Cost Effective – Blowing Agent
For
Polyurethane Foam Applications

Partnership For A Better Environment.
TOPICS TO BE COVERED

- Ecomate product review
- Market Applications
- Spray Foam Application in detail
- Technical Information
- Q&A / Market Challenges
WHAT IS ECOMATE®?

ecomate® is a liquid blowing agent or foam expansion agent.

ecomate® is an alternative to 141b for rigid and flexible applications.

ecomate® has properties similar to 141b.

ecomate® is cost competitive.
**ECOMATE® BA PROPERTIES**

- Clear, Colorless, Flammable Liquid

<table>
<thead>
<tr>
<th>Property</th>
<th>ecomate</th>
<th>141b</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boiling Point</td>
<td>31.5 °C</td>
<td>32°C</td>
</tr>
<tr>
<td>Vapor Pressure, KPa @ 25 °C</td>
<td>64</td>
<td>64</td>
</tr>
<tr>
<td>Molecular Weight</td>
<td>60</td>
<td>117</td>
</tr>
<tr>
<td>LAMBDA, gas @ 25 °C</td>
<td>10.7</td>
<td>10</td>
</tr>
<tr>
<td>Specific Gravity</td>
<td>0.982</td>
<td>1.25</td>
</tr>
</tbody>
</table>
# PURE BLOWING AGENT PROPERTIES

<table>
<thead>
<tr>
<th>BA</th>
<th>MF</th>
<th>ML</th>
<th>iC5</th>
<th>nC5</th>
<th>cC5</th>
<th>UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Physicals</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MW</td>
<td>60</td>
<td>76.1</td>
<td>72</td>
<td>72</td>
<td>70</td>
<td>g/mol</td>
</tr>
<tr>
<td>BP</td>
<td>32</td>
<td>42.3</td>
<td>28</td>
<td>36</td>
<td>49</td>
<td>°C</td>
</tr>
<tr>
<td>$\lambda_{\text{gas}}$ at 20 °C</td>
<td>10.7</td>
<td>11-14</td>
<td>14</td>
<td>14</td>
<td>11</td>
<td>mW/m°K</td>
</tr>
<tr>
<td>SpGr</td>
<td>0.98</td>
<td>0.86</td>
<td>0.6</td>
<td>0.6</td>
<td>0.8</td>
<td>g/l</td>
</tr>
</tbody>
</table>

- **Lowest MW** – less needed
- **BP** – same as 141b
- **Lowest Lambda** – more efficient
- **Hi SpGr** – more like 141b
# PURE BLOWING AGENT PROPERTIES

<table>
<thead>
<tr>
<th>BA:</th>
<th>MF</th>
<th>ML</th>
<th>iC5</th>
<th>nC5</th>
<th>cC5</th>
<th>UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Flammability</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FLASH Pt</td>
<td>-19</td>
<td>-18</td>
<td>-51</td>
<td>-49</td>
<td>-37</td>
<td>°C</td>
</tr>
<tr>
<td>LFL</td>
<td>5</td>
<td>1.6</td>
<td>1.4</td>
<td>1.5</td>
<td>1.1</td>
<td>vol%</td>
</tr>
<tr>
<td>% Oxygen</td>
<td>53.3</td>
<td>42.1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Wt%</td>
</tr>
<tr>
<td>Heat of COMBUSTION</td>
<td>16.2</td>
<td>25</td>
<td>47</td>
<td>50</td>
<td>47</td>
<td>MJ/g</td>
</tr>
</tbody>
</table>

**Ecomate is less Hazardous**
Pure ecomate is Flammable.

- Ecomate blended systems are considered combustible, just like 141b-blown systems:
  
<table>
<thead>
<tr>
<th>Ecomate Form</th>
<th>Combustibility</th>
<th>Flash Point (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ecomate - pure form</td>
<td>flammable</td>
<td>-19</td>
</tr>
<tr>
<td>ecomate – polyol blend</td>
<td>combustible</td>
<td>+70</td>
</tr>
<tr>
<td>ecomate – mdi blend</td>
<td>combustible</td>
<td>+80</td>
</tr>
</tbody>
</table>
# IS **ECOMATE®** - FLAMMABLE?

Pure ecomate is Flammable.

