Processing of Energetic Materials with New Mixing Technologies

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IMEMTS
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Outline

- Introduction
- State of the art
- New mixing technologies
- Results
- Summary
- Outlook

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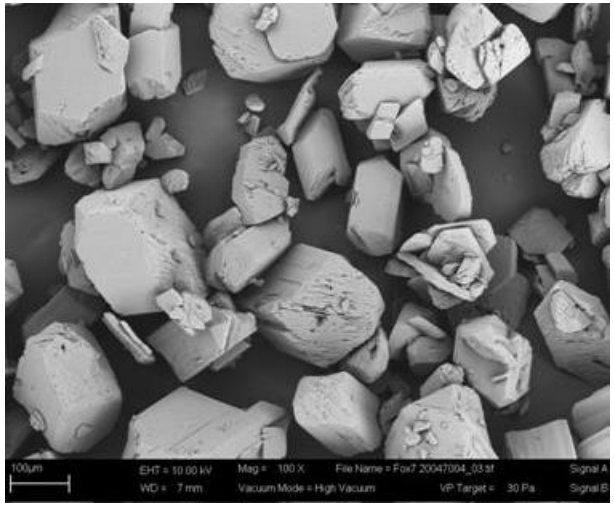
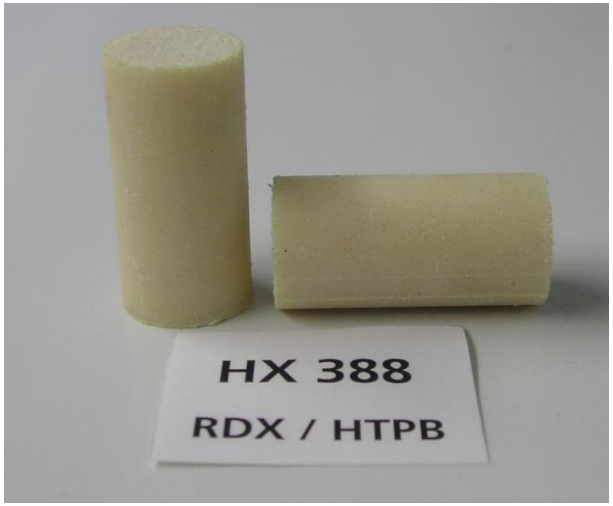
Introduction





Manufacture of explosive charges:

- casting
- pressing
- extrusion

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State of the art: Conventional Planetary Mixer

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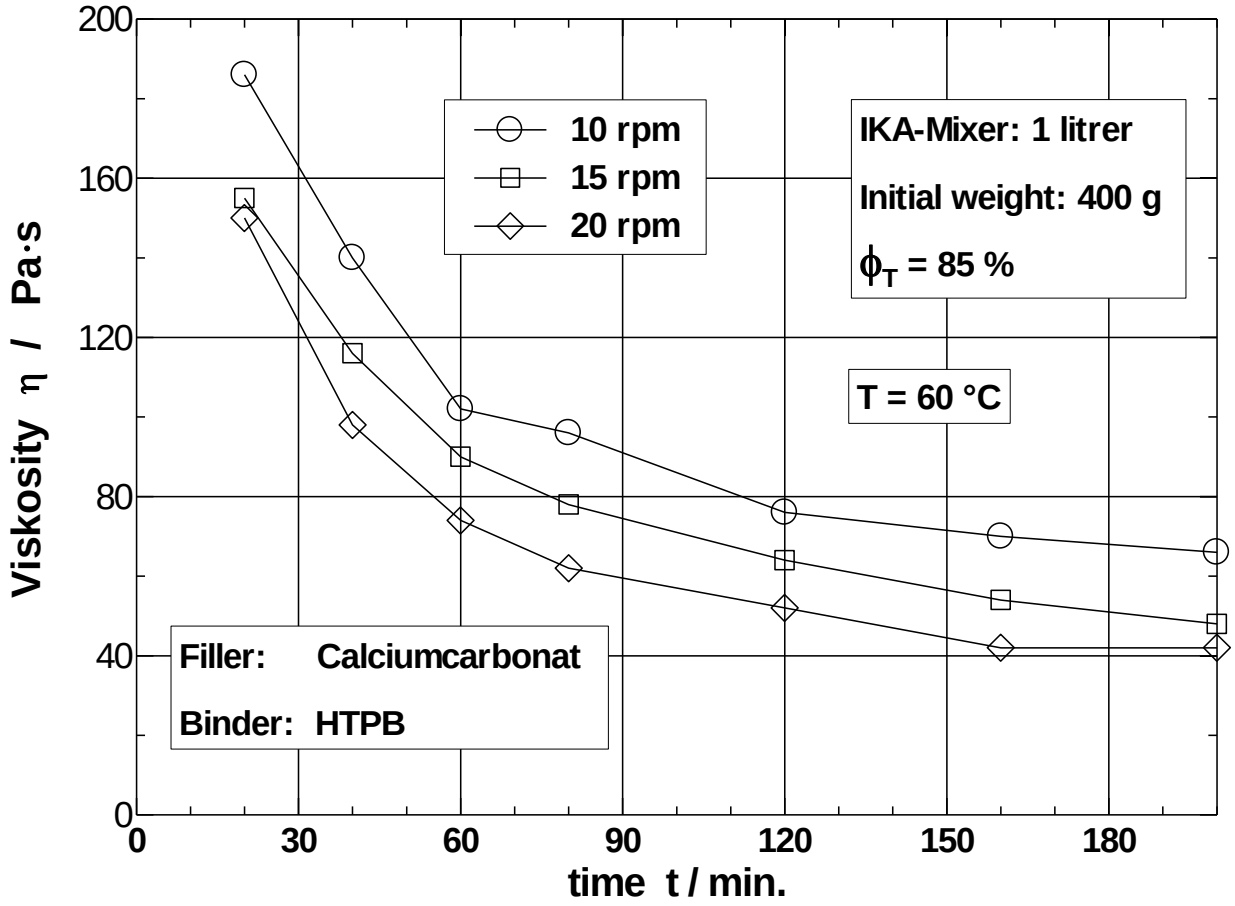
State of the art: Conventional Planetary Mixer



