40th International Pyrotechnics Seminar

ResonantAcoustic® Mixing of PBX

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Outline

- RAM Technology Overview
- Inert PBX Mixing Experiments
- Mixing Evaluation
- Value Proposition
- Live PBX Case Study

RAM Technology Overview

Laboratory Mixers

- **ResonantAcoustic® Mixing (RAM)**
  - Non-contact mixing
- **Low-frequency**
  - 60 Hz
  - Harmonic resonance
- **High-intensity**
  - 100 X's the acceleration of gravity
- **Resonant tracking**
  - Automatic
- **Acoustic field**
  - Efficient energy distribution
  - Uniform & simultaneous micro-mixing

Production Mixers

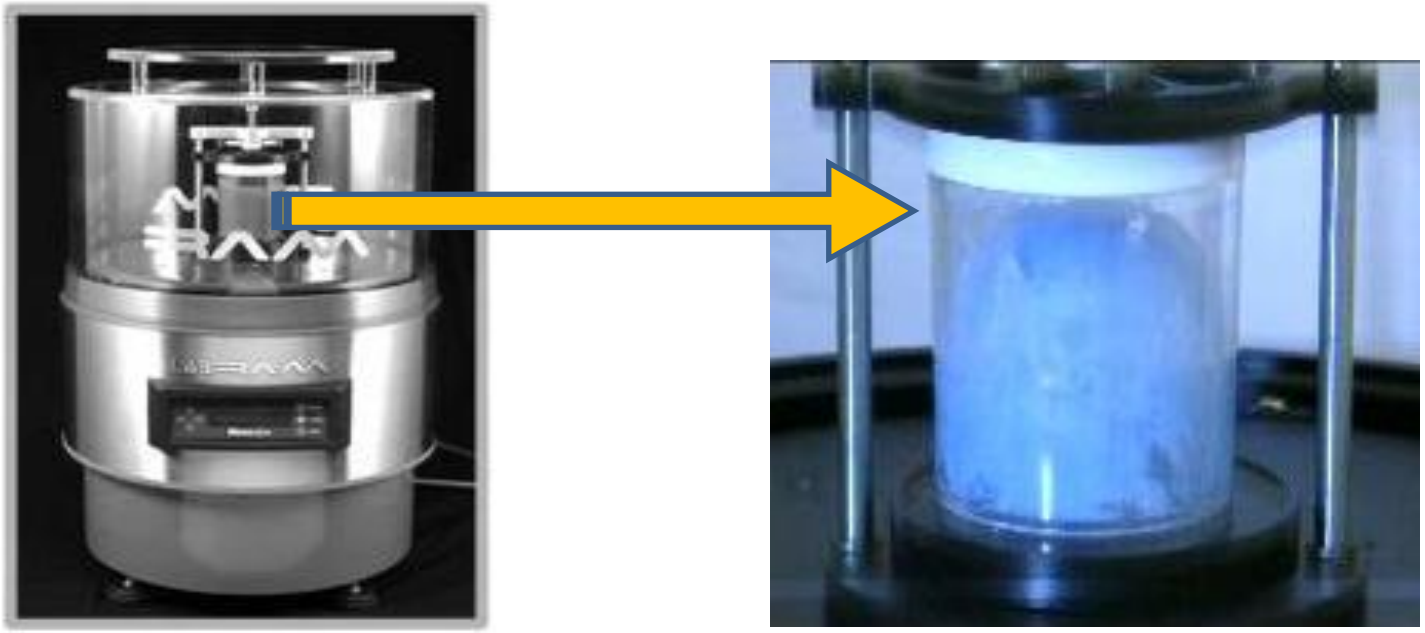
Experimental Procedure

- Inert PBX Formulation

Weight %	Ingredient	Characteristics
7.91	HTPB	Polybutadiene
0.30	Lecithin	Thickening Agent
7.91	DOA	Plasticizer
41.49	Gypsum	Energetic Simulant
41.49	Granulated Sugar	Energetic Simulant
0.05	Blue Pigment	Inert Marker
0.03	DBTDL	Catalyst
0.71	IPDI	Curative

