INDUSTRIAL BINDERS FROM BORREGAARD – PRODUCTION AND APPLICATIONS

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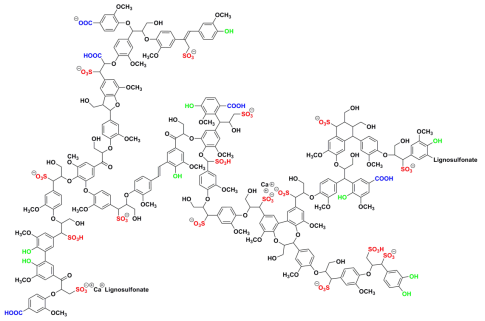
Borregaard
The Sustainable Biorefinery

Lignin-based binders from Borregaard

RAW MATERIAL:
Wood

Separation technology

Lignosulfonate

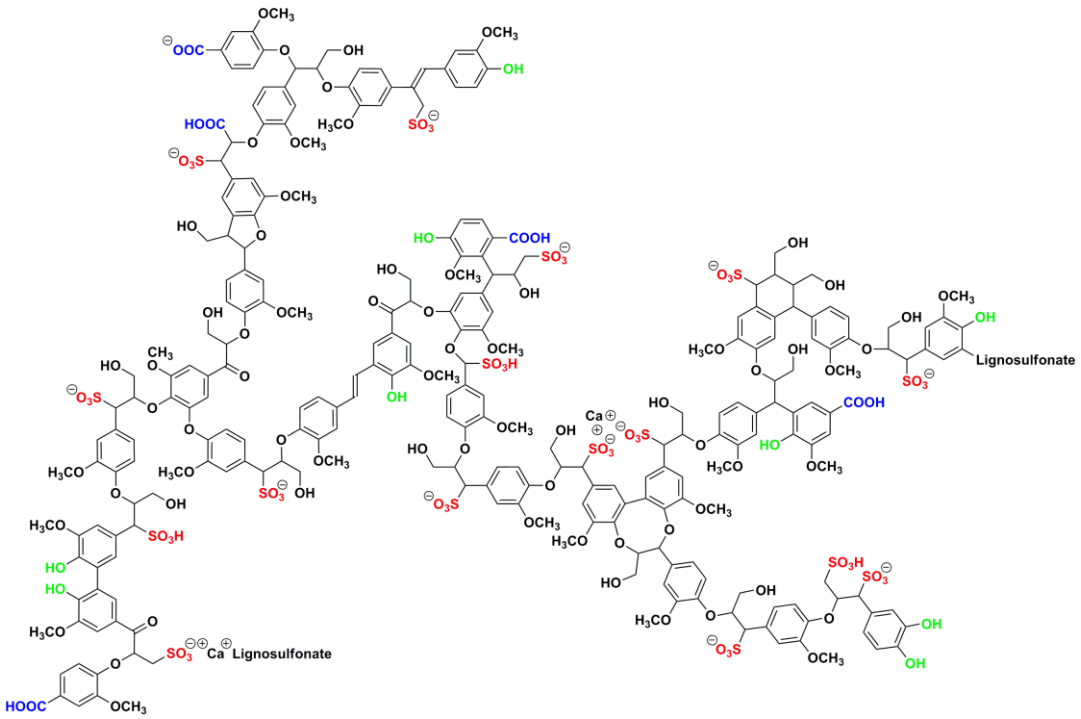


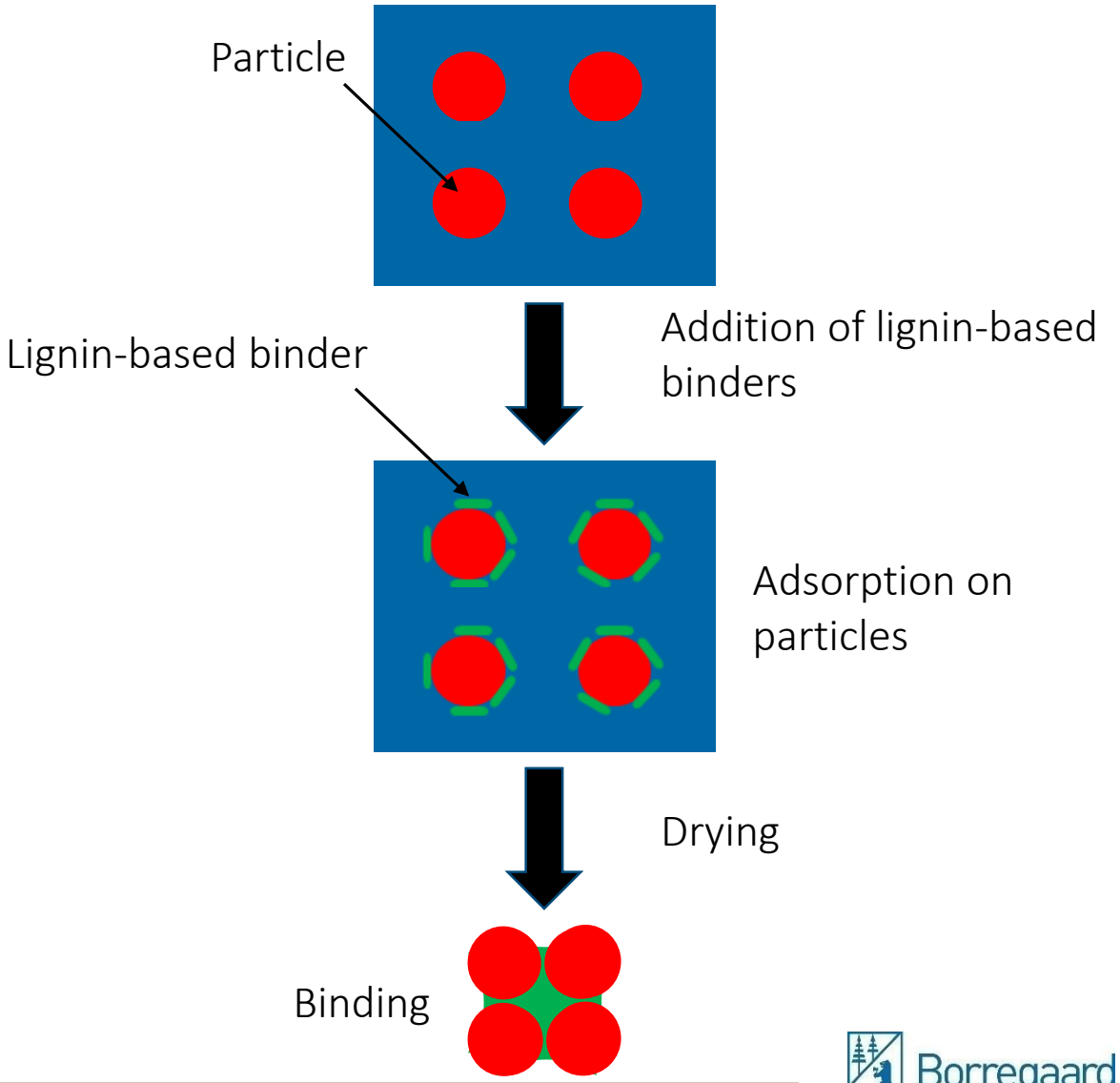