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New Mixing Technologies

Non-contact Planetary Mixer / Centrifugal Mixer /

Dual asymmetrical centrifuge

Resonant Acoustic Mixing

Speed Mixer

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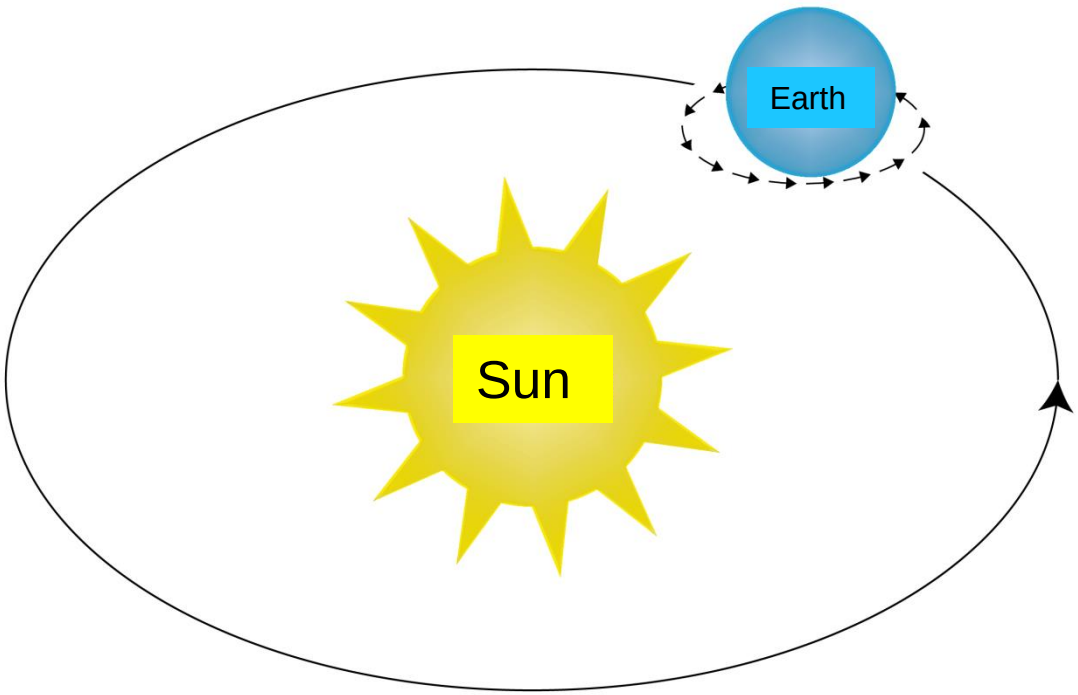
operating principle - planetary motion



