To Pickle or Not To Pickle

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Corrosion Solutions
Sept 2009
Two Reasons To Pickle

• Post Weld Cleaning
  • Weld zone heat tint
  • Not Spatter
  • Not Slag

• Remove Surface Contamination
  • Rust Bloom or Embedded Rust
  • Not Markings
  • Not Scratches
Weld Defects

- Embedded Iron or Rust
- Weld Spatters
- Scratch
- Heat Tint
- Arc Strike
- Undercut
- Rough Grinding Burr
- Paint
Heavy Heat Tint
Corrosion in Heat Tint Area
Repaired Weld Spatter
Un removed Slag
Identification Marking
Surface Scratch
(with imbedded iron)
Things to Consider Before Pickling

- **Alloy Selected**
- Austenitic SS
- Duplex SS
- Safety Margin Required

- **Corrosion Environment**
- Localized corrosion
- General Corrosion
What is Heat Tint

- SS have a thin passive layer on their surface

- With exposure to O2 at high temperature (400 – 1300F), a thin “straw tinted” Cr2O3 layer forms

- As a result a Cr depleted layer forms beneath the heat tint
What is Heat Tint

- With additional exposure and additional O2 pickup the Cr2O3 layer becomes unstable

- A more volatile CrO3 “dark blue/black” layer is formed

- There is an increase in Fe content at the surface
What is Heat Tint

Figure 1. How heat tint leads to loss of corrosion resistance. Formation of a chromium-rich oxide leads to a chromium-depleted zone below.
Corrosive Environment Effect

- **Localized Corrosion**
  - Can break through heat tint and attack Cr depleted zone

- **General Corrosion**
  - May break through heat tint and dissolve Cr depleted zone restoring base corrosion resistance
Heat Tint Color Level Reference

- The FORCE Institute, Denmark
  Reference Color Charts – report 94.54

Fig. 3 Using a Reference Colour Chart, it is possible to specify an acceptable heat tint on and adjacent to TIG welds on stainless steel piping. This permits visual inspection as well as video endoscopy. Courtesy of FORCE Institute.
Alloy Selected

- **Austenitic SS**
  - May be resistant to localized attack under thin “straw colored” heat tint
  - General corrosion environment should remove heat tint with no further attack

- **Duplex SS**
  - Less resistant to localized attack even under thin “straw colored” heat tint
  - General corrosion environment should remove heat tint with no further attack
What is Surface Rust

- Contamination of the surface by particles of carbon steel
- Rust bloom is usually fine particles lightly adhering to the surface (usually can be removed with a pencil eraser)
- Embedded rust is larger particles of carbon steel which have been driven into the stainless steels surface
Corrosive Environment Effect

- **Localized Corrosion**
  - Will attack the pit created by an embedded particle

- **General Corrosion**
  - Could attack the area around an embedded particle more aggressively than the base material
Alloy Selected

- **Austenitic SS**
  - Will be susceptible to localized attack under embedded particles
  - General corrosion environment should remove rust bloom with no further attack

- **Duplex SS**
  - Will be susceptible to localized attack under embedded particles
  - General corrosion environment should remove rust bloom with no further attack
## Cost Implications

Pickling cost as a % of fabricated Tank Cost

<table>
<thead>
<tr>
<th>Diam/Height</th>
<th>20’ (gals)</th>
<th>50’ (gals)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10’</td>
<td>6.5 / 7.5</td>
<td>23500</td>
</tr>
<tr>
<td>20’</td>
<td>7.7 / 8.3</td>
<td>47000</td>
</tr>
<tr>
<td>30’</td>
<td>8.4 / 8.8</td>
<td>71000</td>
</tr>
<tr>
<td>40’</td>
<td>8.1 / 8.1</td>
<td>95000</td>
</tr>
<tr>
<td>50’</td>
<td>8.3 / 9.8</td>
<td>118000</td>
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</table>
## Cost Implications

