

# Continuous Mixing of Solids

Presented by:  
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Sales Engineer



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## Outline

- Continuous Acoustic Mixer (CAM) System Configuration
- Continuous Mixing Principles
- The Transition from Batch to Continuous
- Considerations:
  - Orifice Area
  - Acceleration
- Examples of Continuous Powder Mixing



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## Beyond Batch Mixing

- Batch Mixing Provides Suitable Processing for Materials, but Limitations in the Amount of Material That Can Be Manufactured Are Imposed by the Batch Vessel Size
- Approach Taken to Overcome the Limitation is to Extend the RAM Technology into Continuous Processing



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## Continuous Mixing System Requirements

- **System Requirements - Develop a Continuous Mixing System that**

- Uses the universal RAM technology platform
- Has flexibility for use with all forms of materials
- Does not have 'moving' parts
- Is modular and customizable

- **System Outcome - A Continuous Mixing System has been Developed that**

- Meets all of the above requirements
- Has high mixed material throughput capabilities



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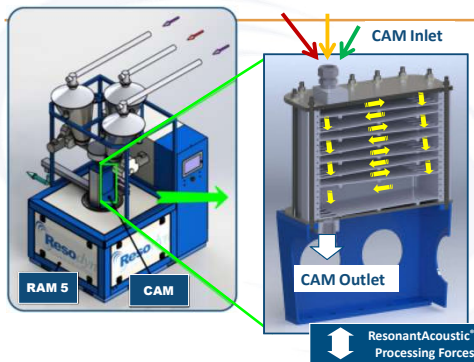
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## Continuous Acoustic Mixer (CAM) Configuration



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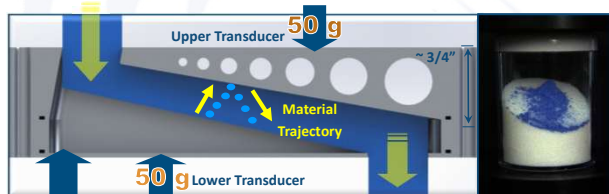
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## Continuous Acoustic Processor



60 Hz Vertical Motion Imposed on Transducer Stack by RAM Platform

Upper and Lower Acoustic Transducers Continuously Work on the Materials Being Mixed



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### CAM Module

- The Fundamentals between Batch and Continuous Mixing are the Same
- RAM Technology Creates Up to 0.55 Inch Oscillating Displacement at ~60 Hz
- Mixing Occurs through Random High Energy Particle Collisions



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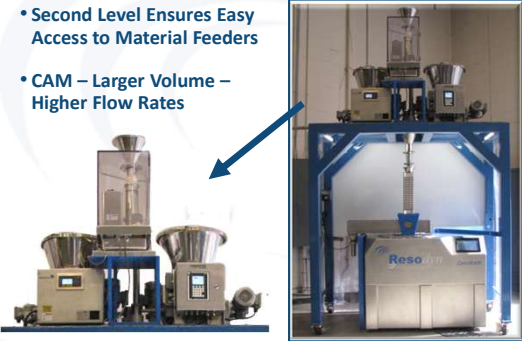
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### Prototype OmniRAM PharmaCAM System

- Second Level Ensures Easy Access to Material Feeders
- CAM – Larger Volume – Higher Flow Rates



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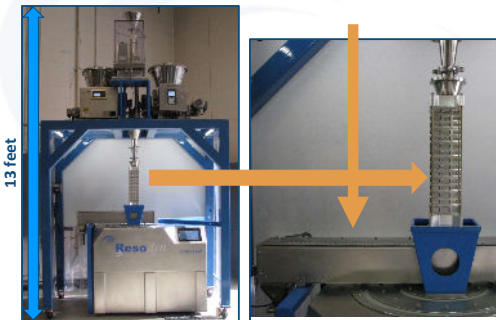
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### Prototype OmniRAM PharmaCAM System



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Conveyer System



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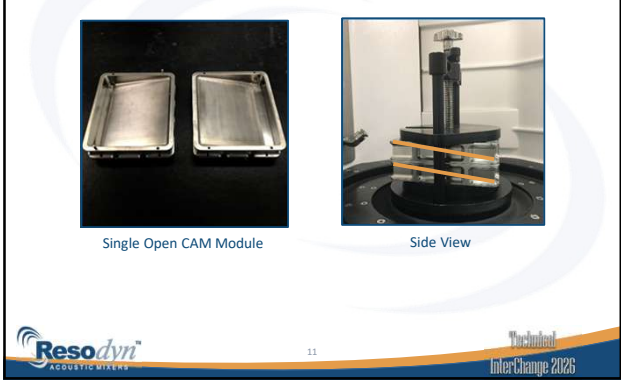
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Single CAM Module



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The Transition



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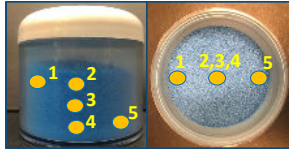
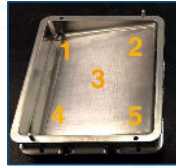
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## Thermal Gravimetric Analysis

- Thermal Gravimetric Analysis (TGA) Provides a Reliable and Reproducible Measure of Homogeneity within a Mix

- A Mix of Two Proprietary Materials

1. 80% Inorganic Material
2. 20% Organic Material



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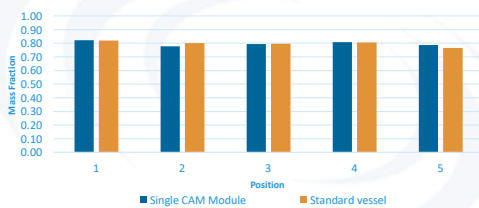
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## CAM Plate Results

