The Benefits of Optimization in Ecomate® Blown Foams

RAPRA 2011 - Dusseldorf

Foam Supplies, Inc
SUITABILITY OF ECOMATE

- Well suited BA for PUR & PIR foams
  + Similar to HCFC-141b
    - BP identical: [32°C]
    - LFL slightly lower: [5 vol% v 7.6 vol%]
    - When blended into polyols – Flammability a non-issue!
    - Solubility stronger with ecomate
  
- But not a Drop-In
  - Requires Optimization [like any other BA]
ADVANTAGES OF ECOMATE

- Environmentally Benign
  - Zero ODP, minimal GWP, VOC-exempt
- Low Gas Lambda 10.7 mW/m.K
- Very Cost Efficient
  - Lowest MW 60
  - Low Cost
  - Pricing independent of Petrochemicals
- Your LAST Transition ??
ECOMATE FLAWS

- Can **Hydrolyze**!
  - An ESTER
- Slightly More FLAMMABLE than 141b
  - Only in Neat form **LFL = 50,000 ppm**
  - In Polyols – handle conventionally
- Slightly Stronger SOLVENCY
  - Can lead to Shrinkage!
The European Chemical Agency [ECHA] guidelines state:

+ "Liquids with a flash point >35°C may be regarded as non-flammable liquids if negative results have been obtained in the sustained combustibility test L.2...."

+ Polyol /ecomate blends, if properly chosen, will not sustain combustion.

Two Minor Steps

- Increasing the XLD of the polymer
- Change Surfactant
  - Type & Amount (lessened)
Increase the Avg Fn

Or

Decrease the Avg XLD

ADJUSTING THE XLD

<table>
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<tr>
<th>POLYOLS</th>
<th>OH#</th>
<th>fn</th>
<th>EqWt</th>
<th>Mn</th>
<th>AMT</th>
<th>avg fn</th>
<th>avg XLD</th>
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<tr>
<td>PS2352</td>
<td>240</td>
<td>2</td>
<td>233.8</td>
<td>467.5</td>
<td>50%</td>
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<tr>
<td>R315x</td>
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<td>3.2</td>
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<td>3.23</td>
<td>200.4</td>
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STEP 2: SURFACTANT CHANGE

- Why change the surfactant?
  - It Affects:
    - Foam DENSITY
    - CELL STRUCTURE
    - THERMAL PROPERTIES
  - It may Affect:
    - Shelf stability
    - Flammability
  - Let’s take a look....
SURFACTANT STUDY

- Same HANDMIX Formulation
  - Master batch w/o Surfactant
    - Split into five Batches
  - Five different Surfactants
    - Added at 1 part /100 parts formula
- Showed effects on
  - Density
  - Compressive Strength
  - Humid Aging
WATER ABSORPTION

Wt gain in WET environment
RESULTS

- Surfactant CHOICE affects:
  - DENSITY
  - STRENGTH
  - SHRINKAGE
  - THERMAL PROPS
  - WT GAIN in Humid Environment
CAN STABILITY

- Surfactant Type affects:
  - Density
  - Cell Fineness
  - Thermal Properties

- Improved Surfactants found
  - Can stable for over 1 year
THE BENEFITS OF OPTIMIZATION

- Line Trials
  - ONE – just RXN & DENS
  - ANOTHER - optimized for Thermals
    - But NOT Physical Properties
System 1

- Pentane blown
- Drop-In Substitution
- Minimal Optimization
  - Uniform Density
  - Equal Reactivity
- USED 4 % LESS CATALYST w ECOMATE
NON-OPTIMIZED LAMINATE RUN #1

- RXN Rate & DENSITY same
- STRENGTH poorer w Ecomate [~15%]
- STABILITY ~ Same
- LAMBDA IMPROVED!
- BURNS IMPROVED!

<table>
<thead>
<tr>
<th>PROPERTY</th>
<th>PENTANE</th>
<th>ECOMATE</th>
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<tbody>
<tr>
<td>CREAM</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>FIRM</td>
<td>40</td>
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<td>DENS</td>
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<td>25.4</td>
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<tr>
<td>CS//</td>
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<td>CS_</td>
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<tr>
<td>DS+5</td>
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<td>-0.3</td>
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<tr>
<td>DS-15</td>
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<td>-0.32</td>
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<tr>
<td>Lambda</td>
<td>22.04</td>
<td>21.49</td>
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<tr>
<td>B2</td>
<td>14.2</td>
<td>13.6</td>
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<tr>
<td>M45</td>
<td>4.9</td>
<td>4.5</td>
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System 2

- Pentane blown
  - 4” THICK
  - Foil faced

- Optimized for Thermal Properties
OPTIMIZED LAMINATE RUN #2

- DENs higher
  + RXN Rate SAME
- STABILITY SIMULAR
- CS // Poorer
- FLAMMABILITY IMPROVED
- THERMALS VASTLY IMPROVED [10-15%]

<table>
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<tr>
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<th>Trial 2</th>
<th>C5 CONTROL</th>
<th>ECOMATE</th>
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<tbody>
<tr>
<td>Dens, pcf</td>
<td>1.75</td>
<td>1.97</td>
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<tr>
<td>CCC, %</td>
<td>98.5</td>
<td>94.6</td>
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<tr>
<td>Δ%Vol, 7d</td>
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<tr>
<td>COLD</td>
<td>0.98</td>
<td>-0.7</td>
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</tr>
<tr>
<td>WET</td>
<td>4.11</td>
<td>5.06</td>
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</tr>
<tr>
<td>DRY</td>
<td>3.03</td>
<td>4.35</td>
<td></td>
</tr>
<tr>
<td>CS //, psi</td>
<td>20.3</td>
<td>12.9</td>
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</tr>
<tr>
<td>FS*</td>
<td>30</td>
<td>25</td>
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</tr>
<tr>
<td>Smoke</td>
<td>400</td>
<td>180</td>
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</tr>
<tr>
<td>Lambda, 20°F</td>
<td>19.3</td>
<td><strong>16.9</strong></td>
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</table>
CONCLUSIONS

- All foam systems can benefit from optimization.
  - Get the most out of YOUR Formulation
  - Without increasing costs, and
  - Potential of vastly superior properties

- Ecomate has **all the properties you might want**
  - Excellent thermal properties
  - Excellent environmental properties
  - Low molar cost
  - Excellent miscibility with all raw materials
  - The ability to produce systems w/o flammability issues

- It can work for you if you are willing to optimize!
- This can be the **LAST BA reformulation you will have to make!**

- **We are eager to work with you**