Studying the Compatibility of CPVC Piping and SPF

Mary Bogdan
Honeywell
Agenda

- Goal
- Background
- Participants
- Study details
- Study funding
- Study timeline
- Study reports
Goal

Demonstrate that no chemical/physical impact to the performance and longevity of CPVC piping and fittings exists when it is in contact with SPF.

• Evaluate chemical, thermal and physical compatibility of spray foam with CPVC piping and fittings

• Issue a 3rd party report on compatibility of the materials

• Remove cautionary statement from Lubrizol listing
Background

- Field failures occurred with acrylic caulk containing phosphate ester in long term contact with CPVC piping and fitting
- Phosphate ester on SPF MSDS utilized as flame retardant in spray foam system
- Cautionary statement issued surrounding contact of SPF and CPVC
- Contractors start to have challenges with inspectors - all markets - open/ close/ OCF in Lake Tahoe, Northern California and Ohio
- Note no known failures due to foam in contact with pipe
## Participants

<table>
<thead>
<tr>
<th>5 Star Insulation</th>
<th>Fomo</th>
<th>Resin Technologies/ The Henry Co.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albe Marle</td>
<td>Gaco Western</td>
<td>Supresta</td>
</tr>
<tr>
<td>BASF BPFE</td>
<td>Honeywell</td>
<td>SWD Urethanes</td>
</tr>
<tr>
<td>Bayer MS</td>
<td>Houlden Contracting</td>
<td>The Insulation Man</td>
</tr>
<tr>
<td>Baysystems</td>
<td>Huntsman</td>
<td>NCFI Polyurethanes</td>
</tr>
<tr>
<td>BioBased Insulation</td>
<td>Icynene</td>
<td>Demilec USA</td>
</tr>
<tr>
<td>Clayton Corp.</td>
<td>IRC Roofing</td>
<td></td>
</tr>
<tr>
<td>Corbond</td>
<td>Mason Knowles Consulting</td>
<td></td>
</tr>
</tbody>
</table>
Potential Failure Modes

- Pressure
- Chemical
- Mechanical/ Installation
Study Variables

- Foam type
- Flame retardant
- Flame retardant concentration
- Soy vs. non-soy based polyols
- Thickness
How to Analyze?

- Current procedures involve extracting solvents from materials and performing a “soak test”
- Consensus need new procedure
- Conclusion use pressure test for QC pipe and look for phosphate migration in foam
Foam Types

- Three types of foam were studied
  - Closed cell foam
  - Open cell foam
  - One component foam

- Generic agreed upon foam systems are used in the study to insure only variables tested are being altered in formulation
Flame Retardant

- Primary concern is phosphate ester materials
- An industry survey of materials was conducted
  - TCPP (Tris (2-chloroisopropyl) phosphate)
    - *most widely used*
  - TEP (Triethyl phosphate)
    - *most aggressive on soak test*
  - TDCP Tris (1,3-dichloroisopropyl) phosphate blend)
    - *used as alternative for one component foam only*
Flame Retardant Concentration

- Determined by industry survey (wt % polyol side)
  - Closed cell foam
    - Low: 4
    - Hi: 10
  - OpenCell Foam
    - Low: 15
    - Hi: 50
  - One Component Foam
    - Low: 0 / 5
    - Hi: 10
Polyol Selection

- Vegetable oils are listed as non compatible with CPVC piping

*Therefore*

- Limited comparative testing will be conducted on one commercial open cell foam system and one commercial closed cell foam system made with soy based polyols
Thickness

- Thickness of foam application impacts foam internal temperature
- Plastics are heat sensitive
- Foam application thickness will be varied to demonstrate impact of temperature exposures

Application thicknesses
- Open cell foam: 3 “
- Closed cell foam: 2” and 4 “
- One component foam: ¾”
## Variables vs Foam Type

<table>
<thead>
<tr>
<th>Foam Type</th>
<th>Closed cell foam – 2 pcf density</th>
<th>Open cell foam - 0.5 pcf density</th>
<th>One component foam (OCF)</th>
<th>Soy based foam systems</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Variables</strong></td>
<td>• Thickness</td>
<td>• Flame retardant: TCPP/ TEP</td>
<td>• Flame retardant: TCPP/ TEP</td>
<td>• Thickness</td>
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<tr>
<td></td>
<td>• Flame retardant: TCPP/ TEP</td>
<td>• Flame retardant concentration</td>
<td>• Flame retardant: TCPP/ TDCPP</td>
<td>• soy based - Polyol</td>
</tr>
<tr>
<td></td>
<td>• Flame retardant concentration</td>
<td></td>
<td>• Flame retardant concentration</td>
<td></td>
</tr>
</tbody>
</table>
Foam Application & Piping

