Keyhole Update - Coating and Wrapping

Fall 2012 Meeting
>Dennis Jarnecke
Coating and Wrapping Outline

> Evaluations of alternatives
  – Hot wax pumped into developed enclosure (Tellus)
  – Terrathane polyurethane evaluation
  – Poly-Set - Polyurethane insulation evaluation

> Need:
  – Industry has requested alternative solutions to effectively coat and wrap metallic components (pipe, fittings, etc.) in keyholes. The application of wax tapes and other traditional products is cumbersome and difficult to apply in keyholes.
  – Corrosion groups have raised questions about applying coatings in keyholes.
# Summary of Past Research

> Evaluation of five materials:

| Coating         | Description                        | Comments                                                        |
|-----------------|------------------------------------|                                                                |
| Poly-Set        | Polyurethane foam                  | Fast and easy                                                  |
| Permabond       | Two part polyurethane pumped into polyurethane bag | Some previous testing at GTI with good results                  |
| Trenton wax tape| Standard petrolatum wax tape       | Included as a benchmark                                         |
| Powerset 100    | Two part hybrid urea-polyurethane  | Fast curing, maybe difficult to get complete coverage           |
| Buzzi Unicem Utility Fill | One step flowable fill | Fast and easy                                                  |
Test Procedures

- Complex geometry steel service tee
- Fittings immersed in a highly corrosive environment
  - Saturated in a 5% salt solution
  - 110°F for over 3000 hrs
Corrosion Rating (ASTM D610)

Rating:
10: ≤ 0.01%
9: 0.01% to 0.03%
8: 0.03% to 0.1%
7: 0.1% to 0.3%
6: 0.3% to 1%
5: 1% to 3%
4: 3% to 10%
3: 10% to 16%
2: 16% to 33%
1: 33% to 50%
0: > 50%
Follow-on Evaluation

> Refinement
  ─ Powerset:
    > Displayed adequate results only when applied in an enclosure that adequately enclosed sample
    > Powerset began development of a keyhole application system
  ─ Polyset:
    > Voids were found in the cross section of the Polyset coating
    > Concern over cure temperature
Follow-on Evaluation

> Powerset

  ─ **Goal** - to ensure application on entire fitting when in a keyhole
  ─ Cartridge gun sourced by Powerset, and acquired by GTI
  ─ Application nozzles bent to ensure coating of fitting underside
  ─ Three evaluations conducted at varying pressures and outlet flows
  ─ Applications in keyhole stand
Follow-on Evaluation

Tellus Underground Corrosion Protection System

- A molded enclosure is used to encapsulate the pipe & fitting
- Hot wax (120 – 125 °F) is pumped into fitting
- Wax pumped in until all the air is pushed out of the enclosure (wax exists from the top 2 tubes)
Follow-on Evaluation

Tellus Underground Corrosion Protection System (continued)

- Visual examination of the pipe revealed no rust spots within the wax-filled portion.
- There were a few light rust spots at the extreme ends (collar) of the enclosure probably where wax was unable to flow in.
Follow-on Evaluation

Tellus Underground Corrosion Protection System (continued)

- After 1000 hour salt test
- Cycling moisture level

<table>
<thead>
<tr>
<th></th>
<th>ASTM D610 rating</th>
<th>% Rust</th>
</tr>
</thead>
<tbody>
<tr>
<td>within wax-filled volume</td>
<td>10</td>
<td>0.0</td>
</tr>
<tr>
<td>under enclosure collar</td>
<td>6</td>
<td>1.0</td>
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</table>
Follow-on Evaluation

> Expanding Polyurethane Foam Products
  ─ Two products (various formulas) tested to date:
    > Poly-Set
    > Terrathane
  ─ One additional product – Advanced-Tec Materials

<table>
<thead>
<tr>
<th>POLYURETHANE FOAM PRODUCT</th>
<th>DESCRIPTION</th>
<th>COMMENTS</th>
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<tbody>
<tr>
<td>POLY-SET</td>
<td>Original formula, hydro-insensitive</td>
<td>Numerous cracks observed in test pours, both vertical and horiz.</td>
</tr>
<tr>
<td>POLY-SET HD</td>
<td>Higher density than regular Poly-Set</td>
<td>Cracks as frequent as regular Poly-Set</td>
</tr>
<tr>
<td>POLY-SET STANDARD</td>
<td>Not hydro-insensitive, no longer available</td>
<td></td>
</tr>
<tr>
<td>POLY-SET (new formula)</td>
<td>New 2012 formula, hydro-insensitive</td>
<td>Med/ hvy cracking along pipe, not continuous to cylinder surface</td>
</tr>
<tr>
<td>TERRATHANE 24-029</td>
<td>This foam was designed for keyhole applications</td>
<td>Heavy splitting in test pour along pipe</td>
</tr>
<tr>
<td>TERRATHANE 24-023</td>
<td>Designed for high thicknesses without splitting</td>
<td>Very short reaction time not practical for hand mixing</td>
</tr>
<tr>
<td>NCFI TERRATHANE 27-004</td>
<td>Designed for slow reactivity, excellent flow</td>
<td>Med/ hvy cracking along pipe, not continuous to cylinder surface</td>
</tr>
<tr>
<td>NCFI TERRATHANE 24-120028</td>
<td>Designed for slow reactivity, excellent flow</td>
<td>Some splitting in center of cylinder only, least of any foam tested.</td>
</tr>
</tbody>
</table>
Follow-on Evaluation

> Poly-set Expanding Polyurethane
  – Poly-set New Formula
    > Eliminates voids but a horizontal crack now present
    > Cure Temperature: 200 – 240 °F
    > Sharing findings with manufacturer
Follow-on Evaluation

> Terrathane Expanding Polyurethane
  - Two additional products evaluated, #27-004, #24-120028
    > Horizontal cracking found following evaluation
    > Similar temperature found during curing as with Poly-set (200 - 240 °F)
Follow-on Evaluation

Pending issues with the Polyurethane foams evaluated to date:

- Cracking
- High exotherm
Next Steps

> Write appendix with current results to add to prior keyhole report.

> Work with Poly-set and Terrathane to address recent cracking issues found with product.

> Initiate the evaluation of the Advanced-Tec expanding foam product.

> Continue to work with Tellus on the hot wax product pumped into the molds.

> Continue to conduct evaluations of the various coating processes using original test methodology
Questions?