ITA Industrial Applications Committee

• Committee overview

• Update on NACE MRO 175 Grade 12 Project

• Invitation for members to participate in Industrial Committee
1. Our mission is to facilitate new applications for titanium in industrial markets:
   - Remove barriers to application
     - Technology for welding and machining
     - Product form availability
   - Assure specifications are updated and appropriate
     - NACE MRO 175/ISO 15156
       - Identified as a high priority target
# Industrial Application Committee

1. Chuck Young-Tricor Metals  
2. Regis Baldauff-Titanium Industries  
3. Bill Bieber-Webco Industries  
4. Rob Henson-VSMPO Tirus US  
5. Mike Stitzlein-Tricor Metals  
6. Mitch Dziekonski-Titanium Engineers  
7. Larry Haubner-Titan Metal Fabricators  
8. Wendy McGowan-Neotiss  
9. Chris Wilson-Uniti Titanium  
10. Sarah Standlee-Element
Why ISO 15156/MRO 175?

1. Specification title:
   – Petroleum and natural gas industries materials for use in H2S-containing environments in oil and gas production.

2. 70% of world oil reserves and 40% of gas reserves contain high levels of sulfur

3. With energy demand growing the production of sour resources will increase dramatically
NACE MRO 175/ISO 15156

Specific guidelines shall be followed for successful applications of each titanium alloy specified in this part of ANSI/NACE MR0175/ISO 15156. For example, hydrogen embrittlement of titanium alloys can occur if these alloys are galvanically coupled to certain active metals (e.g., carbon steel) in H2S-containing aqueous media at temperatures greater than 80 °C (176 °F).

Some titanium alloys can be susceptible to crevice corrosion and/or SSC in chloride environments.

Hardness has not been shown to correlate with susceptibility to SSC/SCC. However, hardness has been included for alloys with high strength to indicate the maximum testing levels at which failure has not occurred.“
NACE MRO 175/ISO 15156

1. Issues with Gr 12 (UNS 53400)
   - UNS R53400 shall be in the annealed condition. Heat treatment shall be annealing at (774 ± 14) °C [(1 425 ± 25) °F] for 2 hours followed by air-cooling.
   - Maximum hardness shall be 92 HRB.
     • UNS 50400 (Gr 2) has a max hardness of 100 HRB
The issues

• Specific guidelines are referenced but guidelines are incomplete
  • Incomplete information about environments which can cause hydrogen embrittlement

• Confusing statement about hardness not being applicable but included to show maximum level tested
  • Process requirements rather than property requirements
Background

- International Titanium Association (ITA) working with Element to revise requirements for UNS R53400 (Titanium Grade 12) in the NACE MR0175 / ISO 15156-3 Standard.

- Original ballot wording was submitted for a specific batch annealed product, which precludes manufacturing with continuous anneal processing.
Document Changes

• Table A.41 footnote c) currently reads:

  • UNS R53400 shall be in the annealed condition. Heat treatment shall be annealing at (774±14)°C [(1,425±25)°F] for 2 h followed by air-cooling. Maximum hardness shall be 92 HRB.

• Propose the following:

  • UNS R53400 shall be in the annealed condition.
Test Plan

• Three specimens from three different heats of material from two suppliers:
  • VDM Metals and Uniti Titanium

• Corrosion testing consisted of the following:
  • Sulfide stress cracking (SSC)
  • Galvanic hydrogen stress cracking (GHSC)
  • Stress corrosion cracking (SCC)
## Materials Properties

<table>
<thead>
<tr>
<th>Heat</th>
<th>Fe</th>
<th>Mo</th>
<th>Ni</th>
<th>O</th>
<th>N</th>
<th>H</th>
<th>C</th>
<th>YS @ Room Temp (ksi)</th>
<th>YS @ 204°C (ksi)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>UNS R53400 Requirements</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>50 Min</td>
<td>-</td>
</tr>
<tr>
<td>612712A</td>
<td>0.06</td>
<td>0.30</td>
<td>0.77</td>
<td>0.142</td>
<td>0.004</td>
<td>0.0012</td>
<td>&lt; 0.005</td>
<td>54.2</td>
<td>25.3</td>
</tr>
<tr>
<td>EM30JL</td>
<td>0.11</td>
<td>0.31</td>
<td>0.76</td>
<td>0.142</td>
<td>0.001</td>
<td>&lt; 0.0010</td>
<td>&lt; 0.005</td>
<td>54.7</td>
<td>26.3</td>
</tr>
<tr>
<td>EM62JX</td>
<td>0.11</td>
<td>0.29</td>
<td>0.71</td>
<td>0.165</td>
<td>0.004</td>
<td>0.0043</td>
<td>0.005</td>
<td>60.0</td>
<td>27.9</td>
</tr>
</tbody>
</table>
## Materials

Grain Structure: Annealed Recrystallized Grains

<table>
<thead>
<tr>
<th></th>
<th>612712A</th>
<th>EM30JL</th>
<th>EM62JX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Image</td>
<td><img src="612712A.png" alt="Image" /></td>
<td><img src="EM30JL.png" alt="Image" /></td>
<td><img src="EM62JX.png" alt="Image" /></td>
</tr>
</tbody>
</table>
Sulfide Stress Cracking
(NACE TM0177 Method A)

• NACE TM0177 Solution A: 5%wt NaCl and 0.5%wt CH₃COOH in deionized water
• Ambient temperature and pressure
• Continuous bubbling with H₂S

RESULTS: No observable cracking
Galvanic Hydrogen Stress Cracking
(NACE TM0177 Method A, Coupled to Carbon Steel)

- NACE TM0177 Solution A: 5%wt NaCl and 0.5%wt CH₃COOH in deionized water
- Ambient temperature and pressure
- Electrically coupled to carbon steel
- Continuous bubbling with H₂S

**RESULTS:** No observable cracking
Stress Corrosion Cracking (NACE TM0177 Method A)

- NACE MR0175 Level VII with elemental sulfur
  - 25%wt NaCl in deionized water with 1 g/L S⁰ in a stirred autoclave
  - 500 psi H₂S and 500 psi CO₂ at a test temperature of 205°C
- Stress applied to 100% AYS of material at 204°C
- Test duration 90 days

- **RESULTS:** No observable cracking
Next Step

1. Ballot proposal will be submitted to the MR0175 / ISO 15156-3 Maintenance Panel and TG299 Oversight committees for approval.
2. Maintenance Panel will have 30 days to respond and any negative responses must be resolved.
3. Approval by TG299 Oversight committee required after clearing Maintenance Panel.
4. Ballot will be submitted near term so we have time to address responses before the fall meeting of Maintenance Panel at EuroCorr 2018.
Interested to Participate?

1. New members are welcome
   – Any ITA member can join
   – Periodic conference calls and e-mail communication
   – Committee needs global participation

2. Contact Jennifer Simpson to discuss participation in the committees
Questions & Answers