INDUSTRIAL BINDERS FROM BORREGAARD – PRODUCTION AND APPLICATIONS

Kristoffer Lund
Lignin-based binders from Borregaard

RAW MATERIAL: Wood

Separation technology

Lignosulfonate

Refining and modification

Binders
Lignin-based binders from Borregaard

Many different functional groups

Particle

Addition of lignin-based binders

Adsorption on particles

Drying

Binding
Lignin-based binders from Borregaard

Lignin-based binders give excellent dry strength to ceramic tiles

Increase in dry strength when using lignin-based binder

<table>
<thead>
<tr>
<th>Dosage</th>
<th>Increase in dry strength (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.7%</td>
<td>15,00%</td>
</tr>
<tr>
<td>1%</td>
<td>20,00%</td>
</tr>
</tbody>
</table>

+ 0.5% BioKeram 110L
Lignin-based binders from Borregaard

Addition of lignin-based binder in the pelletizing pan provides strength and integrity to limestone granules

Crush strength of limestone granules
Continous development of binders

Continously, there is work on-going to develop binders suitable for particular substrates.

However, much focus is also on secondary, often application-unique, properties, such as water-tolerance for IntactAqua or pelleting throughput for PellTech.
Development in collaboration with customers

When needed, development of new binders is done in close collaboration with customers.

Efficient binder properties and secondary application requirements are substrate & process dependent.

Therefore important to have knowledge of:

- Process parameters
- Surface chemistry of substrate
- End-use
- And more
Research & Development

Borregaard has around 90 employees in R&D and spends about 5% of revenues on R&D and innovation.

A significant part of R&D is devoted to development of lignin-based chemicals with laboratories and technical service centers at six different locations around the world:

- Sarpsborg, Norway
- Torrelavega, Spain
- Rothschild, Wisconsin, USA
- Mumbai, India
- Durban, South Africa
- Shandong, China
Lignin is nature’s own binding aid
Lignin-based chemicals from Borregaard

Choice of raw material and processing steps define the type of product

- Broad molecular weight
- Counter-ion (Na, Ca, Mg & NH$_4$)
- Hydrophobicity/Hydrophilicity
- With or without sugars

Tailor-made products for specific applications
Applications for lignin-based chemicals

Construction

Feed

Briquetting

Pelletizing

Fertilizers

Infrastructure

...and more.

Industrial binders for briquetting, pelletizing, granulation and compaction is one of the main application areas for lignin-based chemicals
Business model

Borregaard use wood to produce chemicals
Full utilization of raw material

**Specialty Cellulose**
- Construction materials
- Filters
- Inks and coatings
- Casings
- Food/Pharma/Personal care
- Textiles

**Lignin**
- Industrial binders
- Concrete additives
- Animal feed
- Agrochemicals
- Batteries
- Briquetting
- Soil conditioning

**Vanillin**
- Food
- Perfumes
- Pharmaceuticals

**Bioethanol**
- Pharmaceutical industry
- Biofuel
- Paint/varnish
- Car care

1000 kg Wood

**BIOENERGY**
- Residues from wood

**Wood Yard**

**Digester**

**Bleaching Plant**

**Drying Machine**

**400 kg Specialty-Cellulose**

**50 kg Bioethanol**

**3 kg Vanillin**

**420 kg Lignin**
Borregaard’s sustainable solutions

Life cycle analysis show that the biorefinery concept is sustainable

**RAW MATERIALS**

- Natural, renewable, sustainable

**PRODUCTS**

- Biochemicals replace petrochemicals
Borregaard biorefinery

Lignin 85 kg
Specialty cellulose 80 kg
Bio oil 25 kg
Bioethanol 10 liter
Biogas 8 kg
Bark 15 kg
Knots 4 kg
Vanilla flavor 1 kg

210 ton concrete
3000 spectacle frames
15 liter heavy fuel oil
30 km bus rides
50 liter soil improver
30 sq. meter cardboard
2.000 liter ice cream
5.000 chocolate bars
Properties of lignin-based binders

- Versatile
  - A range of products for different applications
  - Soluble entire pH range
  - Available as liquid and powder

- Organic
  - Low ash and no silicate

- Good heat stability

- Green

- Easy to handle and store

- Sugar-free
  - No bacterial growth
Lignin-based chemicals as binding aid
Example 1: Feed binder

Animal feed often in the form of pellets
- Increased bulk density
- Prevents de-mixing of ingredients
- Increased feed intake

Borregaard’s binding aids have a proven effect on the strength of pellets and fines generation during handling
Lignin-based chemicals as binding aid
Example 1: Feed binder

0.5 – 1% of lignin-based binder give a substantial increase in feed pellet durability. **At best,** four times the amount of clay is needed to obtain the same effect.

Effect of commercial binders on pellet durability

<table>
<thead>
<tr>
<th>Commercial Binder Type</th>
<th>Pellet Durability (units)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONTROL</td>
<td>38.8</td>
</tr>
<tr>
<td>0.5% LIGNIN-BASED BINDER</td>
<td>57.7</td>
</tr>
<tr>
<td>1% LIGNIN-BASED BINDER</td>
<td>67.4</td>
</tr>
<tr>
<td>2% COMMERCIAL CLAY 1</td>
<td>37.2</td>
</tr>
<tr>
<td>2% COMMERCIAL CLAY 2</td>
<td>41.3</td>
</tr>
<tr>
<td>2% COMMERCIAL CLAY 3</td>
<td>45.3</td>
</tr>
<tr>
<td>2% COMMERCIAL CLAY 4</td>
<td>56.7</td>
</tr>
</tbody>
</table>
A company briquetting copper concentrate before use

- Around 5% lignin-based binder is added to the concentrate
- Concentrate mixed and dried after binder addition and then briquetted
- Resultant copper briquettes exhibit excellent strength
  - Little to no damage on the briquettes as they are transported towards the furnace
  - No dust during transport or in the furnace
- Based on results from independent institute ARP, lignin-based binders show great robustness in copper briquetting

Drop test after briquetting (1.5 m, 20 briquettes)
Lignin-based chemicals as binding aid
Example 3: Limestone granules

Limestone is a soil amendment used to raise pH and supply calcium to crops

Limestone often applied as granules
  • Easier to apply
  • Reduced dust issues
  • Easy to blend

Often granulated in a pan or drum pelletizer

FEECO pan pelletizer
Lignin-based chemicals as binding aid
Example 3: Limestone granules

Addition of lignin-based binder in the pelletizing pan provides strength and integrity to limestone granules.
Lignin-based chemicals as binding aid
Example 4: Ceramics

A ceramic is an inorganic, non-metallic solid, shaped in the wet state and then dried and fired to give the desired strength and durability.

Wet → Dry → Fired

A high dry strength minimizes damage of tiles during processing before and during firing.
Lignin-based chemicals as binding aid

Example 4: Ceramics

Lignin-based binders give excellent dry strength of ceramic tiles

Increase in dry-strength when using lignin-based binders

- Dosage = 0.7%
- Dosage = 1%

Flexural strength
Conclusions

• Lignin is nature’s own binding aid
• Lignin-based binders are versatile and known to bind a wide range of substrates
• Our binders are tailor-made for specific substrates and processes

Thank you!

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