







IMX-104 Manufacturing Process Optimization

Insensitive Munitions & Energetic Materials Technology Symposium 2013

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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.

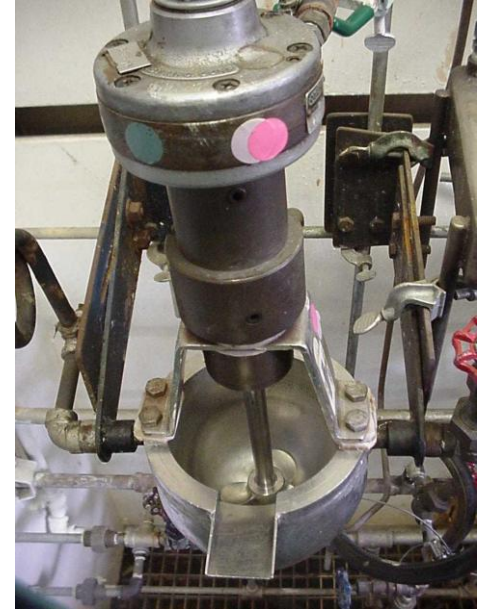
IMX-104 Background

- 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 a 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

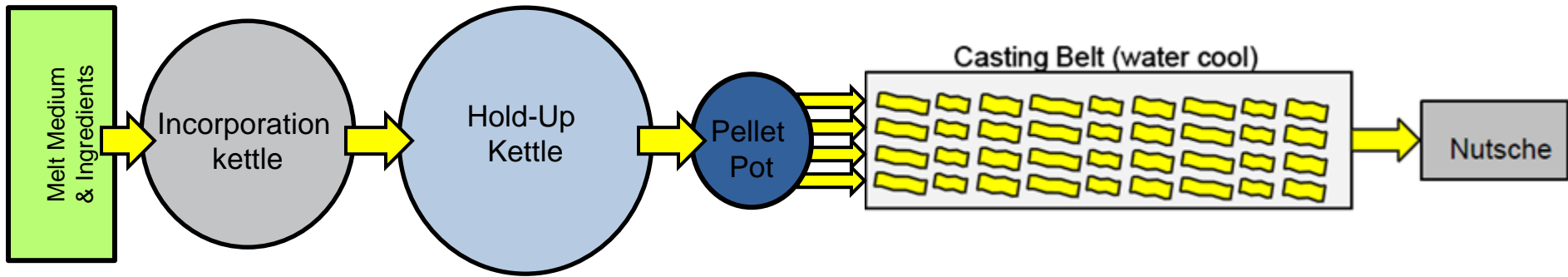
- Test Plan Development
- Laboratory Scale Evaluation
 - Effect of ingredient variation on processability
- Manufacture of Design of Experiment (DOE) Batches
- Pre-Melter Feasibility Study
- Manufacture of FAT Batches
- Conduct
 - First Article Tests
 - Loading Study
- Brookfield Viscosity Measurement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