Surrogate PBX Mix -- LabRAM

- 0.2 kg
- 12 minutes of processing time



Surrogate PBX Mix -- RAM 5

- 20 kg
- 12 minutes of processing time

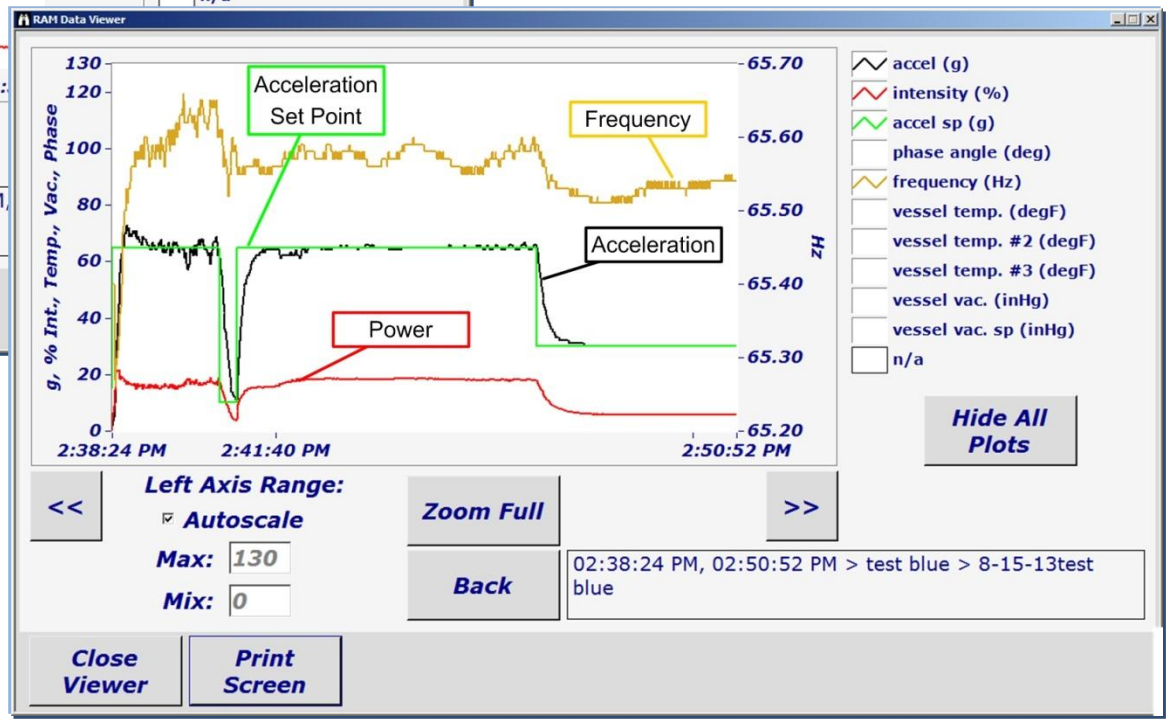
Surrogate PBX Mix -- RAM 55

- 200 kg
- 14 minutes of processing time

RAM 55 Batch Mixing – PBX Surrogate

R45 Based Energetic Surrogate in the RAM 55

Surrogate PBX Mix RAM 5 Compared to RAM 55

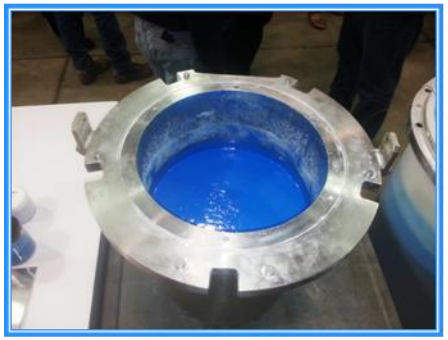


RAM 5 and RAM 55 Mix Test Data

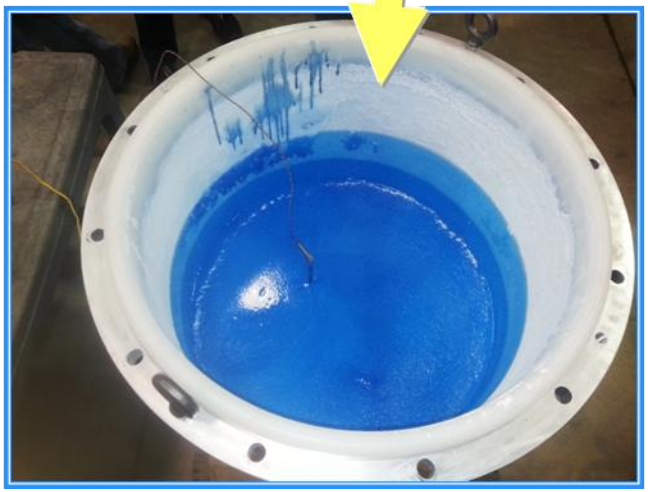
- Comparative Test Results

PLATFORM	MASS	POWER	POWER/kg
RAM 5	21 kg	4.3 kW	156 W/kg
RAM 55	204 kg	36.5 kW	137 W/kg