TGA Analysis



| Single CAM Module  |        | Standard vessel    |        |
|--------------------|--------|--------------------|--------|
| Average            | 79.8%  | Average            | 79.8%  |
| Standard Deviation | 2.05%  | Standard Deviation | 1.76%  |
| RSD                | 2.58 % | RSD                | 2.21 % |

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## Design Considerations

- Loss in Weight Feeders
- Conveyor Design and Belt Speed
- Material Properties
- Area Considerations
  - Orifice Size/Number
- Acceleration Considerations

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### Orifice Size

- At the lower End of Each Plate there is a Transition Hole
- Either a Large Slot or Series of small holes
- Affect the Flow Rate



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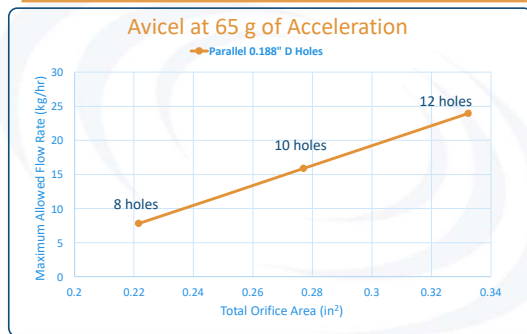
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### Orifice Size/Number of Holes on Max Flow Rate



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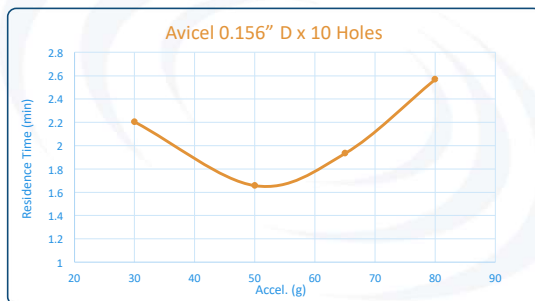
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### Acceleration and Residence Time

- Driving forces of movement down the plates



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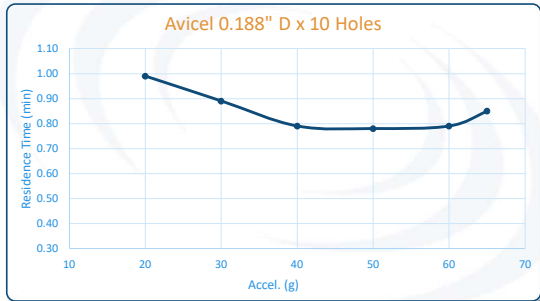
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Acceleration and Residence Time



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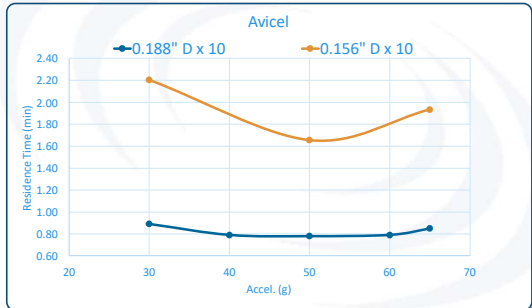
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Acceleration and Residence Time



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Processing Rates

- Capacity of CAM/Residence Time = Flow Rate
- Example: OmniRAM
  - Residence Time: 1 minute
  - CAM Capacity: 5 kg
  - 5 kg/1 min= 5kg/min or 300 kg/hr

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## Processing Rates

- Capacity of CAM/Residence Time = Flow Rate

- Example: RAM5

- Residence Time: 1 minute
- CAM Capacity: 36 kg
- 36 kg/1 min = 36kg/min or 2,160 kg/hr



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## Solid-Solid Mixing: Uniform Particle Size

- White Sand and 9.1% Dyed Sand

- White sand in at 3.2 kg/min
- Red dyed sand (260 ppm) in at 0.32 kg/min
- 12 plates in CAM
- 30 g acceleration
- Collected samples every 5 sec from exit orifice



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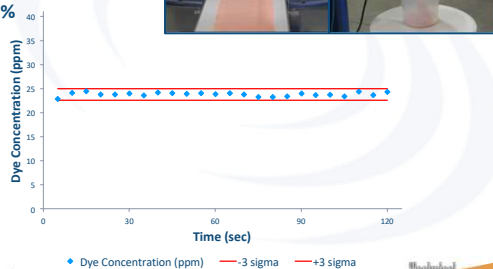
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## Solid-Solid Mixing: Uniform Particle Size

- Average at Outlet 23.8 ppm, 95% CI =  $\pm 0.18$  ppm

- RSD 1.7%



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## RAM Batch Compared to CAM



### Comparisons Between Batch and Continuous RAM Mixer Methods Demonstrate Similar Mixing Results



| Batch Mixing                  | Continuous Mixing             |
|-------------------------------|-------------------------------|
| 4.2 wt% Glucose w/ 0.25% EH-5 | 4.2 wt% Glucose w/ 0.25% EH-5 |
| 95.8 wt% Avicel PH-200        | 95.8 wt% Avicel PH-200        |
| Low head height               | N/A                           |
| 80g's                         | 60g's                         |
| 25 seconds                    | 25 seconds                    |
| %RSD = 3.7                    | %RSD = 2.7                    |

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## Biogen OmniRAM Continuous Pharmaceutical Mixer

- Continuously Mixes From 10 to 20 kg/hr
- Residence Time Variable from < 30 sec to >120 sec
- Multiple and Complex Excipient Feeds
- Very Low Percentage Active Ingredient
- Exceptional RSD (<2%)
- Integrated with Upstream and Downstream Product Manufacturing Processes



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## Summary

- Platform of the CAM Remains the Same
- Design Considerations
  - Orifice Area
  - Acceleration
- Confidence from Batch to Continuous

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Thank you for your time  
and attention.



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