Refining and modification

Binders

Lignin-based binders from Borregaard

Many different functional groups





Borregaard

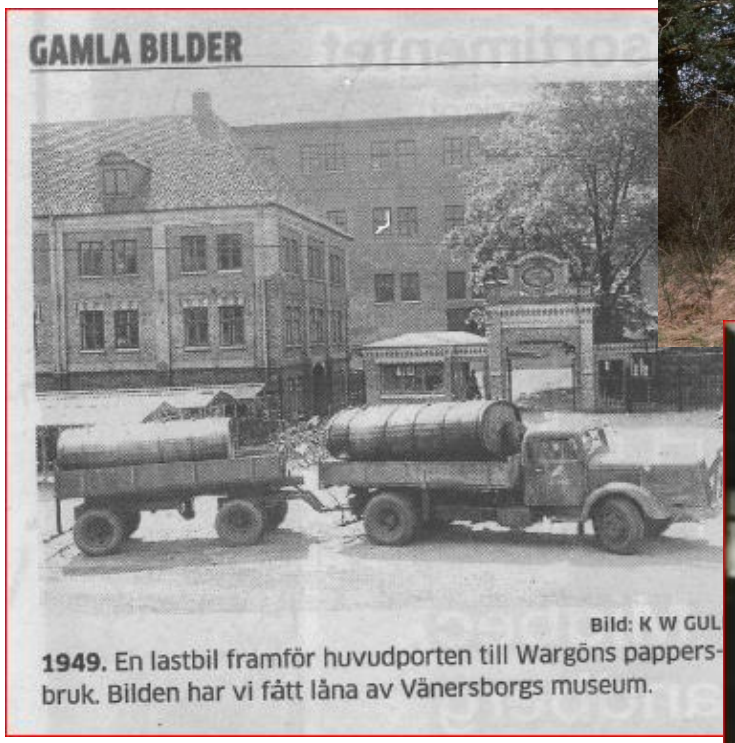
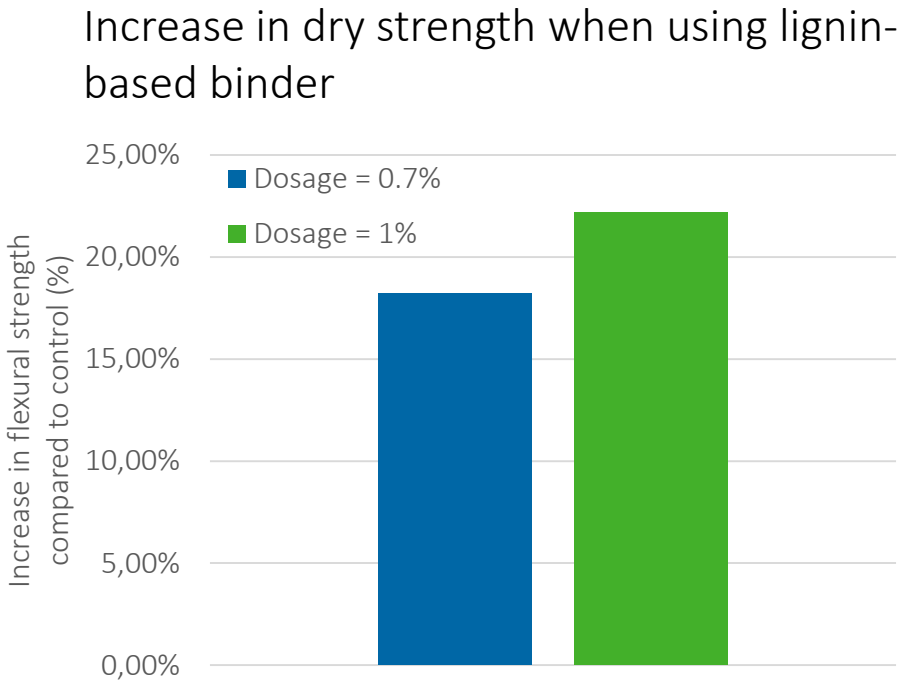