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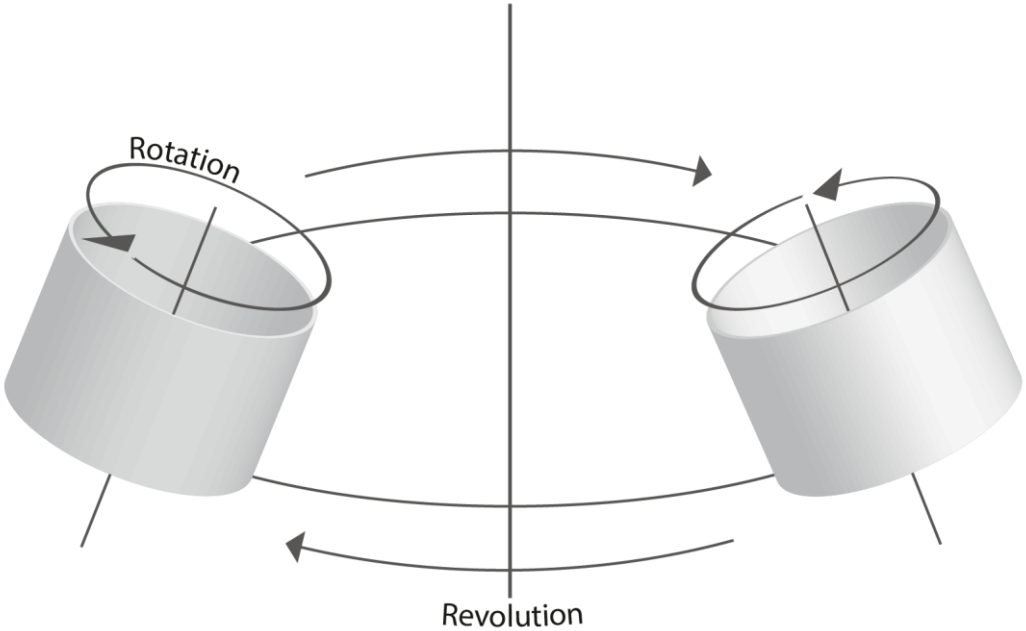
Non-contact planetary mixer



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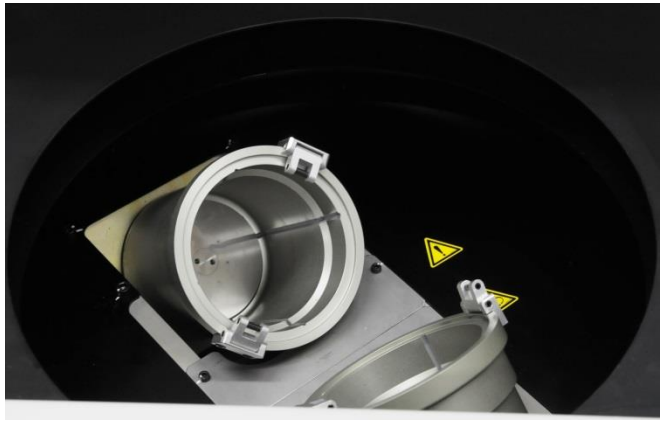
Non-contact planetary mixer



