### COMPARISON OF COMMON MINERAL PROCESSING FROTHERS

<table>
<thead>
<tr>
<th>Relative Performance</th>
<th>Chemical Structure</th>
<th>Maximum Foam Volume</th>
<th>Foam Half-Life</th>
<th>Froth Comprehensiv-e Index</th>
<th>Foam Rise Velocity</th>
<th>Foam Duration</th>
<th>Froth Surface Tension</th>
</tr>
</thead>
<tbody>
<tr>
<td>From 1 (Low) to 5 (High) Stars based on recovery performance</td>
<td>Denotes chemical functionality and compatibility</td>
<td>Larger volume indicates stronger foaming ability</td>
<td>Longer half life indicates better foam stability</td>
<td>Higher index indicates better overall flotation performance</td>
<td>Larger velocity means lower foam viscosity</td>
<td>Form duration with ongoing aeration @ 0.05 g/L</td>
<td>Indicates ability of the frother to break surface tension of water</td>
</tr>
<tr>
<td><strong>Aliphatic</strong></td>
<td></td>
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</tr>
<tr>
<td>Methyl Isobutyl Carbinol (MIBC)</td>
<td><img src="image" alt="Chemical Structure" /></td>
<td>96.75 mL</td>
<td>4.0 s</td>
<td>4.84</td>
<td>0.64 cm/s</td>
<td>80 s</td>
<td>70.12 mN/m</td>
</tr>
<tr>
<td>2-Ethyl Hexanol</td>
<td><img src="image" alt="Chemical Structure" /></td>
<td>192.43 mL</td>
<td>7.0 s</td>
<td>16.84</td>
<td>0.66 cm/s</td>
<td>95 s</td>
<td>64.52 mN/m</td>
</tr>
<tr>
<td>BK 201</td>
<td><img src="image" alt="Chemical Structure" /></td>
<td>230.37 mL</td>
<td>8.5 s</td>
<td>24.48</td>
<td>0.63 cm/s</td>
<td>95 s</td>
<td>59.84 mN/m</td>
</tr>
<tr>
<td><strong>Cyclic</strong></td>
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</tr>
<tr>
<td>Pine Oil 90</td>
<td><img src="image" alt="Chemical Structure" /></td>
<td>102.12 mL</td>
<td>6.0 s</td>
<td>7.66</td>
<td>0.48 cm/s</td>
<td>95 s</td>
<td>62.12 mN/m</td>
</tr>
<tr>
<td>Terpenic Oil #2</td>
<td><img src="image" alt="Chemical Structure" /></td>
<td>152.65 mL</td>
<td>6.5 s</td>
<td>12.40</td>
<td>0.47 cm/s</td>
<td>95 s</td>
<td>53.93 mN/m</td>
</tr>
<tr>
<td><strong>Polyglycols</strong></td>
<td></td>
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</tr>
<tr>
<td>FloMin® 650</td>
<td><img src="image" alt="Chemical Structure" /></td>
<td>67.72 mL</td>
<td>4.5 s</td>
<td>3.81</td>
<td>0.31 cm/s</td>
<td>67 s</td>
<td>51.35 mN/m</td>
</tr>
<tr>
<td>FloMin® 660</td>
<td><img src="image" alt="Chemical Structure" /></td>
<td>80.63 mL</td>
<td>5.5 s</td>
<td>5.54</td>
<td>0.24 cm/s</td>
<td>67 s</td>
<td>46.16 mN/m</td>
</tr>
<tr>
<td>50-50 Blend (MIBC &amp; F650)</td>
<td><img src="image" alt="Chemical Structure" /></td>
<td>102.12 mL</td>
<td>6.0 s</td>
<td>7.66</td>
<td>0.48 cm/s</td>
<td>95 s</td>
<td>59.84 mN/m</td>
</tr>
</tbody>
</table>

### DATA SOURCE
From Frother Performance Analysis by Central South University in Changsha, China (March 2012) – Commissioned by Celanese

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**COMPARISON OF COMMON MINERAL PROCESSING FROTHERS**

**Graphical Comparison of Frother Characteristics (Versus Frother Concentration in g/L)**

- **Maximum Foam Volume (mL)**
- **Foam Half-Life (s)**
- **Froth Comprehensive Index (FCI)**
- **Mean Foam Rise Velocity (cm/s)**
- **Froth Surface Tension (mN/m)**

- **MIBC**
- **2-Ethyl Hexanol**
- **BK 201**
- **Pine Oil 90**
- **Terpenic Oil #2**
- **FloMin® 650**
- **FloMin® 660**
- **50-50 Blend (MIBC/F650)**

**Visual Comparison of Foam Uniformity**

- **Methyl Isobutyl Carbinol (MIBC)**
- **2-Ethyl Hexanol**
- **BK 201**
- **Pine Oil 90**
- **Terpenic Oil #2**
- **FloMin® 650**
- **FloMin® 660**
- **50-50 Blend (MIBC/F650)**

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