IMX-104 Manufacturing Process Optimization

Insensitive Munitions & Energetic Materials Technology Symposium 2013

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## Acknowledgements

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<tr>
<th>US ARMY RDECOM</th>
<th>US ARMY PEO-AMMO</th>
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<tr>
<td>• Army ManTech Funding</td>
<td>Project Manager Combat Ammunition Systems (PM-CAS)</td>
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<td>• Stakeholder</td>
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<td>Munitions Engineering &amp; Technology Center (METC)</td>
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Outline

- Objective
- Background
- Approach
- Process Flow Diagram
- Design of Experiments (DOE)
- Brookfield Viscometer
- Dewatering Techniques
- Schedule
- Major Accomplishments & Status
Objective

• To maximize the manufacturing efficiency of IMX-104 to lower its unit cost while maintaining the desirable properties.
IMX-104 Background

- An insensitive melt-pour explosive to replace Composition B for Mortar Applications
- IMX-104 and all starting ingredients manufactured at Holston Army Ammunition Plant
- Exhibited superior IM properties and comparable performance over Composition B in 81mm Mortar HE
- IMX-104 will minimize collateral damage when it is exposed to unplanned stimuli including fires, shock and impact
- IMX-104 qualified as an main fill explosive in June, 2011
- Type qualification on-going for 60 & 81mm Mortar HE (120mm to follow)
- Over 100,000 LB. manufactured at HSAAP
Approach

- Test Plan Development
- Laboratory Scale Evaluation
  - Effect of ingredient variation on processability
- Manufacture of Design of Experiment (DOE) Batches
- Pre-Melter Feasibility Study
- Manufacture of FAT Batches
- Conduct
  - First Article Tests
  - Loading Study
- Brookfield Viscosity Measurement Development
- Improve Raw Ingredients Dewatering Technique
Design of Experiments

<table>
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<tr>
<th>Variables</th>
<th>Conditions</th>
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<tbody>
<tr>
<td>Baseline</td>
<td>1,325 lb batch</td>
</tr>
<tr>
<td></td>
<td>Ingredient addition temp @ 105°C</td>
</tr>
<tr>
<td></td>
<td>Final mixing time &amp; temp 90 minutes @ 100°C</td>
</tr>
<tr>
<td>DNAN Pre-Melter</td>
<td>Various loading methods of DNAN</td>
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<tr>
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<td>Various steam supply levels</td>
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<tr>
<td>Process Temperature</td>
<td>Elevated ingredient addition and processing temperature</td>
</tr>
<tr>
<td>Ingredients Addition Rate</td>
<td>Fastest possible addition rate without compromise on product temp in kettle</td>
</tr>
<tr>
<td>Final Mixing Time &amp; Temperature</td>
<td>Reduced mixing time combined with higher mixing temperature</td>
</tr>
<tr>
<td>Batch Size</td>
<td>High and low (1,500 lb / 700 lb)</td>
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Pre-Melter

Melt Medium → Ingredients

Pre-Melter → Incorporation kettle → Hold-Up Kettle → Pellet Pot

Casting Belt (water cool) → Nutsche

Ingredients

Pre-Melter

Incorporation kettle

Hold-Up Kettle

Pellet Pot

Casting Belt (water cool)

Nutsche
Brookfield Viscometer

- Brookfield Viscometer is a rotational viscometer
- Torque required to turn an object in a fluid is a function of the viscosity of the fluid.
- Relatively reliable and repeatable
- Much more sensitive than Efflux viscosity measurement
- Less subjective, less operator dependent measurement
Dewatering Techniques

- Existing dewatering infrastructure
  - Labor intensive
  - Time consuming
  - Inconsistent moisture content
  - Extensive maintenance
- Bladder press
  - Commercially available
  - Rubber bladder expands with water pressure to press material against the basket to remove water
- Filter Press
  - Commercially available
  - Widely used liquid/solids separation equipment
Major Accomplishments / Status

• Completed Tasks
  • Laboratory scale evaluation of raw ingredients characteristics
  • Manufacture of DOE batches
  • Prove-out of pre-melter
  • Manufacture of FAT batches using optimized process parameters
  • Development of Brookfield viscosity test method

• Planned Activities
  • 81mm mortar loading study
  • Raw ingredients dewatering study