- Thinky: ARV 930 Twin
- Container size: 2*930 ml
- Vacuum optional

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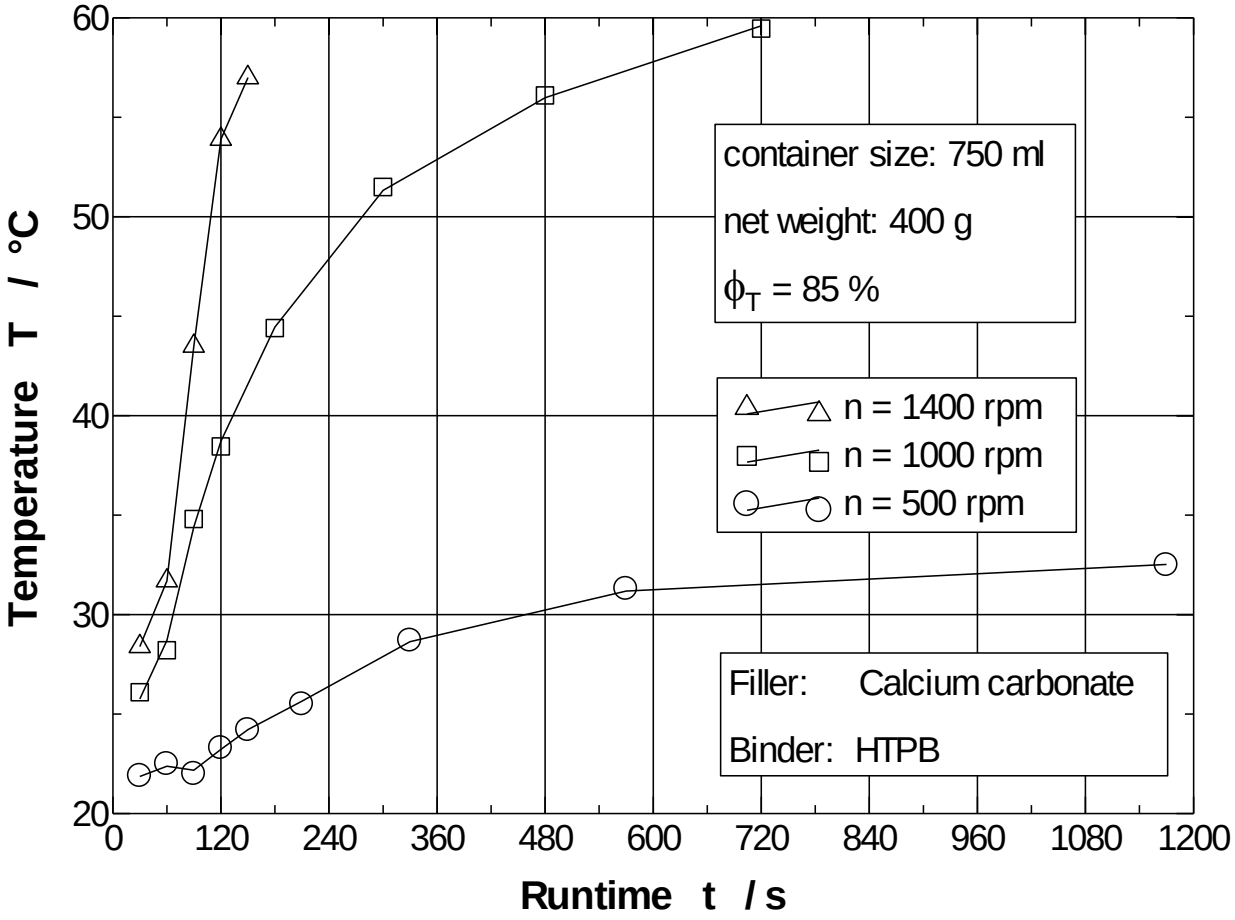
Non-contact planetary mixer



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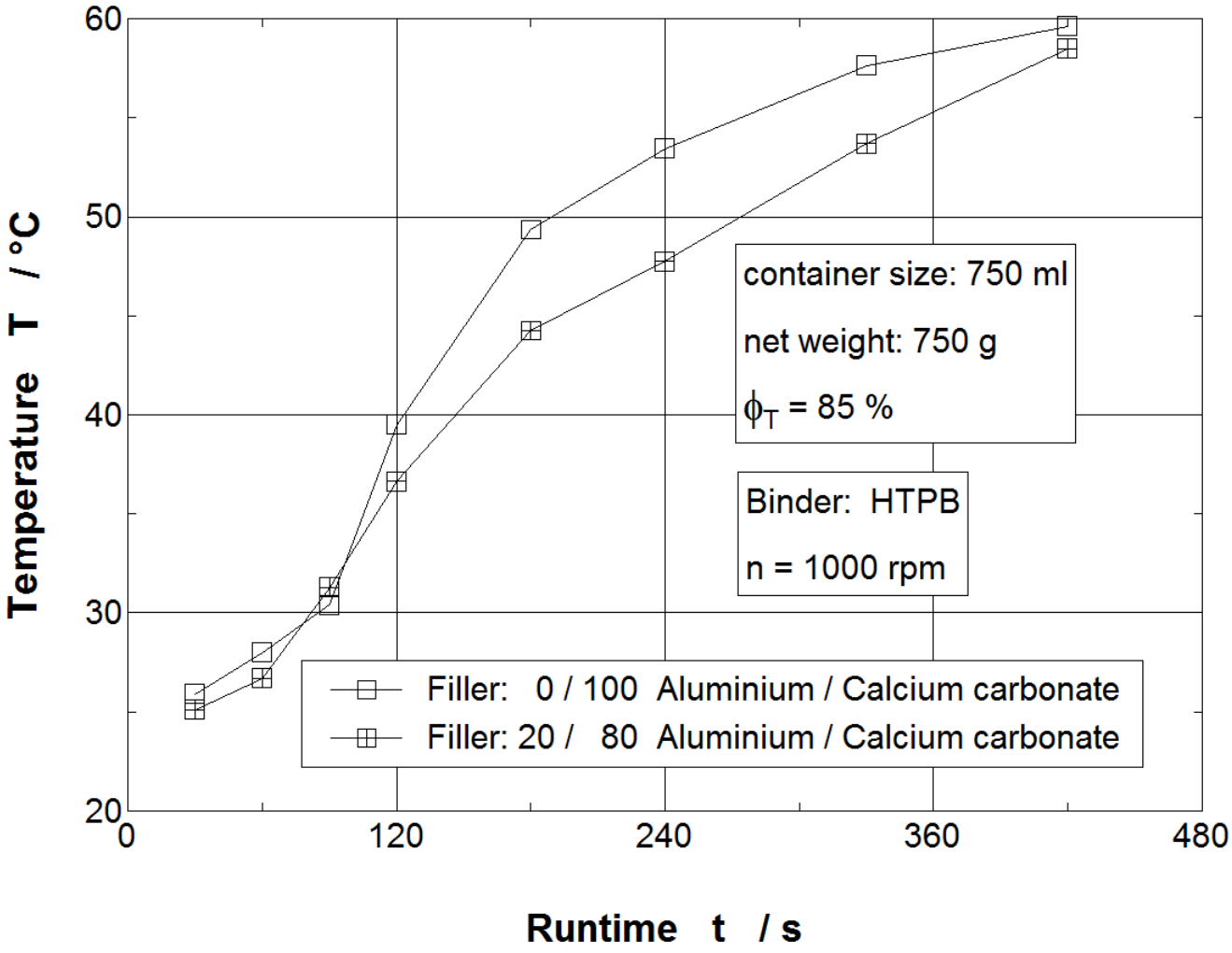
Non-contact planetary mixer



