Development of Promising New Cast Cure Explosives

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Outline

• Objective and approach
• Performance
• Formulation processing
• Shock Sensitivity
• Bullet Impact
• Cook-off
• Summary
Objectives and Approach

Objectives: Develop new cast cure explosives which meet the following criteria:

• Improved performance over PBXN-110
• Equivalent IM response to PBXN-110
  – Measured by shock sensitivity, bullet impact sensitivity, and cook-off

Approach: Increase solids loading to 89% in an HTPB binder system

• Non-aluminized formulation DLE-C051 for metal-driving applications
• Aluminized formulation DLE-C050 for dual purpose applications – metal driving and blast
Theoretical Performance

Cheetah performance prediction comparison to PBXN-110:

- DLE-C051 has 4.5% increase in Energy @V/V₀ = 6.5
- DLE-C050 has 31% increase in total mechanical energy (blast)
- Cylinder expansion testing is planned to quantify delivered energy

<table>
<thead>
<tr>
<th>Formulation</th>
<th>DLE-C050</th>
<th>DLE-C051</th>
<th>PBXN-110</th>
</tr>
</thead>
<tbody>
<tr>
<td>HMX</td>
<td>74</td>
<td>89</td>
<td>88</td>
</tr>
<tr>
<td>Aluminum</td>
<td>15</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>HTPB/Plasticizer</td>
<td>11</td>
<td>11</td>
<td>12</td>
</tr>
<tr>
<td>Total Solids (%)</td>
<td>89</td>
<td>89</td>
<td>88</td>
</tr>
<tr>
<td>Density (g/cc)</td>
<td>1.776</td>
<td>1.705</td>
<td>1.678</td>
</tr>
<tr>
<td>P_cj (Kbar)</td>
<td>247</td>
<td>264</td>
<td>249</td>
</tr>
<tr>
<td>V_d (km/s)</td>
<td>7.59</td>
<td>7.89</td>
<td>7.75</td>
</tr>
<tr>
<td>CJ Temperature (°K)</td>
<td>4734</td>
<td>3757</td>
<td>3682</td>
</tr>
<tr>
<td>Energy @ V/V₀ = 6.5 (kJ/cc)</td>
<td>8.15</td>
<td>7.22</td>
<td>6.91</td>
</tr>
<tr>
<td>Total Mechanical Energy (kJ/cc)</td>
<td>11.46</td>
<td>9.10</td>
<td>8.77</td>
</tr>
</tbody>
</table>
Processing

Processing at 89% solids with a bimodal blend of HMX (coarse and fine) was a significant challenge

- A new plasticizer reduced mix viscosity compared to IDP used in PBXN-110

<table>
<thead>
<tr>
<th>Formulations at 88% Solids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formulation</td>
</tr>
<tr>
<td>HMX</td>
</tr>
<tr>
<td>Plasticizer</td>
</tr>
<tr>
<td>EOM Viscosity (kp)</td>
</tr>
</tbody>
</table>

- A special grind of fine HMX reduced viscosity about 6 kPa
- Excellent casting and flow of mixes
An advanced weapon and space systems company

Shock Sensitivity

Large Scale Gap Test (LSGT) conducted
  • Sensitivity similar to PBXN-110

<table>
<thead>
<tr>
<th>Formulation</th>
<th>Go/No-go # Cards</th>
</tr>
</thead>
<tbody>
<tr>
<td>DLE-C050</td>
<td>173/175</td>
</tr>
<tr>
<td>DLE-C051</td>
<td>176/177</td>
</tr>
</tbody>
</table>

LSGT of DLE-C050

LSGT of DLE-C051

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.
Bullet Impact Testing

50 caliber impact of bare $\frac{1}{2}$ lb billet is used for initial screening

- Data acquisition
  - Pressure
  - High speed digital video
  - Both were very useful!

Overall View

Close-Up Of Billet
Bullet Impact Results

No reaction evident in bullet impact of DLE-C050

- Blast overpressure same as inert sample

Bullet impact of bare billet of DLE-C051 is planned along with bullet impact of 3.2 in. generic shaped charges of both formulations
Variable Confinement Cookoff Testing (VCCT) used to evaluate formulations

- VCCT testing of DLE-C050 showed excellent results

<table>
<thead>
<tr>
<th>Wall Thickness (in.)</th>
<th>Reaction Temperature (°C)</th>
<th>Reaction Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.030</td>
<td>182</td>
<td>burn</td>
</tr>
<tr>
<td>0.045</td>
<td>167</td>
<td>pressure rupture</td>
</tr>
<tr>
<td>0.060</td>
<td>182</td>
<td>pressure rupture</td>
</tr>
<tr>
<td>0.075</td>
<td>186</td>
<td>pressure rupture</td>
</tr>
<tr>
<td>0.090</td>
<td>172</td>
<td>deflagration</td>
</tr>
</tbody>
</table>

- VCCT planned with DLE-C051
- Slow cookoff testing planned with 3.2 in. generic shaped charges
VCCT of DLE-C050

0.030”  0.045”  0.060”  0.075”  0.090”
Summary

New cast cure HMX-based explosives developed

- Aluminized (DLE-C050) and non-aluminized (DLE-C051) formulations

89% solids improves on the performance of PBXN-110

Mixes have excellent processing characteristics

Shock sensitivity similar to PBXN-110

Bullet impact and VCCT response of DLE-C050 are excellent

- Similar tests are planned with DLE-C051

Further IM testing is planned using 3.2 in. generic shaped charges