- **Ecomate blended systems are considered combustible, just like 141b-blown systems:**
  
<table>
<thead>
<tr>
<th>Ecomate Type</th>
<th>Flammability</th>
<th>Flash Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>ecomate - pure form</td>
<td>flammable</td>
<td>-19°C</td>
</tr>
<tr>
<td>ecomate – polyol blend</td>
<td>combustible</td>
<td>+70°C</td>
</tr>
<tr>
<td>ecomate – mdi blend</td>
<td>combustible</td>
<td>+80°C</td>
</tr>
</tbody>
</table>

**Why is this important?** Compared to Flammables and Hydrocarbon PU systems:

- **ecomate® systems** are **safer to handle**
- **ecomate® systems** are much **lower shipping, handling & storage costs**
- Facilities equipped to handle 141b and/or isocyanates **need little to no changes** or upgrades. No need for large capital changes to facilities.
- **ecomate® systems** **Insurance premiums are much lower**
## ECO MATE® COST EFFICIENCY

<table>
<thead>
<tr>
<th>BLOWING AGENT</th>
<th>MW</th>
<th>FACTOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>HCFC 141b</td>
<td>117</td>
<td>1</td>
</tr>
<tr>
<td>HFC 245fa</td>
<td>134</td>
<td>1.15</td>
</tr>
<tr>
<td>HFC 365/227</td>
<td>149</td>
<td>1.27</td>
</tr>
<tr>
<td>n-C5</td>
<td>72</td>
<td>0.62</td>
</tr>
<tr>
<td>ecomate</td>
<td>60</td>
<td>0.51</td>
</tr>
<tr>
<td>Compound</td>
<td>ODP</td>
<td>GWP</td>
</tr>
<tr>
<td>-------------------</td>
<td>------</td>
<td>-------</td>
</tr>
<tr>
<td>HCFC-141b</td>
<td>0.1</td>
<td>630</td>
</tr>
<tr>
<td>HFC-134a</td>
<td>0</td>
<td>1300</td>
</tr>
<tr>
<td>HFC-245fa</td>
<td>0</td>
<td>1040</td>
</tr>
<tr>
<td>HFC-365mfc</td>
<td>0</td>
<td>930</td>
</tr>
<tr>
<td>Hydrocarbons</td>
<td>0</td>
<td>None</td>
</tr>
<tr>
<td>H2O/CO2</td>
<td>0</td>
<td>None</td>
</tr>
<tr>
<td>ecomate®</td>
<td>0</td>
<td>None</td>
</tr>
</tbody>
</table>
ECOMATE® MARKETS

- **Pour in Place Rigid Insulating Foams**
  - Commercial Foodservice Equipment
  - Industrial & Transport Refrigeration
  - Continuous & Block
- **Spray Foams**
  - Industrial
  - Dwellings
- **Integral Skin Foams**
- **Flexible Molded Foams**
- **Slabstock Foams**
- **XPS**
COMMERCIAL FOODSERVICE EQUIPMENT

- Ecomate approved by major commercial manufacturers for major end users
- Meets Industry energy standards similar to HCFC-141b
- No compromise on properties to foams made with HCFC-141b
  - Thermal Efficiency
  - Density
  - Compressive Strength & Dimensional Stability
INDUSTRIAL & TRANSPORT REFRIGERATION

- Results similar to HCFC-141b systems
- Can be processed through standard and/or existing equipment
CONTINUOUS & BLOCK

- Results similar to HCFC-141b systems
- Can be processed through standard and/or existing equipment
- Some instances slight adjustments are required
- Trials for cryogenic applications (-160°C) in process
- Co-blown options with hydrocarbons – improved thermal and fire properties
SPRAY FOAMS – INDUSTRIAL & DWELLINGS

- Worldwide Use: Africa, Asia, Americas, Australia, China, Europe, etc.
- Produces standard densities [32kg/m³ (2pcf)]
- Can be processed through standard and/or existing equipment
- Blends with currently available raws for 141b –
  - Polyesters, Mannichs, Sucrose, Amines, & Surfactants & Catalysts
- Mexican systems houses achieved successful trials (UNDP project)
ECOMATE® REGULATORY

✓ US EPA SNAP Approved
✓ RoHS and Wee Compliant
✓ GRAS Approved
✓ Non-Toxic
✓ VOC-Exempt
✓ Montreal & Kyoto Protocol Compliant
✓ UL, FM & USCG Classified Systems
**ECOMATE® CASE STUDY**

**DISCONTINUOUS PANEL**

**MALT TANKS – PRIOR TO FOAMING**

Foaming Trials were conducted in Italy with a large equipment supplier.