Mix Comparison



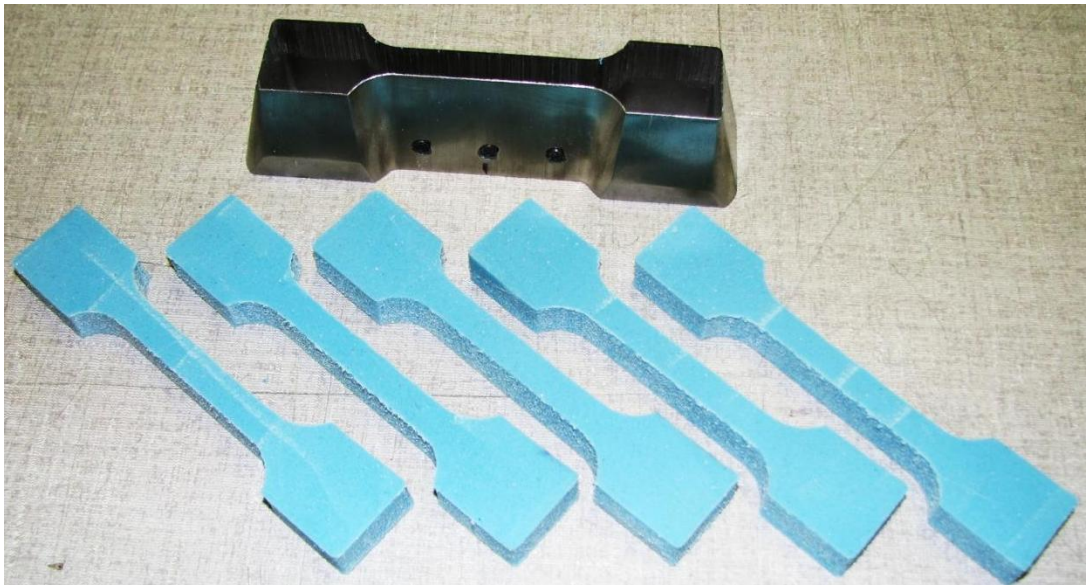
21 kg mix – 12 minutes



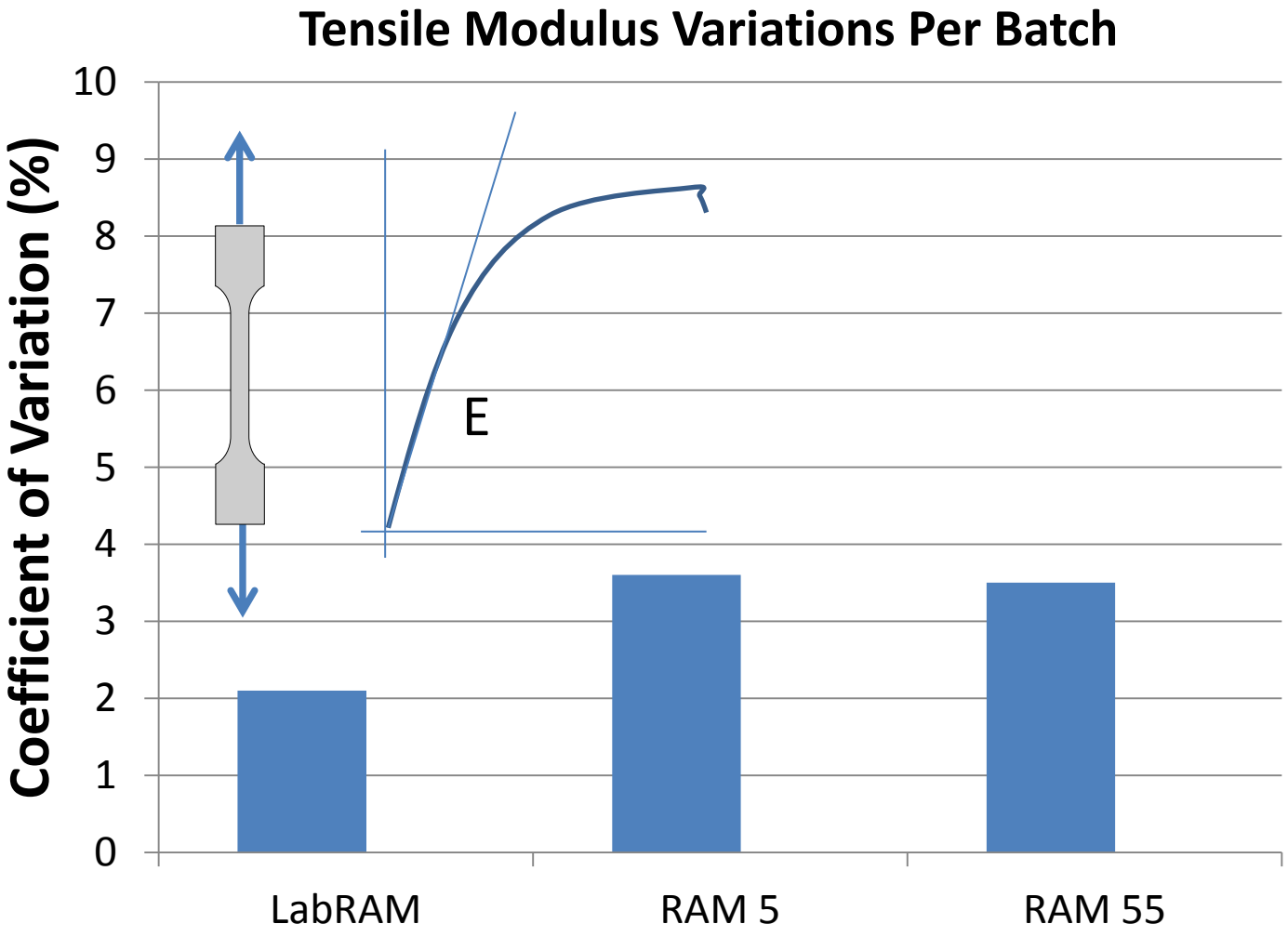
204 kg mix – 14 minutes

Mix Evaluation

- JANNAF Dog Bones Per CPIA Pub 21
- Gage Length Cross Section, 0.95 by 1.27 cm



PBX Simulant Across Platforms

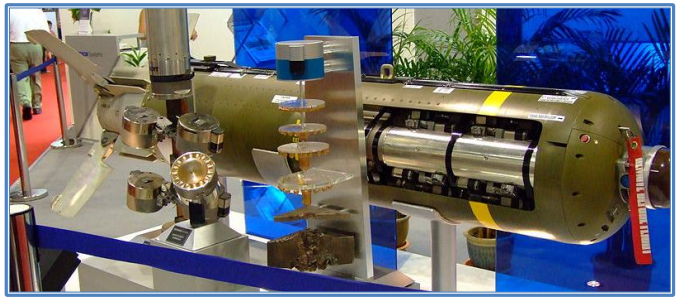


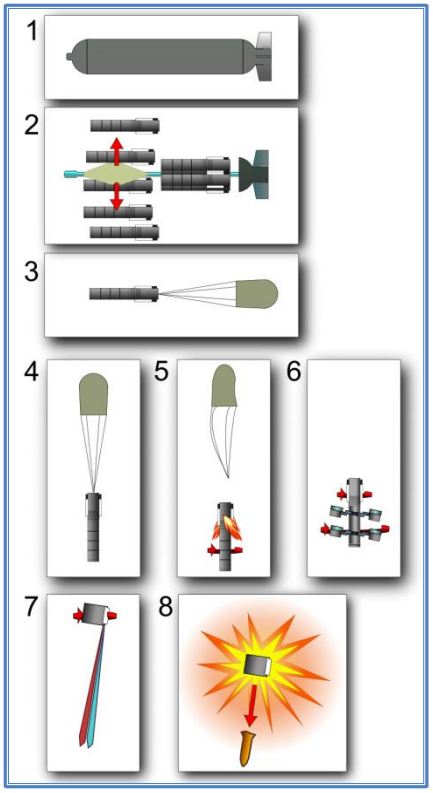
Value Proposition Cost Reductions

- **Equipment and Labor Reductions**
  - Reduced equipment stations
  - Reduced processing steps
  - Reduced processing time
- **One Step Ingredient Addition**
- **Mix-in-Mold or Mix-in-Case**
  - Near net shape to minimize post-cure machining
  - Final shape : mix-in-case
- **Energy Costs Reduced**
  - Reduced mix times
  - No mix vessel heat addition required
- **Reduced Waste**

RAM 5 CASE STUDY
McAlester Army Ammunition Plant

- **Manufacture 108 Cluster Bomb Boosters for the U.S. Air Force**
- **Current Process**
  - **Cut and Machine from solid round extrusion**
  - **Previous Cost $1,250 per part**
- **ResonantAcoustic® Manufacturing Process**
  - **Near-net-shape each part**
  - **Production capabilities of 500 per month**
  - **Anticipated Cost $450 per part**



