Understanding Installation of Steam Tracing for Long-Term Application Success

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Best Overall Solutions for Pipe Tracing
Most Options for Equipment Jacketing
Most Effective Systems for Tank Heating
Steam Heating Systems for Piping

- High Heat
- Medium Heat
- Freeze Protection (Isolation Tracer)
- QMax Jacketed Pipe
- Special Case Heating
- Long Run Hot Oil

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Is this a good Steam Tracing System installation?
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Today we’ll look at:

- Conduction Heat Transfer
- What is Heat Transfer Compound (HTC)
- Test Results – Melting Sulfur w/ Steam Tracing using HTC
  - Steam Tracing Designs Tested
  - Simulating Varying HTC Thicknesses
  - Melt-Out Test Results
  - Lessons Learned
Heat Transfer 101

- Conduction
- Convection
- Radiation
Conductive Heat Transfer

- $Q = U A d T$, $U = \frac{k}{l}$
Conductive Heat Transfer

- \( Q = UA \Delta T \), \( U = k/l \)

**Poor “k”**
- Large “l”
  - **Poor Heat Transfer**

**Poor “k”**
- Very Small “l”
  - **Excellent Heat Transfer**
What is Heat Transfer Compound

Heat Transfer Compound (HTC) is used to bridge the thermal gap between two parts (in this case, pipe and conductive tracing).

HTC contains graphite and one or more binder components which are formulated for different applications.
Heat Transfer Boundaries of Conductive Steam Tracing

1) Film Coefficient of Steam
2) Conduction thru Tubing
3) Conduction thru very thin HTC
4) Conduction thru Aluminum
5) Conduction thru very thin HTC
6) Conduction thru Pipe Wall
7) Film Coefficient of Process
### Purpose of Heat Transfer Compound

<table>
<thead>
<tr>
<th>Material</th>
<th>Heat Transfer Coefficient (BTU/hr ft² °F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steam (Cond)</td>
<td>500</td>
</tr>
<tr>
<td>0.035&quot; Wall SS</td>
<td>3400</td>
</tr>
<tr>
<td>0.020&quot; HTC</td>
<td>300</td>
</tr>
<tr>
<td>3/4&quot; Thick AL</td>
<td>1920</td>
</tr>
<tr>
<td>0.062&quot; HTC</td>
<td>96</td>
</tr>
<tr>
<td>0.090&quot; HTC</td>
<td>67</td>
</tr>
<tr>
<td>0.160&quot; HTC</td>
<td>37.5</td>
</tr>
<tr>
<td>Liquid Sulfur (Flowing)</td>
<td>2880</td>
</tr>
<tr>
<td>Air (Still)</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

**HTC = Heat Transfer Compound (k = 0.5 BTU/hr ft F)**
High-Performance Heat Tracing

Bottom Line

Heat Transfer Compound has a poor “k” so it MUST be used in very thin layers to achieve good heat transfer.

The HTC must also stay in place for long-term success.
How does this affect the thermal performance?
Melt-Out Testing Using Steam Tracing and HTC
Steam Tracing Designs Tested

**CST (Carbon Steel Tracing)**
Maximize the heat transfer from a contoured, carbon steel tube to the pipe wall / process

Minimize the HTC layer between tracing and pipe
Steam Tracing Designs Tested

**FTS (Fluid Tracing System)**

Maximize the heat transfer from a single tube into pipe wall/process using highly conductive aluminum

Minimize the HTC layer between tracing and pipe
Simulating Varying HTC Thicknesses

**Field Effects on Thickness**

- Raised Weld Crowns
- Uneven Distribution of HTC
- Air Gaps between pipe & Trace
- Imperfect Fitting/Welding of tracing
Simulating Varying HTC Thicknesses

(3) Different Simulated Gaps

- 1/32 inch (0.031 inch or 0.8 mm)
- 3/32 inch (0.094 inch or 2.4 mm)
- 5/32 inch (0.156 inch or 4.0 mm)
Melt-Out Test Results

Figure 8: Temperature with respect to time for FTS tests

 temperatures (°F)
## Melt-Out Test Results

<table>
<thead>
<tr>
<th>Test</th>
<th>HTC Layer Thickness (inches)</th>
<th>Time to heat sulfur from 105-248 °F</th>
</tr>
</thead>
<tbody>
<tr>
<td>FTS-A</td>
<td>1/32</td>
<td>2 hours, 26 minutes</td>
</tr>
<tr>
<td>FTS-B</td>
<td>3/32</td>
<td>3 hours, 29 minutes</td>
</tr>
<tr>
<td>FTS-C</td>
<td>5/32</td>
<td>5 hours, 34 minutes</td>
</tr>
<tr>
<td>FTS-D</td>
<td>No HTC – Bare FTS tracer on pipe</td>
<td>4 hours, 36 minutes</td>
</tr>
</tbody>
</table>
Melt-Out Test Results

Figure 7: Temperature with respect to time for CST tests
## Melt-Out Test Results

Table 3: Time to melt sulfur using CST with various HTC thicknesses

<table>
<thead>
<tr>
<th>Test</th>
<th>HTC Layer Thickness (inches)</th>
<th>Time to heat sulfur from 105-248 °F</th>
</tr>
</thead>
<tbody>
<tr>
<td>CST-A</td>
<td>1/32</td>
<td>2 hours, 24 minutes</td>
</tr>
<tr>
<td>CST-B</td>
<td>3/32</td>
<td>4 hours, 3 minutes</td>
</tr>
<tr>
<td>CST-C</td>
<td>5/32</td>
<td>5 hours, 12 minutes</td>
</tr>
<tr>
<td>CST-D</td>
<td>No HTC – Bare CST tracer on pipe</td>
<td>4 hours, 7 minutes</td>
</tr>
</tbody>
</table>
Melt-Out Test Results

Figure 9: Time required for sulfur melt-out as a function of HTC thickness
Take-Aways

1) Follow Manufacturers’ Guidelines for Installation

2) Training Installers on the purpose and use of Heat Transfer Compound

3) Use a Conductive Steam Tracing System that allows for excellent contact (small layers of HTC)

4) Avoid running Steam Tracing over weld beads
Tight Contact Leads to Long-Term Success
Loose Contact Leads to Failure
Thank you

Thomas Perry
Carson Hannah