3/4" Pipe

Foam cut to 1” square around pipe

3/4” Pipe

Attached to chamber- sample under pressure containing water
### Samples

**Testing 50 foam samples**

**Testing pipe controls without foam**

<table>
<thead>
<tr>
<th>Type of foam</th>
<th>Fame Retardant (FR)</th>
<th>Concentration FR, wt% polyol side</th>
<th>Thickness Foam, in</th>
<th>Sample Test Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closed cell</td>
<td>TCPP</td>
<td>10</td>
<td>4</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>TCPP</td>
<td>10</td>
<td>2</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>TCPP</td>
<td>4</td>
<td>4</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>TCPP</td>
<td>4</td>
<td>2</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>TEP</td>
<td>10</td>
<td>4</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>TEP</td>
<td>10</td>
<td>2</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>TEP</td>
<td>4</td>
<td>4</td>
<td>X</td>
</tr>
<tr>
<td>Open Cell</td>
<td>TCPP</td>
<td>50</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>TCPP</td>
<td>15</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>TEP</td>
<td>50</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>TEP</td>
<td>15</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>OCF</td>
<td>TCPP</td>
<td>5</td>
<td>¾” +/-</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>TCPP</td>
<td>10</td>
<td>¾” +/-</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>TDCPP</td>
<td>10</td>
<td>¾” +/-</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>No Phosphorousester</td>
<td>0</td>
<td>¾” +/-</td>
<td>X</td>
</tr>
<tr>
<td>BIO-POLYOL</td>
<td>Open cell- Biobased</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Closed cell- Demilec</td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
Sample Preparation

139 samples prepared by 4 facilities

<table>
<thead>
<tr>
<th>Type</th>
<th># For testing including initial</th>
<th># In Test Chamber</th>
<th># Extra for shipment damage</th>
<th># extra for application improvement</th>
<th>Total #</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closed Cell Foam</td>
<td>28</td>
<td>21</td>
<td>14</td>
<td>14</td>
<td>56</td>
</tr>
<tr>
<td>Open Cell Foam</td>
<td>16</td>
<td>12</td>
<td>8</td>
<td>8</td>
<td>32</td>
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<tr>
<td>One Component</td>
<td>16</td>
<td>12</td>
<td>8</td>
<td>8</td>
<td>32</td>
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<tr>
<td>Soy – Open</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>10</td>
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<tr>
<td>Soy – Closed</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>Total</td>
<td>67</td>
<td>50</td>
<td>36</td>
<td>36</td>
<td>139</td>
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</tbody>
</table>

Thank you to Demilec USA, LLC, BioBased Insulation, NCFI Polyurethanes, Clayton Corp. for providing laboratory services
Testing Conditions

- Chamber temperature 150 F
- Pipe assemblies are under water pressure
  - 670 hr  20.3 mpas
  - 3000 hr  18.4 mpas
  - 6000 hr  17.5 mpas
- Samples removed from chamber at 670 hr/ 3000 hr/ 6000 hr
Testing

- Two types of testing will be performed on each sample
  - Pressure testing - looking for stress cracking or fatigue in samples
    - Via visual analysis
  - Chemical
    - Looking for phosphate migration to surface of pipe
    - Looking for phosphate ester presence in stress cracking
    - Via ICP or IR

- Testing to be done by corporate labs at Lubrizol
- Results reviewed @ 50% confidence interval
Funding- $$ & Labor

- SPFA- allocated a portion 2008 budget for research program
- CPI- provided grant money through the Rigid Foams Committee
- Systems houses providing lab services and raw materials
- Suppliers coordinating program and providing raw materials
- Lubrizol providing testing, piping, laboratory equipment for program
# Time Table

<table>
<thead>
<tr>
<th>Date</th>
<th>Event Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer '07</td>
<td>Problems start to appear in field</td>
</tr>
<tr>
<td>10/08</td>
<td>SPFA taskforce formed</td>
</tr>
<tr>
<td>11/08</td>
<td>Receive CPI funding</td>
</tr>
<tr>
<td>12/07-1/08</td>
<td>Foam systems optimized</td>
</tr>
<tr>
<td></td>
<td>Define samples and test protocol</td>
</tr>
<tr>
<td>2/08</td>
<td>Identify consultant</td>
</tr>
<tr>
<td></td>
<td>Define pipe testing conditions and test program</td>
</tr>
<tr>
<td></td>
<td>Submit CPI abstract</td>
</tr>
<tr>
<td>3/08</td>
<td>Pipe samples prepared</td>
</tr>
<tr>
<td>4/08</td>
<td>Testing begins</td>
</tr>
<tr>
<td>5/08</td>
<td>1 mo study results</td>
</tr>
<tr>
<td>6/08</td>
<td>1 mo study results</td>
</tr>
<tr>
<td>7/08</td>
<td>1 mo study results</td>
</tr>
<tr>
<td></td>
<td>3 mo study results</td>
</tr>
<tr>
<td>9/08</td>
<td>Present project at CPI</td>
</tr>
<tr>
<td>12/08</td>
<td>6mo study completed</td>
</tr>
<tr>
<td>1/09</td>
<td>Final report issued</td>
</tr>
</tbody>
</table>
Consultant

Why
- 3rd party report essential for dealing with code bodies
- Need independent evaluation of the data
- Need peer review of study by plastics and foam industry

Who
- Jim Paschal, PE
  - James Paschal Engineering and Forensic Consulting, LLC
  - Chairperson of ASTM Committee on CPVC Testing
  - 30 years
Consultant cont…

**What**

- Provides review of test protocol
- Insures that equipment and samples are properly installed
- Writes interim reports on data
- Writes final report on project in format acceptable for use with code officials
Reporting & Communication Plan

Study reports
- Test protocol
- Interim reported each time data is issued
- Final report at completion of study

External Communication
- CPI paper on program
- Letter for building inspectors
- Publication in Spray Foam Magazine
- Publication on SPFA website
- Preparation of industry white paper for use with trades and CPVC industry
Thank You

Questions ????

*Example of your SPFA dues working for you*