Ecomate system used.

Standard densities were obtained as with a 141b system.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Compressive Strength</strong></td>
<td><strong>180 kPa</strong></td>
</tr>
<tr>
<td><strong>Closed Cell content</strong></td>
<td><strong>&gt;95%</strong></td>
</tr>
<tr>
<td><strong>K-Value</strong></td>
<td><strong>0.023 W/mK</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Nominal Density</th>
<th>Core density</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Left side</td>
<td>Center</td>
</tr>
<tr>
<td>Panel &quot;a&quot;</td>
<td>40 kg/m³</td>
<td>34.35 kg/m³</td>
</tr>
<tr>
<td>Panel &quot;b&quot;</td>
<td>42.5 kg/m³</td>
<td>39.27 kg/m³</td>
</tr>
</tbody>
</table>
**ECOMATE® CASE STUDY**

**BLENDS - LAMINATOR RESULTS**

<table>
<thead>
<tr>
<th>Continuous Line Trial [100 mm]</th>
<th>HC blend (mW/m°K)</th>
<th>Ecomate blend (mW/m°K)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lambda 24 °C</td>
<td>21.3</td>
<td>19.3</td>
</tr>
<tr>
<td>Lambda 10 °C</td>
<td>20.9</td>
<td>17.9</td>
</tr>
<tr>
<td>Lambda -6.7 °C</td>
<td>19.8</td>
<td>16.9</td>
</tr>
</tbody>
</table>

- One can get very LOW LAMBDA's with Ecomate Blends
## ECOMATE CASE STUDY
### BLENDS – LAMINATOR RESULTS

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>DENS</td>
<td>31</td>
<td>kg/m³</td>
</tr>
<tr>
<td>CS/\</td>
<td>90</td>
<td>Kpa</td>
</tr>
<tr>
<td>DIM STAB</td>
<td>7 DAY</td>
<td></td>
</tr>
<tr>
<td>COLD</td>
<td>-0.70%</td>
<td></td>
</tr>
<tr>
<td>WET</td>
<td>5.06%</td>
<td></td>
</tr>
<tr>
<td>DRY</td>
<td>4.30%</td>
<td></td>
</tr>
</tbody>
</table>
ECOMATE®

CASE STUDY

- EGYPT

SPRAY FOAM TRIAL

TRIAL RUN WITH ECO-SPRAY R-3000

- Good spray pattern and fine cell structure.
- Foam density 32 – 42 g/l [2 – 2.6 pcf]
- λ- Value 0.0226 W/mK.
- CS// 235 kPa at 42g/l
- Dimensional stability 32 and 42 g/l, no measurable change @ -25 °C
- Typical Sprayed thickness 100 – 250mm
ECOMATE® EMISSIONS – SPRAY 3RD PARTY TESTING

S P R A Y F O A M E X A M P L E

O S H A R E G U L A T I O N S
100 PPM

ecomate® - emissions recorded while spray job was in progress

The emissions collected where concentration were expected to be the HIGHEST -

Results
- At gun head 10 - 12 PPM
- Over rising foam 20 - 23 PPM
**ECOMATE® EMISSIONS – SPRAY 3RD PARTY TESTING**

ECOMATE CONCENTRATIONS WERE MEASURED AT THE SPRAY OPERATORS AND IN THE IMMEDIATE VICINITY. RESULTS INDICATE THAT ECOMATE CONCENTRATIONS WERE WELL BELOW THE PRESCRIBED LIMIT (250 MG/M³).

