INFLUENCE OF THE PELLETIZING PROCESS PARAMETERS ON THE MECHANICAL PROPERTIES OF RECEIVED ALUMINA OXIDE PELLETS

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I. Introduction
Pelletizing is a common process to optimize the mechanical properties of various powder materials. Industrially produced alumina oxide (γ-Al₂O₃) granules are used here as primary model particles for the pelletizing process, carried out in a laboratory rotating pan-pelletizer (spherizer) at constant processing time of 20 minutes. Solution of viscoelastic polymer - hydroxypoly methylcellulose (HPMC) is used as binder. Its concentration was increased until finding of the most suitable binder content for the model pellets. The rotational velocity of the pan-pelletizer was varied in order to find the optimal speed, which provides pellets with improved properties. The influence of the process parameter on the received pellet product properties like density and porosity, size distribution, breakage characteristics and breakage probability was analysed.

II. Materials : Primary particles and binder

γ-Al₂O₃ properties

<table>
<thead>
<tr>
<th>characteristic</th>
<th>value</th>
</tr>
</thead>
<tbody>
<tr>
<td>diameter (μm)</td>
<td>1.0</td>
</tr>
<tr>
<td>crush strength (kPa)</td>
<td>45</td>
</tr>
<tr>
<td>bulk density (g/cm³)</td>
<td>740 ± 20</td>
</tr>
<tr>
<td>porosity (%)</td>
<td>75</td>
</tr>
</tbody>
</table>

Hypromellose (HPMC) Solution

<table>
<thead>
<tr>
<th>characteristic</th>
<th>value</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>5.0 - 7.5</td>
</tr>
<tr>
<td>chemical reaction</td>
<td>non Newtonian fluid</td>
</tr>
</tbody>
</table>

III. Experimental setup

1. Pelletizing

Critical velocity: \( v_c = \frac{\sqrt{\frac{E \cdot \Pi}{\rho \cdot \gamma}}}{\sqrt{d}} \), m/s

Force balance: \( \sum F = 0 \)

Solid bridges formed from consolidated binder

2. Compression Test

- The breakage test was carried out using special equipment provided by Eweite, Germany. The loading velocity \( v \) was fixed to 0.05 mm/s.
- In order to perform a reliable compression test the pellet has to take an initial stable position. During the stressing a deformed contact area will be developed between the pellet and the piston.
- The roughness of the irregularly shaped pellet is considered as a distribution of hemispherical asperities with the curve radius (diameter) of the primary particles d ≤ 30 μm that forms the surface of the pellet. Thus for the approach, one may assume characteristic, microscopically smooth, hemispherical asperities, whose curvatures are equivalent to the primary particles so that the force-displacement models of Hertz and Tomas can be applied.

![Diagram of force balance and solid bridges formed from consolidated binder](image)

![Diagram of compression test setup and force-displacement curves](image)

3. Force-displacement behaviour and breakage probability

Elastic: Hertz law \( E = \frac{1}{2} \frac{1 - \nu^2}{M} \)

Elastic-plastic: Tomas \( E = \frac{1}{2} \frac{1 - \nu^2}{M} \)

![Diagram of force-displacement behavior and breakage probability](image)

V. Conclusions

- It was clearly shown that the change in the rotational velocity of the bottom rotating disk and the amount of added binder exert an enormous influence on the mechanical properties of the received agglomerated product.
- It was proven that larger pellets can be obtained by increasing the binder amount.
- Strong and compact pellets can be produced at large rotational velocities.
- The binder content in the pellet increases its breakage resistance, but changes the breakage behaviour because of the binder’s plasticity and proves to be more problematic in case of binder addition to the batch of primary particles.

![Diagram of force-displacement behavior and breakage probability](image)

Future outlook:

- As future outlook, an investigation of the influence of the primary particle diameter on the mechanical properties of the pellets is suggested.
- The influence of different binders will be proved in future research.
- In order to understand better the process of breakage of the pellet by compression, DEM simulations should be accomplished in future.

![Diagram of stress-strain curves and binder content vs. fracture strength](image)