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New Mixing Technologies

Non-contact Planetary Mixer / Centrifugal Mixer /

Dual asymmetrical centrifuge

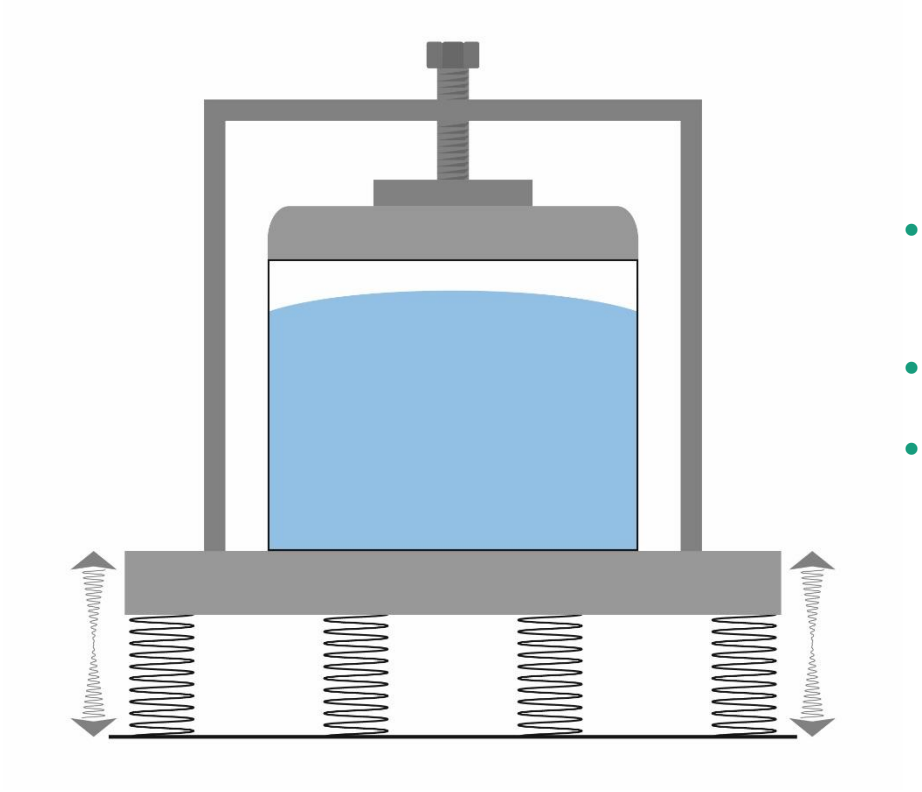
Resonant Acoustic Mixing

Speed Mixer

© Fraunhofer ICT

Resonant Acoustic Mixing

principle of operation



- Resonance frequency: approx. 60 Hz
- Acceleration 50 ... 100 g
- Mixing of liquids, solids and pastes possible

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Resonant Acoustic Mixing

LAM RAM Vakuum Mixer

Resodyne Acousitic Mixers

- Mixing capacity: up to 500 g
- Vacuum optional

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Production of plastic-bonded explosive samples

- Formulation based on: 84 wt. % Filler content
  64 wt. % Hexogen
  20 wt. % Aluminium
  16 wt. % HTPB-Binder
- Three different mixers
  - Conventional Planetary Mixer
  - ARV 930 Twin, Thinky Company
  - Lab Ram Mixer, Resodyn Company
- Determination of processing parameters
- Characterization of the properties of plastic-bound explosive samples

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Resonant Acoustic Mixing

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Lab Ram Mixer

Resonant Acoustic Mixer

Fa. Resodyn Acoustic Mixer Inc.