Lab-scale Melt Kettle



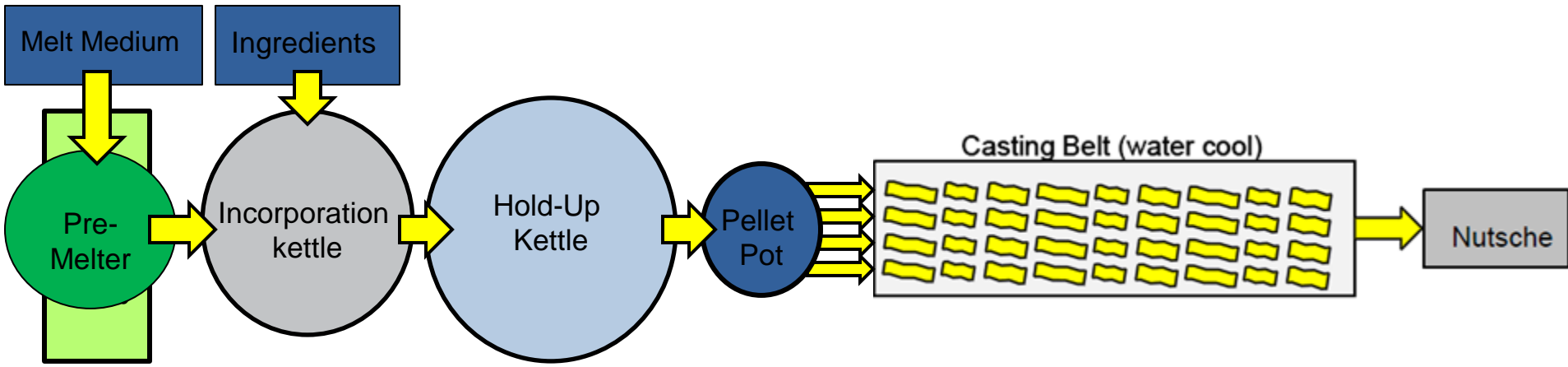
Process Flow Diagram



Design of Experiments

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

Pre-Melter



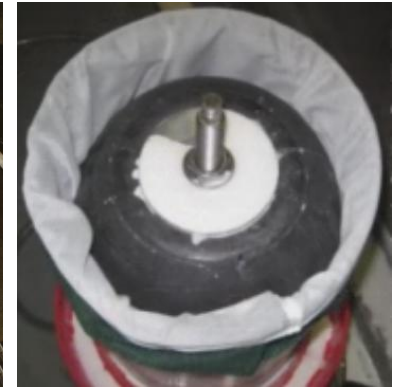
Brookfield Viscometer

- 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

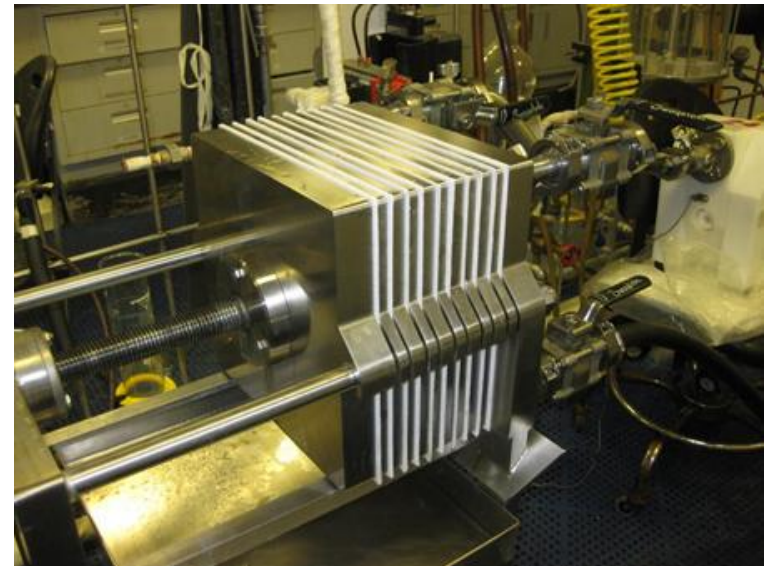


Dewatering Techniques

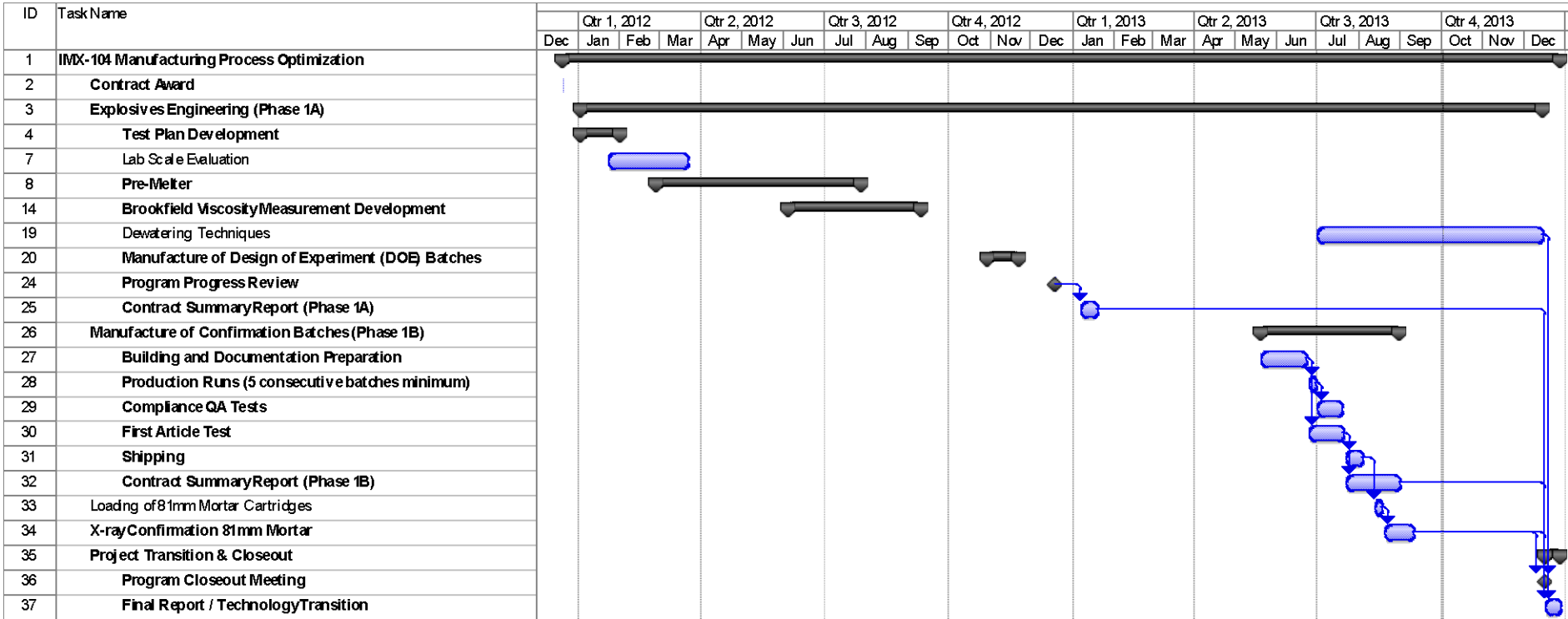
- Existing dewatering infrastructure
 - Labor intensive
 - Time consuming
 - Inconsistent moisture content
 - Extensive maintenance
- Bladder press
 - Commercially available
 - Rubber bladder expands with water pressure to press material against the basket to remove water
- Filter Press
 - Commercially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



Bladder Press (Top), Filter Press (Bottom)



Schedule



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