NACE Beaumont Texas Meeting

November 19, 2013
The American Petroleum Institute was established on March 20, 1919:
to afford a means of cooperation with the government in all matters of national concern
to foster foreign and domestic trade in American petroleum products
to promote in general the interests of the petroleum industry in all its branches
to promote the mutual improvement of its members and the study of the arts and sciences connected with the oil and natural gas industry.
Standardization
The second effort was the standardization of oil field equipment. During World War I, drilling delays resulted from shortages of equipment at the drill site, and the industry attempted to overcome that problem by pooling equipment. The program reportedly failed because there was no uniformity of pipe sizes, threads and coupling. Thus, the new association took up the challenge of developing industry-wide standards and the first standards were published in 1924.

Today, API maintains more than 500 standards and recommended practices covering all segments of the oil and gas industry to promote the use of safe, interchangeable equipment and proven and sound engineering practices.
Coatings and Engineering Standards Organizations

NACE-National Association of Corrosion Engineers

SSPC-The Society for Protective Coatings

ANSI-American National Standards Institute

ASME-American Society of Mechanical Engineers

ASTM-American Society for Testing and Materials

ISO-International Organization for Standardization

PIP-Process Industry Practices

AWS-American Welding Society
Refining and Equipment Standards

Mechanical Equipment

Aboveground Storage Tank

Heat Transfer Equipment

Piping and Valves

Refining Equipment

Fitness-for-Service

Instrument and Control Systems

Pressure Relieving Systems
Refining and Equipment Standards

Corrosion and Materials

Inspection
Corrosion and Materials Subcommittees

RP 571 - Damage Mechanisms Affecting Fixed Equipment in the Refining Industry

RP 582 - Welding Guidelines for the Chemical, Oil, and Gas Industries

RP 934-G - Coke Drums

Std. 936 - Refractory Installation Quality Control Specification - Inspection and Testing Monolithic Refractory Linings and Materials
Corrosion and Materials Subcommittees

API 510 - Pressure Vessel Inspection Code
API 570 - Piping Inspection Code
RP 572 - Inspection of Pressure Vessels
RP 573 - Inspection of Fired Heaters and Boilers
RP 574 - Inspection of Piping System Components
RP 575 - Inspection of Aboveground Storage Tanks
RP 576 - Inspection of Pressure-Relieving Devices
RP 577 - Inspection of Welding and Metallurgy
RP 578 - Material Verification Program for New and Existing Alloy Piping
RP 580 - Risk-Based Inspection
RP 581 - Risk-Based Inspection Methodology
RP 583 - Corrosion Under Insulation
RP 574 - Inspection of Piping System Components

7.4.4 CUI

7.4.4.1 Insulated Piping Systems Susceptible to CUI

7.4.4.2 Typical Locations on Piping Circuits Susceptible to CUI
RP 580 - Risk-Based Inspection

a) understanding the design premise;
b) planning the RBI assessment;
c) data and information collection;
d) identifying damage mechanisms and failure modes;
e) assessing probability of failure;
f) assessing consequence of failure;
g) risk determination, assessment and management;
h) risk management with inspection activities and process control;
i) other risk mitigation activities;
j) reassessment and updating;
A Joint Industry Project for Risk-Based Inspection (API RBI JIP) for the refining and petrochemical industry was initiated by the American Petroleum Institute in 1993. The API RBI JIP made improvements to the technology in *API RP 581, Second Edition* in 2008 when the software development was split from methodology development. Since that project separation in November 2008, the API 581 task group has been improving the methodology and revising the document for a Third Edition release in 2014.
RP 583 - Corrosion Under Insulation
And
Fireproofing
CUI is one of the most destructive forces in all industries, simple because it goes unseen.
Typical Test Methods for Elevated Temperature Coatings

ASTM B-117: Salt Fog Chamber 3500-4500 hours

- ASTM 2485: This test ensures adhesion based on CTE after severe thermal shock
- ASTM 2402: Mass loss is critical in determining porosity and longevity of a coating
- EIS Testing: Electrical Impedance Spectroscopy, permeability before and after thermal exposure
## Typical Protective Coating Systems for Carbon Steels Under Thermal Insulation and Fireproofing

