the Energy to Lead

Keyhole Update - Coating and Wrapping

Fall 2012 Meeting

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gti

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.

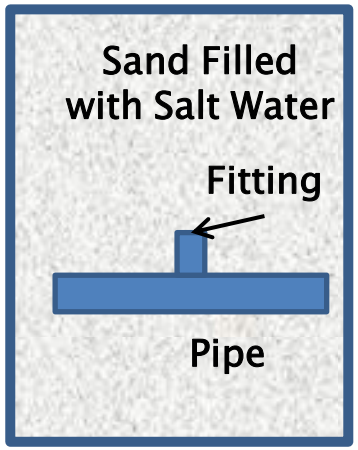
Summary of Past Research

> Evaluation of five materials:

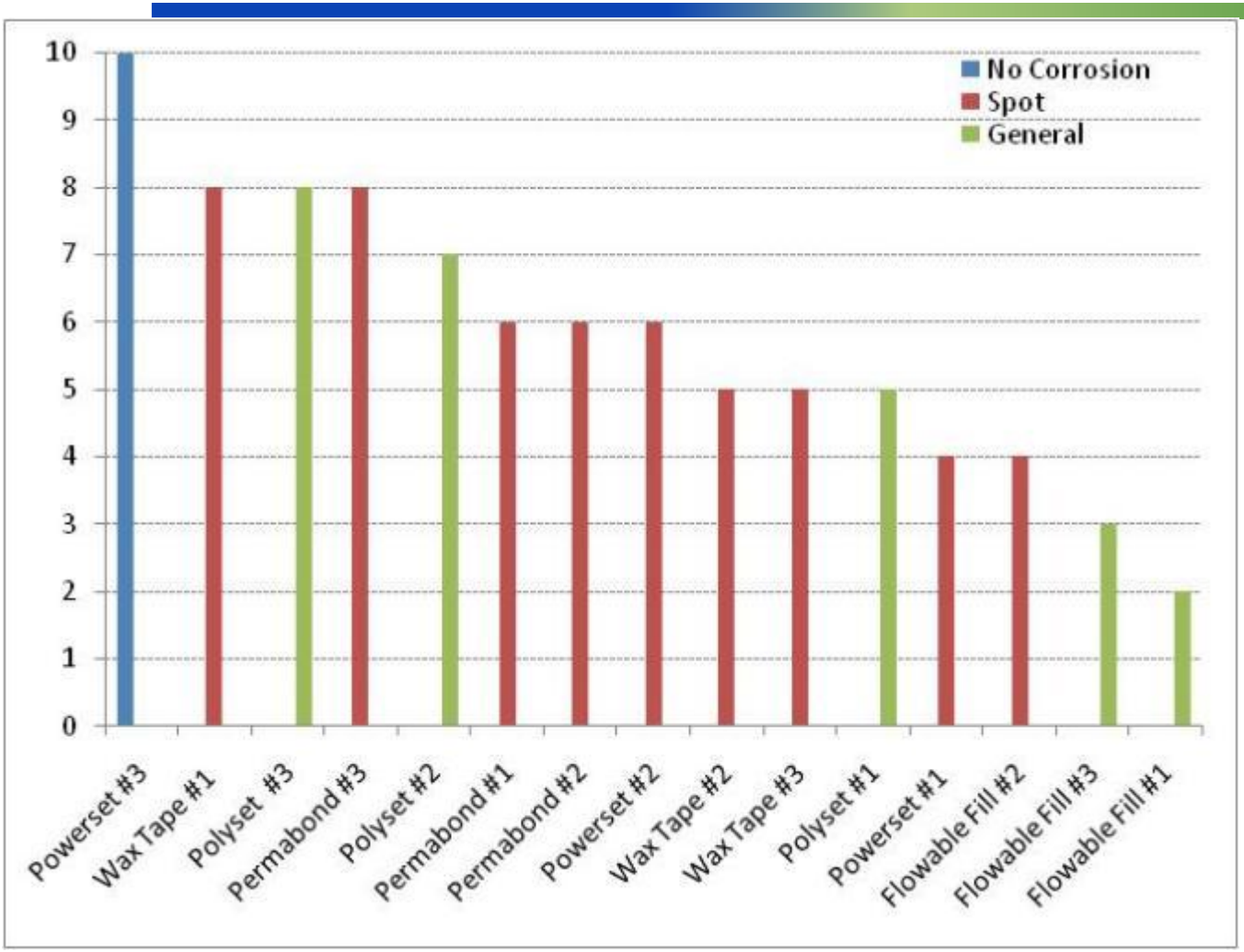
Coating	Description	Comments
Poly-Set	Polyurethane foam	Fast and easy
Permabond	Two part polyurethane pumped into polyurethane bag	Some previous testing at GTI with good results
Trenton wax tape	Standard petrolatum wax tape	Included as a benchmark
Powerset 100	Two part hybrid urea-polyurethane	Fast curing, 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
  - 110F 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%