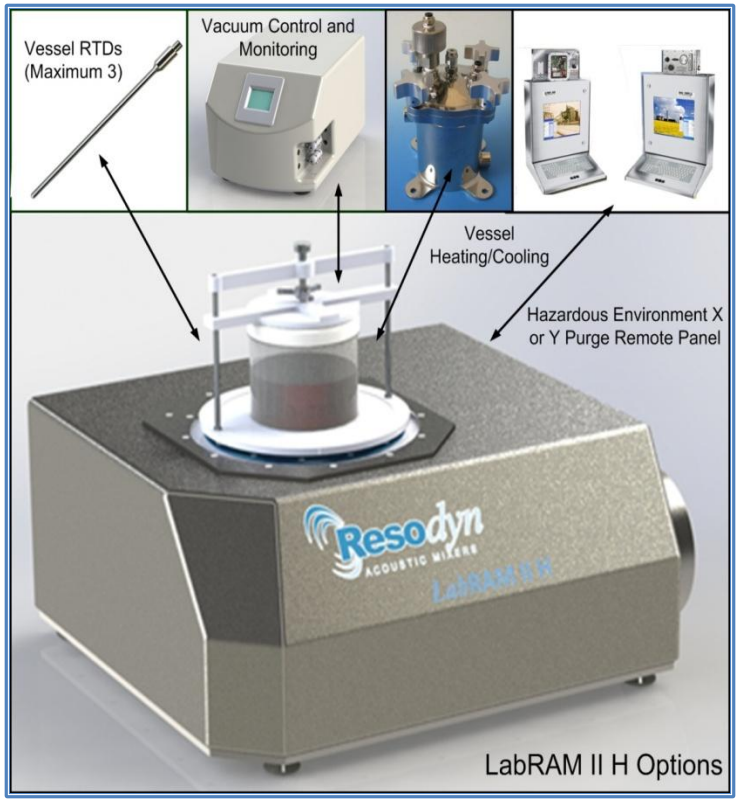


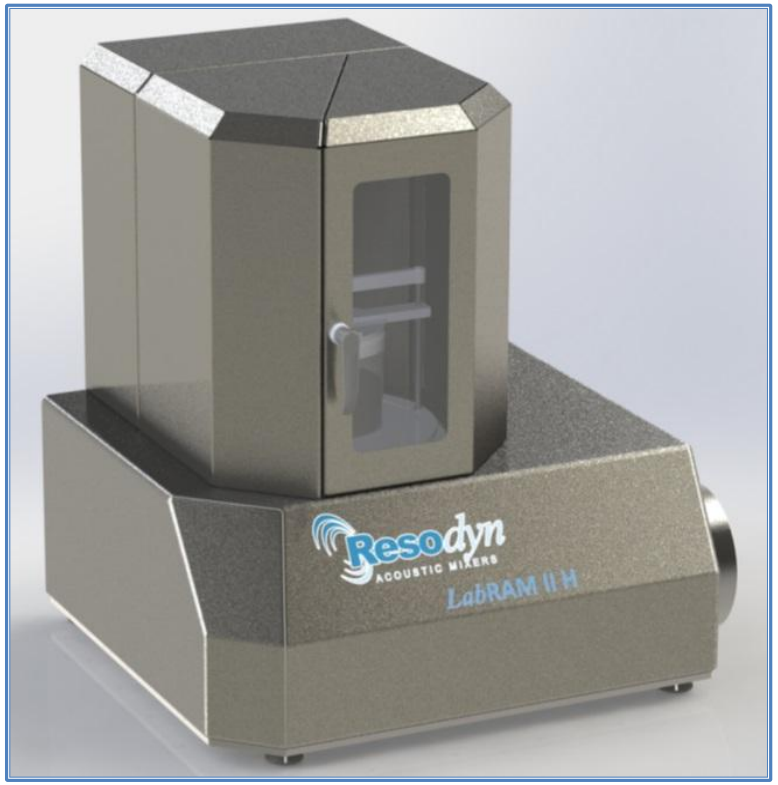
McAlester RAM 5 Installation

- **Value Proposition --Net Economic Outcome/Gain**
  - **Saves ~$800 per part**
  - **Payback < 12 months**
  - **Provides ability to meet current product demand**

- **RAM 5 for Mixing Energetics Installed and Started Up December 2013**
- **Energetic Manufacturing Currently in Full Production**

Resodyn Acoustic Laboratory Mixer
Hazardous Environment





- Class I, Division 1; Class II, Division 2
- 1,000 grams (2.2 lbs.) capacity
- Remote Operations
- Stainless Steel Cabinet
- Consolidated Mechanical, Electrical and Controls Package

Contact Information

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Innovative Mixing Technology

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