Compaction,
the art of sticking together

An Introduction to
High Efficient Particle Agglomeration methods using Pressing Forces
- in a dry way with or without additional binders –

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Why (dry) Agglomeration

1. Prevent segregation of mixtures
2. Increase bulk density (savings on storage / shipping)
3. De-dusting (safety, handling, …)
4. Create a narrow particle size distribution
5. Improve handling & metering properties
6. Improve efficiency/capacity of tablet presses, sachet filling, capsule filling
7. Influence (+ or -) dissolving properties, surface reactivity
8. Allow proper gas permeability (furnace / calcining processes)
9. Improve granule (deformation) stability, reduce attrition

→ Usage of binders required?!
Alpine press-agglomeration methods

- Compactor
- Briquetting
- Gear Pelletizer
- Bextruder
Part 1
Briquetting and Dry Granulation
(briquetting + roll compaction)
General Basics 1

**With material bridges**

- Chemical reactions, sintering, melting
- Adsorption layers
- Liquid bridges
- Binder bridges
- Form fit binding

**Without material bridges**

- Molecular forces Van-der-Waals-Forces
- Electrostatic forces
- Magnetic forces
- Valence forces

10^{-10} m
10^{-4} \mu m
1. Compaction is no more that removing gasses from products. Densification can go up to e.g. 95% of the specific density. E.g. 100 → 1000 g/ltr

2. External high forces on the particles by pre-densifier screw and rollers. These lead to the required “Van der Waals” forces.

3. No liquid binders/solutions are necessary – therefore no subsequent drying required → Minimal risk of thermal damage of the products.

4. The particle size of the materials to be processed is not very important. Pre-grinding is usually not required.

5. Too high press forces (“overpressing”) can destroy already created agglomerates and add significant heat → reduced process efficiency
Forces in the Working Gap

Pressing force $\leq 600$ Mt
Specific force typically 1 to 20 N/mm$^2$
Capacity range $\sim 20$ to 120,000 kg/h
Compactor set-up

- Coupling
- Motor
- Gear-box
- Forcelfeeding unit
- Compacting head
- Hydraulic system
Briquetting plant

1. Silos, raw materials dosing
2. (Liquid addition)
3. Mixer
4. Briquetting press
5. (Safety) Screen
6. Fines recycling
7. Final product - briquettes
Roll compaction + granulation

1. Silos, raw materials dosing
2. Compactor
3. Pre-crusher
4. Crusher
5. Sieving machine
6. (Coarse recycling)
7. Fines recycling
8. Final product - Granules
# Machines

MS heavy duty series
300 to 1200mm roller diameter

<table>
<thead>
<tr>
<th>Model</th>
<th>Type</th>
<th>Drive [kW]</th>
<th>Roll Ø [mm]</th>
<th>Press Force [kN]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpine Kompaktor®</td>
<td>ARC MS 36</td>
<td>18.5</td>
<td>300</td>
<td>36</td>
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<td>Alpine Kompaktor®</td>
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<td>400</td>
<td>60</td>
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<td>132</td>
<td>520</td>
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<td>720</td>
<td>300</td>
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<tr>
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<td>Alpine Kompaktor®</td>
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<td>600</td>
</tr>
<tr>
<td>Alpine Kompaktor®</td>
<td>ARC MS 800</td>
<td>1,200</td>
<td>1200</td>
<td>800</td>
</tr>
</tbody>
</table>
Application examples

**Thermal processes**
Materials which shall be thermally treated, molten or burned:
- Magnesite / Magnesium oxide
- Metal dust, Ore or dust from metal plant
- Ceramics, Glass mixtures
- Coal, Charcoal

**Waste material management**
Materials which shall be deposited / shipped:
- Filter dust incineration plants, flue gas, ore dust
- Nuclear waste
- Sulphur

**Dosing properties, dedusting**
Materials which shall be handled easily:
- Salts
- Intermediate chemicals
- Mineral fillers into plastics (talcum)

**Dissolvability**
Materials which need controlled release /dissolving:
- Industrial washing detergents
- Fertilizers
## Product examples