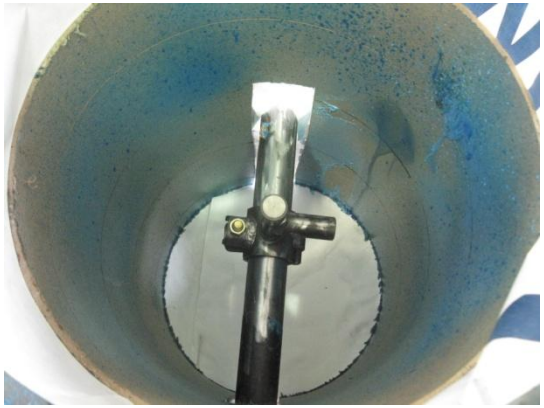
Follow-on Evaluation

- 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

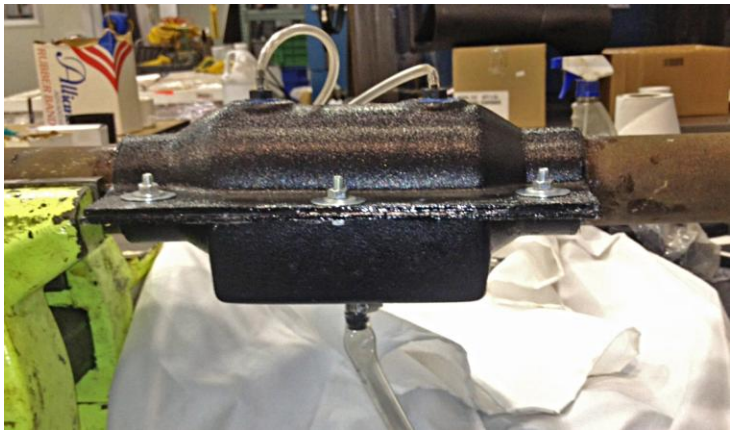
> Powerset

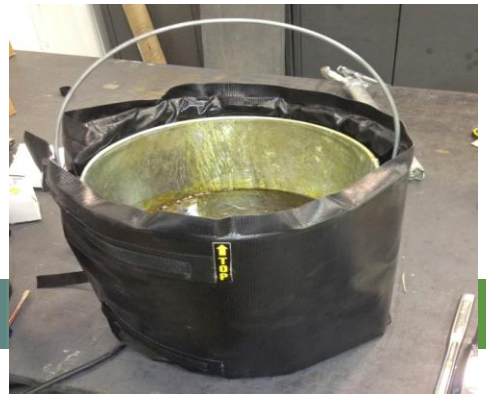
- **Goal-** to ensure application on entire fitting when in a keyhole
- Cartridge gun sourced by Powerset, and acquired by GTI
- Application nozzles bent to ensure coating of fitting underside
- Three evaluations conducted at varying pressures and outlet flows
- Applications in keyhole stand



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 lt 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

	ASTM D610 rating	% Rust
within wax-filled volume	10	0.0
under enclosure collar	6	1.0

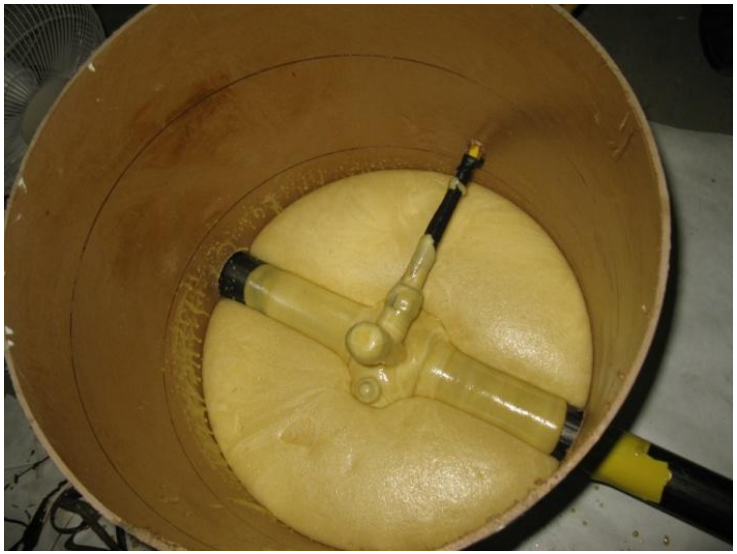
Follow-on Evaluation

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

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

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?