<table>
<thead>
<tr>
<th>System Number</th>
<th>Temperature Range (A)(B)</th>
<th>Surface Preparation</th>
<th>Surface Profile, µm (mil) (c)</th>
<th>Prime Coat, µm (mil) (D)</th>
<th>Finish Coat, µm (mil) (D)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS-1, CS-2, CS-3</td>
<td>Epoxy, Fusion Bonded Epoxy, Epoxy Phenolic</td>
<td>minus 110° to 302°F [minus 45° to 150°C]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CS-4</td>
<td>-45° to 205°C (-50 to 400°F)</td>
<td>NACE No. 2 / SSPC-SP 10</td>
<td>50-75 (2-3)</td>
<td>Epoxy novalac or silicone hybrid, 100-200 (4-8)</td>
<td>Epoxy novalac or silicone hybrid, 100-200 (4-8)</td>
</tr>
<tr>
<td>CS-5</td>
<td>-45° to 595°C (-50 to 1100°F)</td>
<td>NACE No. 1 / SSPC-SP 5</td>
<td>50-100 (2-4)</td>
<td>TSA, 250-375 (10-15) with minimum of 99% aluminum</td>
<td>Optional: Sealer with either a thinned epoxy-based or silicone coating (depending on maximum service temperature) at approximately 40 (1.5) thickness</td>
</tr>
<tr>
<td>CS-6</td>
<td>-45° to 650°C (-50 to 1200°F)</td>
<td>NACE No. 2 / SSPC-SP 10</td>
<td>40-65 (1.5-2.5)</td>
<td>Inorganic copolymer or coatings with an inert multipolymeric matrix, 100-150 (4-6)</td>
<td>Inorganic copolymer or coatings with an inert multipolymeric matrix, 100-150 (4-6)</td>
</tr>
<tr>
<td>CS-7</td>
<td>Petroleum wax primer; ambient to 140°F [60°C]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CS-8</td>
<td>Shop primers and topcoats for inorganic zinc (IOZ)</td>
<td>minus 110° to 750°F [minus 45° to 400°C]</td>
<td>Novolac, phenolic, inorganic copolymer and inert polymeric matrix</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Testing & Physical Properties

<table>
<thead>
<tr>
<th>CRITERIA</th>
<th>Thermal Spray Aluminum (TSA)</th>
<th>Inorganic Ceramic Inert High Build</th>
<th>High Build CSA, Aluminum, Titania Coatings</th>
<th>Phenolic / Novalac Glass Filled or MIO Filled</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density of Film [gm/cm³]</td>
<td>2.7</td>
<td>5.2</td>
<td>2.5 - 3.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Mass Retention @ 400°F [204°C] Isothermal Service</td>
<td>100%</td>
<td>92%</td>
<td>80% - 85%</td>
<td>75% - 80%</td>
</tr>
<tr>
<td>CUI Chamber Test Method II 5% NaCl</td>
<td>FAIL</td>
<td>PASS</td>
<td>FAIL</td>
<td>FAIL</td>
</tr>
<tr>
<td>Chemical Resistance</td>
<td>NO</td>
<td>YES</td>
<td>NO</td>
<td>YES</td>
</tr>
<tr>
<td>CTE (10⁻⁶)/ °C ambient to 600°C</td>
<td>17</td>
<td>10</td>
<td>5 internal/20 surface</td>
<td>17-20</td>
</tr>
<tr>
<td>Porosity/Permeability [impedance Spectroscopy]</td>
<td>5%</td>
<td>6-8%</td>
<td>10-17% NA</td>
<td>6-10% Good</td>
</tr>
<tr>
<td>DFT Fracture Limits (Cyclic Immersion)</td>
<td>15 mils [375 microns]</td>
<td>18-20 mils [450-500 microns]</td>
<td>8-10 mils [200-250 microns]</td>
<td>8 mils [200 microns]</td>
</tr>
<tr>
<td>Coatings hardness ASTMD3363 (ambient Temperature)</td>
<td>H+</td>
<td>4B</td>
<td>6B</td>
<td>3H</td>
</tr>
</tbody>
</table>
# Mass Loss Test Data

## ASTM 2402 Mass Loss Comparison

<table>
<thead>
<tr>
<th>Product</th>
<th>400°F</th>
<th>600°F</th>
<th>800°F</th>
<th>1000°F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inorganic Ceramic Inert</td>
<td>1.0</td>
<td>3.2</td>
<td>7.3</td>
<td>9.6</td>
</tr>
<tr>
<td>High Build Cold Spray Aluminum (CSA)</td>
<td>1.5</td>
<td>5.1</td>
<td>11.7</td>
<td>21.2</td>
</tr>
<tr>
<td>Inorganic Co-Polymer / Aluminum Titania Siloxane</td>
<td>1.8</td>
<td>5.3</td>
<td>10.9</td>
<td>16.7</td>
</tr>
<tr>
<td>Glass Filled or MIO Filled Phenolic Novolac Epoxy</td>
<td>2.0</td>
<td>6.0</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>
Your #$&* Coating Failed!
We offer three kinds of service:
GOOD - CHEAP - FAST
You can pick any two
GOOD service CHEAP won’t be FAST
GOOD service FAST won’t be CHEAP
FAST service CHEAP won’t be GOOD