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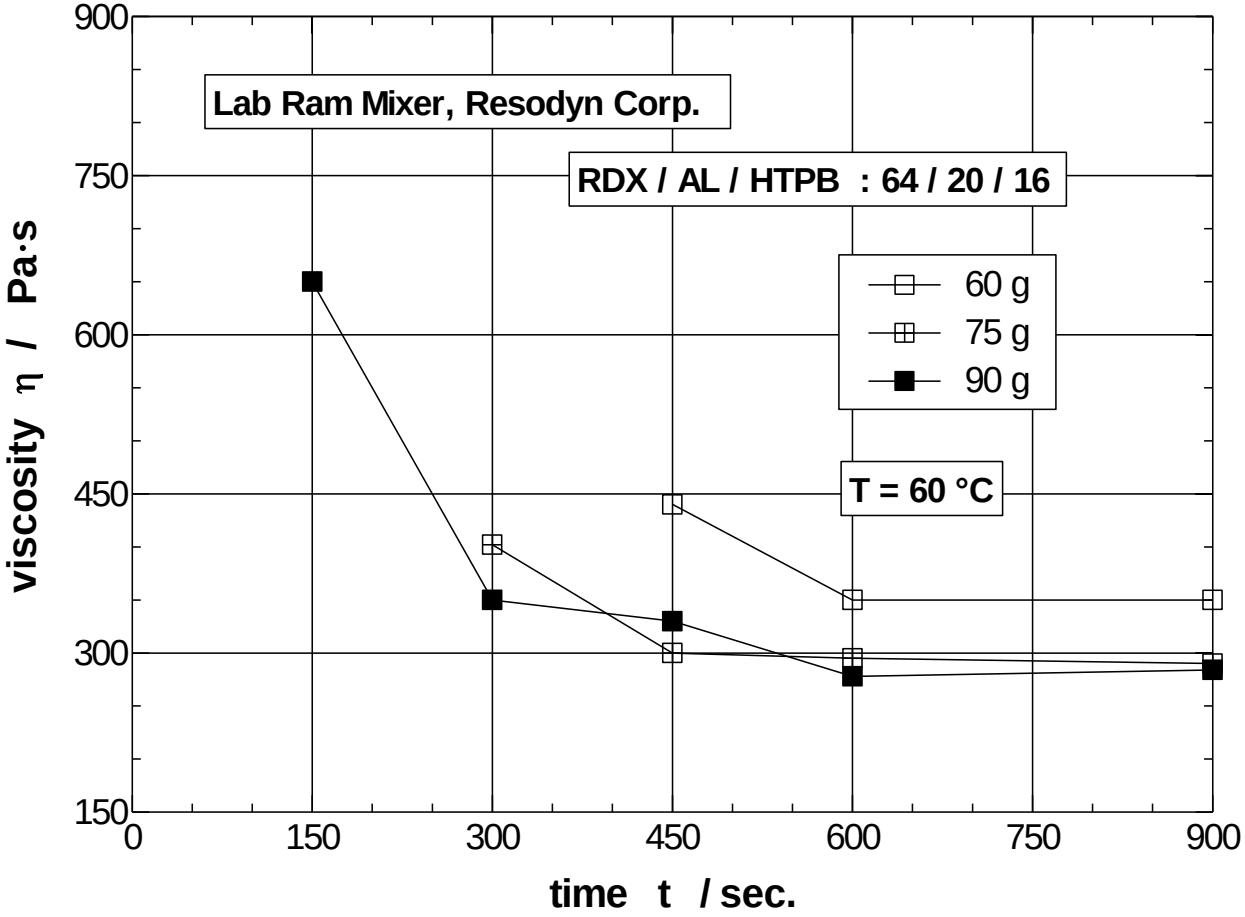
Resonant Acoustic Mixing