**Pickling cost $ vs. Fabricated Tank cost $**

<table>
<thead>
<tr>
<th>Diam/Height</th>
<th>20’</th>
<th>20’</th>
<th>50’</th>
<th>50’</th>
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<tbody>
<tr>
<td></td>
<td>Pickle K$</td>
<td>Pickle K$</td>
<td>Pickle K$</td>
<td>Pickle K$</td>
</tr>
<tr>
<td></td>
<td>Total K$ 304/316</td>
<td>Total K$ 2304/2205</td>
<td>Total K$ 304/316</td>
<td>Total K$ 2304/2205</td>
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<tr>
<td>10’</td>
<td>4</td>
<td>5</td>
<td>16</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>60 / 63</td>
<td>66 / 68</td>
<td>206 / 222</td>
<td>223 / 238</td>
</tr>
<tr>
<td>20’</td>
<td>6</td>
<td>7</td>
<td>18</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>76 / 80</td>
<td>83 / 86</td>
<td>250 / 269</td>
<td>270 / 288</td>
</tr>
<tr>
<td>30’</td>
<td>8</td>
<td>9</td>
<td>21</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>92 / 97</td>
<td>100 / 105</td>
<td>293 / 317</td>
<td>317 / 338</td>
</tr>
<tr>
<td>40’</td>
<td>9</td>
<td>12</td>
<td>23</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>108 / 114</td>
<td>117 / 123</td>
<td>340 / 368</td>
<td>363 / 388</td>
</tr>
<tr>
<td>50’</td>
<td>11</td>
<td>14</td>
<td>25</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>128 / 136</td>
<td>139 / 146</td>
<td>404 / 437</td>
<td>422 / 450</td>
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</table>
So “What to Do”

<table>
<thead>
<tr>
<th>Evaluate Condition</th>
<th>Evaluate Corrosion</th>
<th>Understand Alloy Selection</th>
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</thead>
<tbody>
<tr>
<td>• Heat Tint</td>
<td>• Localized</td>
<td>• Duplex SS</td>
</tr>
<tr>
<td>• Surface Contamination</td>
<td>• General</td>
<td>• Austenitic SS</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Evaluate Safety Margin</th>
<th>Determine Pickling Needed</th>
<th>Weigh Cost Implications</th>
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</thead>
<tbody>
<tr>
<td>• Pushed to the limit</td>
<td>• Weld Areas</td>
<td>• Cost of pickle and disposal</td>
</tr>
<tr>
<td>• Over alloyed</td>
<td>• Larger surface Areas</td>
<td>• Cost of premature failure</td>
</tr>
</tbody>
</table>
Recommendations for Heat Tint

• Localized Corrosion Environment
  Pickle for all alloy/tint combinations

• General Corrosion Environment
  Pickle dark blue/black heat tints
  Consider leaving light “straw” colored heat tints
Recommendations for Surface Rust

• Embedded Rust Particles
  Pickle for all alloy/environment combinations

• Surface Rust Bloom
  Make sure it is lightly adherent (eraser method)
  If it is leave it for all alloy/environment combinations
Test Medium: $10\% \text{ FeCl}_3 \cdot 6\text{H}_2\text{O}$

- Basic Material
- Weld
- Heat-affected Zone

Surface Conditions

A: original conditions (oxide coating, welding scale)

B: pickled with liquid pickle ($\text{HNO}_3 + \text{HF}$)

E: pickled with Antox 71 E (Metasco)
Test Medium: 10% FeCl₃ 6H₂O

- Basic Material
- Weld
- Heat-affected Zone

Surface Conditions

C  ground
(disk coarseness 60)

F  blasted with glass beads

E  pickled with Antox 71 E (Metasco)
Test Medium: 10% FeCl$_3$ 6H$_2$O

- Basic Material
- Weld
- Heat-affected Zone

Surface Conditions

C  ground  
  (disk coarseness 60)

D  ground and pickled with Antox 71 E (Metasco)

E  pickled with Antox 71 E (Metasco)
Test Medium: $10 \% \text{ FeCl}_3 \cdot 6\text{H}_2\text{O}$

- Basic Material
- Weld
- Heat-affected Zone

Surface Conditions

- \text{F} \quad \text{blasted with glass beads}
- \text{E} \quad \text{pickled with Antox 71 E (Metasco)}
- \text{G} \quad \text{blasted and pickled with Antox 71 E (Metasco)}
IN SUMMARY

WHEN

IN

DOUBT????? PICKLE!!!!