<table>
<thead>
<tr>
<th>Sample</th>
<th>ecomate Concentration</th>
<th>Actual Flow Rate</th>
<th>Period of Sampling</th>
<th>Person/area sampled</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3.1</td>
<td>65.8</td>
<td>12:00 - 12:50</td>
<td>Vivian Grobler (spray operator)</td>
</tr>
<tr>
<td>2</td>
<td>1.6</td>
<td>70.3</td>
<td>12:03 - 12:50</td>
<td>Joe Moemi (assistant)</td>
</tr>
<tr>
<td>3</td>
<td>4.8</td>
<td>71.3</td>
<td>12:05 - 12:50</td>
<td>Static Sample on centre pole</td>
</tr>
</tbody>
</table>
ECOMATE® SYSTEM
EMISSIONS

Stored Systems in Drums/Totes

“B” Isocyanate
(ecomate® Blowing Agent)

“A” Polyol Blend
(ecomate® Blowing Agent)

< 22% LEL
0-5cm above bung
@ 30-32°C

22% LEL
within drum headspace
For neither HCFC-141b nor methyl formate the LFL will be even remotely be approached under standard process conditions (ambient temperatures 15-40 °C; substance emissions under legal exposure limits) as the following calculations show:

**Methyl Formate**

- LEL = 5% in air by volume = 125 g/m³ = 50,000 ppm
- Maximum concentration allowed by OSHA/NIOSH/ACGIH:
  - TWA = 100 ppm = 250 mg/m³ = 0.20% of LFL
  - STEL = 150 ppm = 375 mg/m³ = 0.30% of LFL

**HCFC-141b**

- LEL = 7.4% in air by volume = 925 g/m³ = 193,000 ppm
- Maximum concentration allowed (WEEL):
  - TWA = 500 ppm = 2.4 g/m³ = 0.26% of LFL
  - STEL = 3,000 ppm = 14.4 g/m³ = 1.56% of LFL

4. **CONCLUSIONS**

- Methyl formate as a pure liquid is very flammable and requires proper safeguards. The risk of explosion is, however, remote because its low heat of combustion;
- A PU system base on methyl formate can be formulated as a low combustible liquid and will not reach the LFL even in the drum’s head space; and
- There is no reason to treat methyl formate differently from HCFC-141b.
For neither HCFC-141b nor methyl formate will the LFL be even remotely approached under standard process conditions (*ambient temperatures 15 - 45 °C; substance emissions under legal exposure limits*) as the following calculations show:
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  - STEL = 150 ppm = \(0.375 \text{ g/m}^3\) = 0.30% of LFL

**HCFC-141b**
- LEL = 7.4 % in air by volume = \(925 \text{ g/m}^3\) = 193,000 ppm
- Maximum concentration allowed (WEEL):
  - TWA = 500 ppm = \(2.4 \text{ g/m}^3\) = 0.26% of LFL
  - STEL = 3000 ppm = \(14.4 \text{ g/m}^3\) = 1.56% of LFL
4. CONCLUSIONS

- Methyl formate as a pure liquid is very flammable and requires proper safeguards. The risk of explosion is, however, remote because of its low heat of combustion;

- A PU system based on methyl formate can be formulated as a low combustible liquid and will not reach the LFL even in the drum’s head space; and

- There is no reason to treat methyl formate differently from HCFC-141b.
ECOMATE® - CONSIDERATIONS

- Choice of Polyols is Universal
- No Need to Emulsify Blowing Agent
- Cost Efficient Foam Blowing – w Reduced Costs over HFCs, HFOs
- Minimal Capital Expense - Fractional versus HC Technology
- A Most Thermally Efficient Blowing Agent
- Least Flammable of the Lead Candidates
- Environmentally Benign
- Save 1 Mt CO₂ e / kg of ecomate used
- Commercially Viable - since 2002
PROS / CONS

ADVANTAGES

• Liquid at Room Temp.
• Safe To Use
• Thermally Efficient
• Environmentally Benign
• Economically Advantageous
• Good End Product Properties
• Can replace HCFCs, HFCs, HC’s, and HFOs.
• Worldwide Patent Position
• GRAS Approval

DISADVANTAGES

ECOMATE®

foam supplies, inc. ecomate®

PROS / CONS

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DISADVANTAGES

• Has 10 less years in market than HCs
• Not as well known in market
• Not a “Household” name behind the technology
• False & misleading rumors
Ecomate® Availability - systems and ecomate®
**ECOMATE® CONCLUSIONS**

**ecomate® is environmentally safe**
- Meets Montreal Protocol Regulations
- Meets Kyoto Protocol Regulations
- LCA [Life Cycle Analysis] compliant

**ecomate® is cost competitive**

**ecomate® is a safe option**

**ecomate® is available in your market**

TRY IT ... AND YOU WILL APPRECIATE IT
Thank you for your time.

WWW.FOAMSUPPLIES.COM

www.ecomatesystems.com