that could have been subjected to \( \text{H}_2\text{S} \) cracking
# NACE MR0103 & MR0175

Material Requirements, Limitations & Service Restrictions

<table>
<thead>
<tr>
<th>Requirements &amp; Limitations (general overview)</th>
<th>NACE MR0175</th>
<th>NACE MR0103</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Material Requirements</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acceptable Materials</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Hardness Limits</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Heat Treatment Limitations</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Material Condition Limitations</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Chemical Compositions</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Welding (Fabrication)</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td><strong>Service Restrictions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exposed Bolting</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Special Component Material Requirements</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Environment Exposure Restrictions</td>
<td>x</td>
<td></td>
</tr>
</tbody>
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NACE MR0103 & MR0175
Material Requirements, Limitations & Service Restrictions

• Not all of the requirements and limitations listed on the previous page are required for every material in every standard

• These standards only address material cracking in H$_2$S environments
  • All other types of failure modes need to be addressed separately by end-user

• Allowable environmental conditions for approved uses
  - MR0175 – environmental conditions are well defined
  - MR0103 – as compared to MR0175 environmental conditions are not as well defined for the end-user. End-user judgment on conditions may be required. As an example, field experience of an unlisted alloy may be used as justification for its use

• End-user is responsible to determine:
  - Operating conditions
  - If their application falls within MR0175 or MR0103
  - If the material is satisfactory for a given service
NACE MR0103 & MR0175

Material Requirements, Limitations & Service Restrictions

• To fully specify valve compliant to NACE MR0175-2003 or newer version, the end-user must define the following environmental restrictions:
  - Max temperature
  - Max system pressure
  - Existence of elemental sulfur
  - Max chloride content
  - pH
  - Partial pressure of H$_2$S
  - Will the valve be buried or insulated?

• Manufacturer is responsible to comply with requirements set forth by end-user & to ensure the materials supplied to the end-user metallurgically comply with NACE standards

• Purchasing a NACE compliant product only means the materials conform to NACE. It does not mean that the selected material is acceptable for all NACE MR0175 services.
References

• References:
  • NACE MR0103, Multiple Versions
  • NACE MR0175, Multiple Versions