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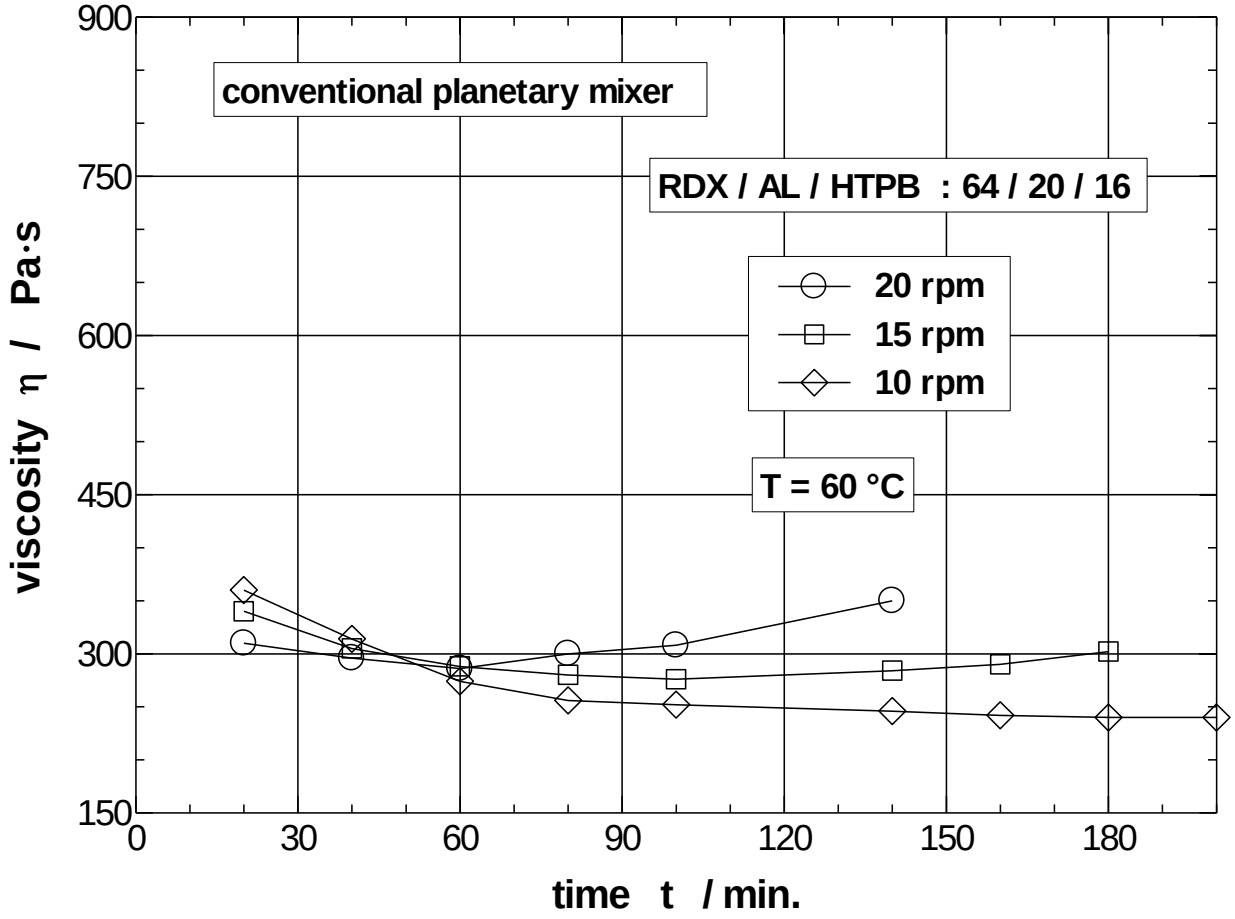
Conventional Planetary Mixer



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PBX - Characterization: Density

He-gas pycnometer at 20 °C

th. Density: 1,6803 g/cm³

Sample	$\rho / \rho_{th.}$
IKA 5 rpm	98,9 %
IKA 10 rpm	99,4 %
IKA 15 rpm	99,5 %
Lab Ram 60 g	98,3 %
Lab Ram 70 g	99,0 %
Lab Ram 80 g	99,1 %
Lab Ram 90 g	99,4 %

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PBX - Characterization: Mechanical Properties

Tensile test at 20 °C, n = 5

MINI Sample	E-Modulus MPa
IKA 5 U/min	54,2
IKA 10 U/min	49,0
IKA 15 U/min	45,1

MINI Sample	E-Modulus MPa
Lab Ram 60 g	35,9
Lab Ram 70 g	42,6
Lab Ram 75 g	42,8
Lab Ram 80 g	41,5
Lab Ram 85 g	38,8
Lab Ram 90 g	43,9

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Speedmixer

Producer: Hausschild

- DAC-400:
- 30 g up to 300 g
- vacuum
- n = 800 ... 2750 rpm.

