



Continuous Production of Paste (Energetic Material)

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Project Overview

Objectives

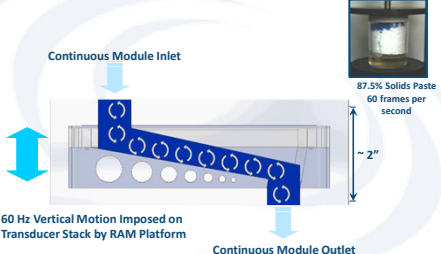
- Design, Fabricate and Test an Energetics Rated Continuous Acoustic Mixing – Clean In Place (CAM-CIP) system
- Demonstrate Energetic PBX Production at NAWCWD China Lake Using the Energetics Rated CAM-CIP system

Results



- CAM-CIP Module Completed and Tested
- Testing of Energetics Rated Ancillary System Ongoing

Continuous Acoustic Mixer - Paste

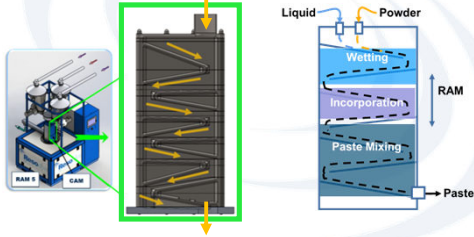


Upper and Lower Acoustic Transducers Continuously work on the Materials being Mixed

Continuous Mixing Schematics

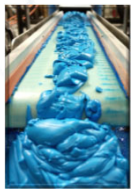
Continuous Acoustic Mixer (CAM)



Mixing Pastes Continuously

CAM-CIP for RAM 5

- Paste Viscosities: >1,000,000 cP at Room Temperature
- Tested at: 3.0 kg/min or 180 kg/hr

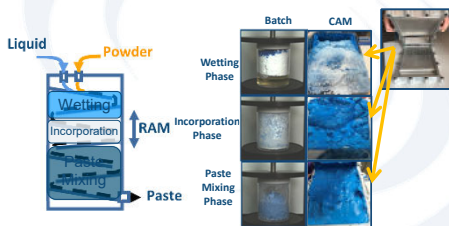


Continuous Mixing System

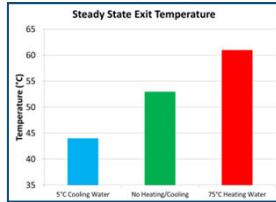
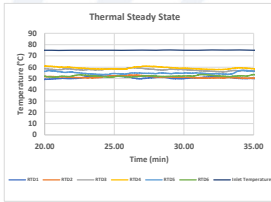


Continuous Module Mix Regimes

Mix Regimes are the Same within the CAM as in Batch



CAM-CIP Temperature Control



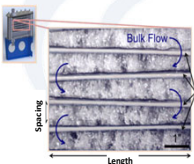
Clean-in-Place (CIP)

Current Typical Batch Cleaning

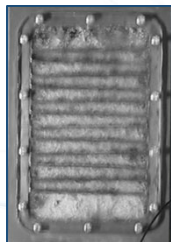
- Uses Organic Solvents
 - Hazardous Air Pollutants (HAP)
 - Exposure source for workers
- Creates Waste
 - Residual material ≈ 5% by mass
 - Cleaning supplies and PPE ≈ 10% by mass



Clean-in-Place (CIP)



Prototype CAM Processing
Water and Air



CAM Clean in Place (CIP)

- Cleaning Inert PBX Surrogate from CAM using Clean-in-Place
- 5 kg of Material Wasted
- Less than 9 L of Aqueous Waste
- 100% Removal Efficiency Achieved

After Runout
Before Cleaning



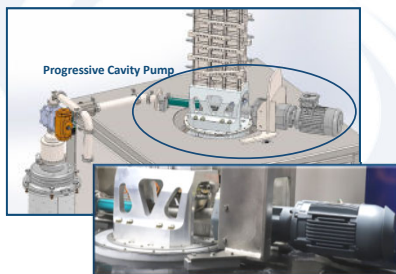
After Clean-in-Place



Transition to an Operational Environment

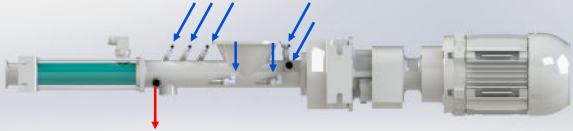


Material Transport

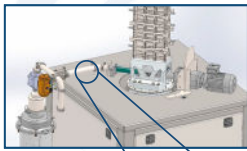


Progressive Cavity Pump

Pump Clean in Place (CIP)



Mixedness Sensor

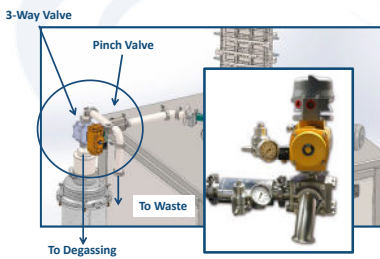


One Transmitter and One Receiver can Measure Composition and Mixedness by analyzing the Time of Flight Against a Standard and to Each Other

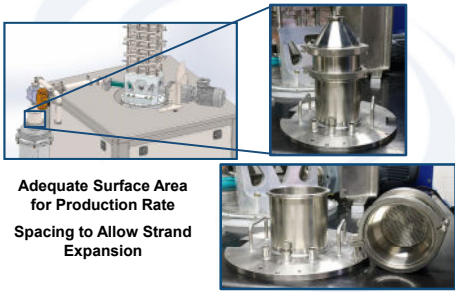
Ultrasonic Receiver

Ultrasonic Transmitter

Automatic Diversion System



Continuous Degassing System



Adequate Surface Area
for Production Rate
Spacing to Allow Strand
Expansion



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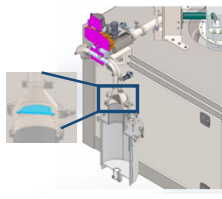
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Continuous Degassing System Assembly