<table>
<thead>
<tr>
<th>Active carbon/charcoal</th>
<th>Limestone</th>
<th>Sodium nitrate</th>
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</thead>
<tbody>
<tr>
<td>Adhesives</td>
<td>Maleic anhydride</td>
<td>Sodium Cyanide</td>
</tr>
<tr>
<td>Airbag explosives</td>
<td>Melamine</td>
<td>Stabilizers</td>
</tr>
<tr>
<td>Alumina / al. (hydr)oxide</td>
<td>MgO</td>
<td>Strontium carbonate</td>
</tr>
<tr>
<td>Metal chips</td>
<td>Pesticides</td>
<td>Sugar</td>
</tr>
<tr>
<td>Ammonium sulphate</td>
<td>Phenolic resin</td>
<td>Sweetener</td>
</tr>
<tr>
<td>Bromium / compounds</td>
<td>Phosphate ore</td>
<td>TCCA</td>
</tr>
<tr>
<td>CaO, CaCl2</td>
<td>Phytosanitary</td>
<td>Tea Dust</td>
</tr>
<tr>
<td>Catalysts</td>
<td>Pigments</td>
<td>Teflon</td>
</tr>
<tr>
<td>Detergents</td>
<td>Plant seed</td>
<td>Titanium (alumin.) dioxide</td>
</tr>
<tr>
<td>DMT</td>
<td>Plastics</td>
<td>Toner fines</td>
</tr>
<tr>
<td>Fertilizer</td>
<td>Potash</td>
<td>Tricalcium phosphate</td>
</tr>
<tr>
<td>Flame retardants</td>
<td>K-chloride/Hydroxide/iodide</td>
<td>Uranium dioxide</td>
</tr>
<tr>
<td>Flavours</td>
<td>Rat poison</td>
<td>Valerian</td>
</tr>
<tr>
<td>Formaldehyde</td>
<td>Salt NaCl, KCl</td>
<td>Vanadium pentoxide</td>
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<tr>
<td>Frozen food</td>
<td>Precip. Silica</td>
<td>Varnish sludge</td>
</tr>
<tr>
<td>Glass batch</td>
<td>Soda ash</td>
<td>Zinc ammonium chloride</td>
</tr>
<tr>
<td>Graphite</td>
<td>Sodium benzoate</td>
<td>Pharmaceutical active ingredients</td>
</tr>
<tr>
<td>Gypsum</td>
<td>Sodium perborate</td>
<td>.... And many more</td>
</tr>
<tr>
<td>Ironoxide</td>
<td>Sodium silicate</td>
<td></td>
</tr>
</tbody>
</table>
Example

dusty, toxic, corrosive, pyrophoric, radioactive, heat sensitive products
Example
potent products

Pneum. Conveying + dust from sieve

Compactor

Pre-crusher

2\textsuperscript{nd} crusher

Sieve

Pharmapaktor ® series 80 to 250mm roller diameter
Part 2
Alpine Pelletizing methods

Liquids? Binders? Viscosity?
Medium and Low Pressure Extrusion

Alpine Bextruder ABX

Alpine Gear Pelletizer AGF
Medium Pressure Extrusion

Alpine Gear Pelletizer AGF

AGF GMS 300

Technical Data

<table>
<thead>
<tr>
<th>Model</th>
<th>Type</th>
<th>Drive [kW]</th>
<th>Roll Ø [mm]</th>
<th>Width [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpine Gear Pelletizer</td>
<td>AGF GCS 200</td>
<td>4.0 – 7.5</td>
<td>200</td>
<td>40 - 100</td>
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<tr>
<td>Alpine Gear Pelletizer</td>
<td>AGF GCS 300</td>
<td>18.5</td>
<td>200</td>
<td>80 - 120</td>
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<tr>
<td>Alpine Gear Pelletizer</td>
<td>AGF GMS 200</td>
<td>11</td>
<td>200</td>
<td>80 - 120</td>
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<tr>
<td>Alpine Gear Pelletizer</td>
<td>AGF GMS 300</td>
<td>22</td>
<td>300</td>
<td>200</td>
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<td>Alpine Gear Pelletizer</td>
<td>AGF GMS 300 D</td>
<td>30</td>
<td>300</td>
<td>2 x 200</td>
</tr>
</tbody>
</table>
Extrusion principle

Press tool
Compression room
Wall
Compacted material

Densification
Discharging

Filling
Pressing
Discharging

Pressing tool

Densification

Discharging

Compacted material

Filling
Pressing
Discharging

HOSOKAWA ALPINE Compaction
A Division of HOSOKAWA ALPINE Aktiengesellschaft
Application

Viscosity is needed!

- Moisture content: < 10%
- Additives:
  ► Stearate, PVA, PEG
  ► Oil, fat, sugar, maltodextrine
  ► Lignine, starch, molasse

Examples
Stabilisators, CaO with additives, sugar, alternative energy sources, coal based materials, washing detergents, pyrite, filter cake materials, peroxide mixtures, ...
Low Pressure Extrusion

Alpine Bextruder ABX

<table>
<thead>
<tr>
<th>Model</th>
<th>Type</th>
<th>Drive [kW]</th>
<th>Throughput [kg/h]</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABX 150</td>
<td>3</td>
<td>1</td>
<td>300</td>
</tr>
<tr>
<td>ABX 300</td>
<td>8</td>
<td>200</td>
<td>800</td>
</tr>
<tr>
<td>ABX 450</td>
<td>11</td>
<td>400</td>
<td>1,600</td>
</tr>
<tr>
<td>ABX 600</td>
<td>17</td>
<td>800</td>
<td>3,200</td>
</tr>
</tbody>
</table>
Application

Viscosity is needed!

- Moisture content: 10 – 20 %
- Additives:
  - Water
  - Alcohol

Good dissolvability:
Dry soup, Instant tea, Instant coffee, Fish feed, Pesticides, Polymer additives, Dry cleaning agents, ...
Summary
Briquetting, Dry Granulation, Low pressure extrusion

Selection:
Dry process?
Binders required?
Particle size?

Alpine press-agglomeration processes:
• Low energy consumption
• Minimal product heating
• Dust free processing
• Consistent results
• Automatic operation
Many thanks for your attention