Available mixers up to a mixer capacity of 3 kg for a weight of 1,2 tonnes

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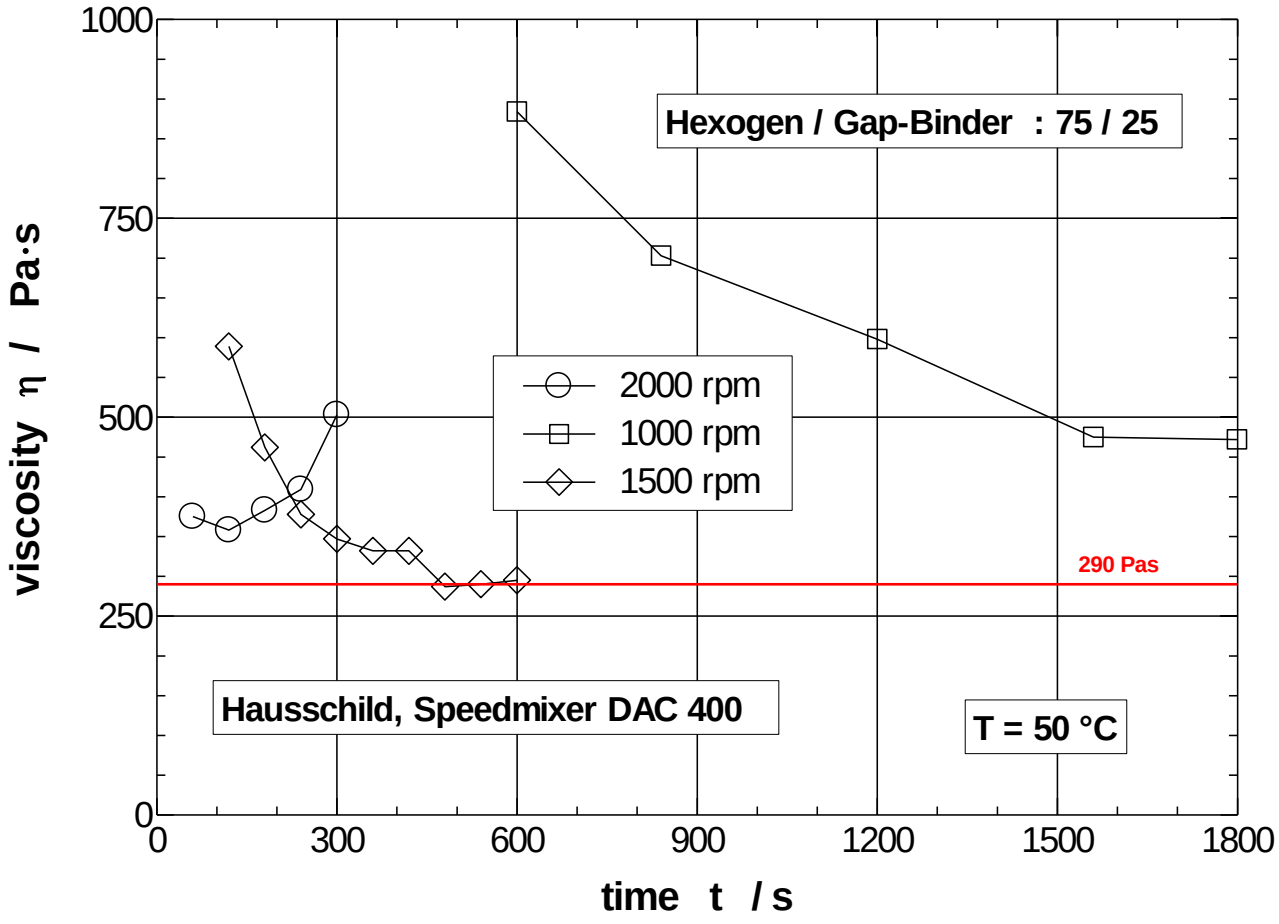
PBX – Based on Gap-Binder



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Summary

- New Mixing Technologies ⟷ conventional mixing technology
  - shortened mixing times
  - Reduced cleaning effort
  - comparable viscosity of the mixed compounds
  - Comparable densities
  - Energy input has to be limited
  - Temperature rise during mixing 20 °C up to 60 °C is controllable

Outlook

- Scale up aspects
- continuous mixing

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- Project supervision — WTD 91, Meppen, J. Heymer

WTD 91

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Thank you for your attention - Questions ?

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