View of Degas Assembly



Degassed Mix Material
Collection Vessel



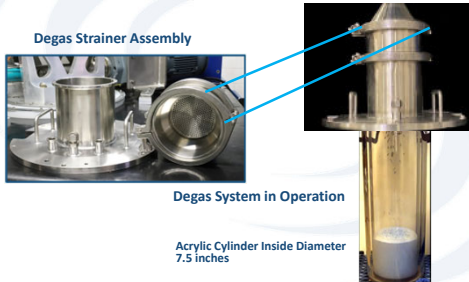
Cross-section View of Degas
Assembly



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Continuous Mixed Material Degassing System in Operation



Degas Strainer Assembly

Degas System in Operation

Acrylic Cylinder Inside Diameter
7.5 inches



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Degassed Mixed Material Collection at End of Run

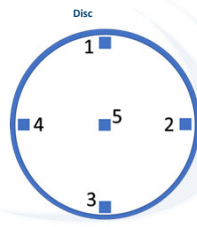
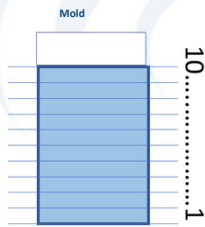
Mixed and Degassed
Material Production Rate
60 kg/hour



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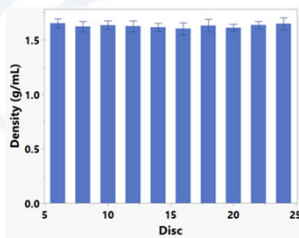
Energetic Rated System Testing



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Energetic Rated System Testing



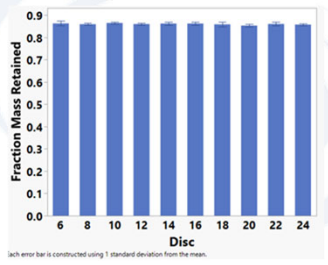
Each error bar is constructed using 1 standard deviation from the mean.



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Energetic Rated System Testing



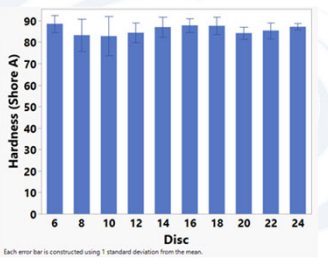
Each error bar is constructed using 1 standard deviation from the mean.



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Energetic Rated System Testing



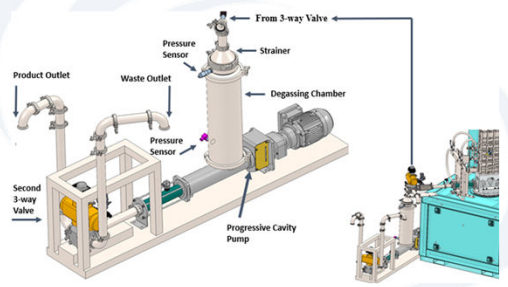
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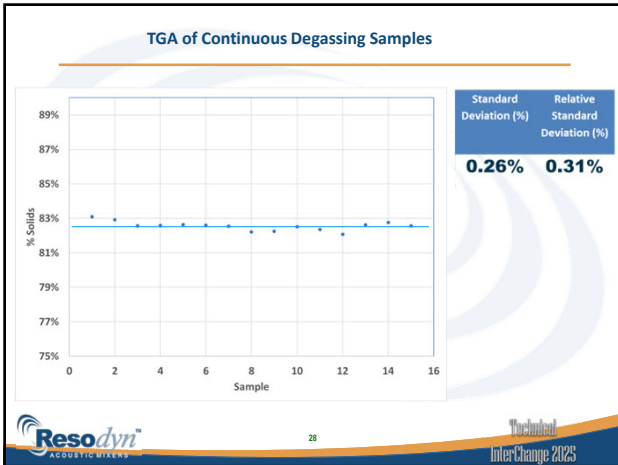
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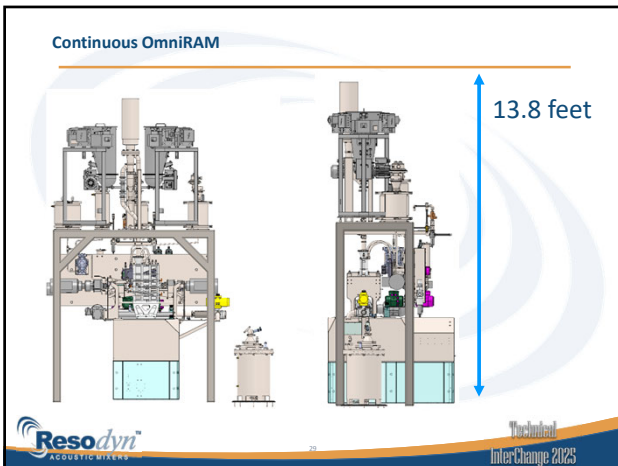
Continuous Mixed Material Degassing System for Continuous Filing



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Summary

Accomplishments

- Energetics Rated CAM-CIP Ready for Energetics Testing
- CAM-CIP Demonstrated with 100% Efficiency
- Temperature Control, Degassing

Next Steps

- Production of Mixed Energetic Material from this System at NAWC WD China Lake
- Development of Inline Mix Quality Sensor
- Testing of the OmniRAM Continuous system
- Installation of Continuous OmniRAM at DSTG

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Thank you for your time and attention



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