GAMLA BILDER

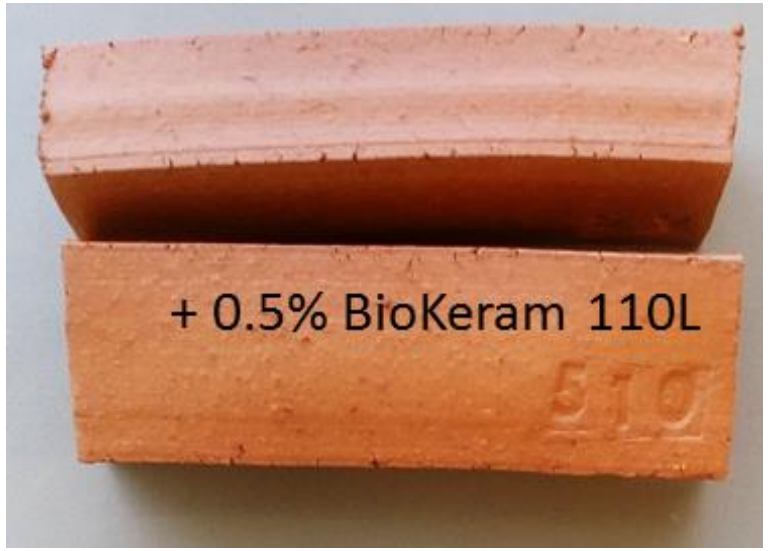
Bild: K W GUL

1949. En lastbil framför huvudporten till Wargöns pappers-bruk. Bilden har vi fått låna av Vänersborgs museum.

Lignin-based binders from Borregaard

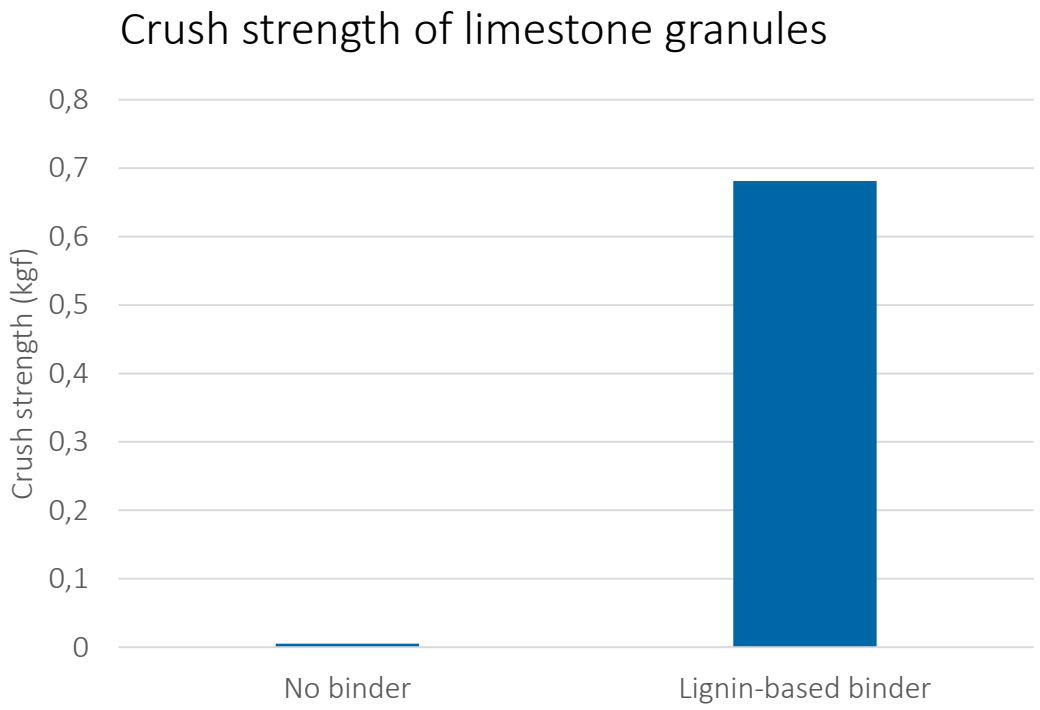
Lignin-based binders give excellent dry strength to ceramic tiles





Lignin-based binders from Borregaard

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

IntactAqua®
More Than A Binder

LignoBond DD®
Nature's Best Binder

PellTech®
More Pellets—More Quality

dustex

BioKeram
Green efficiency for ceramic applications

Borregaard

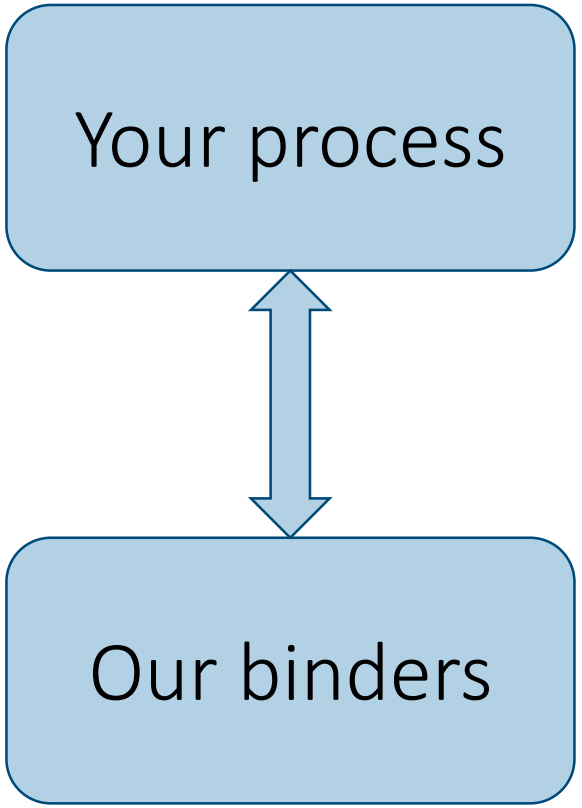
Development in collaboration with customers

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



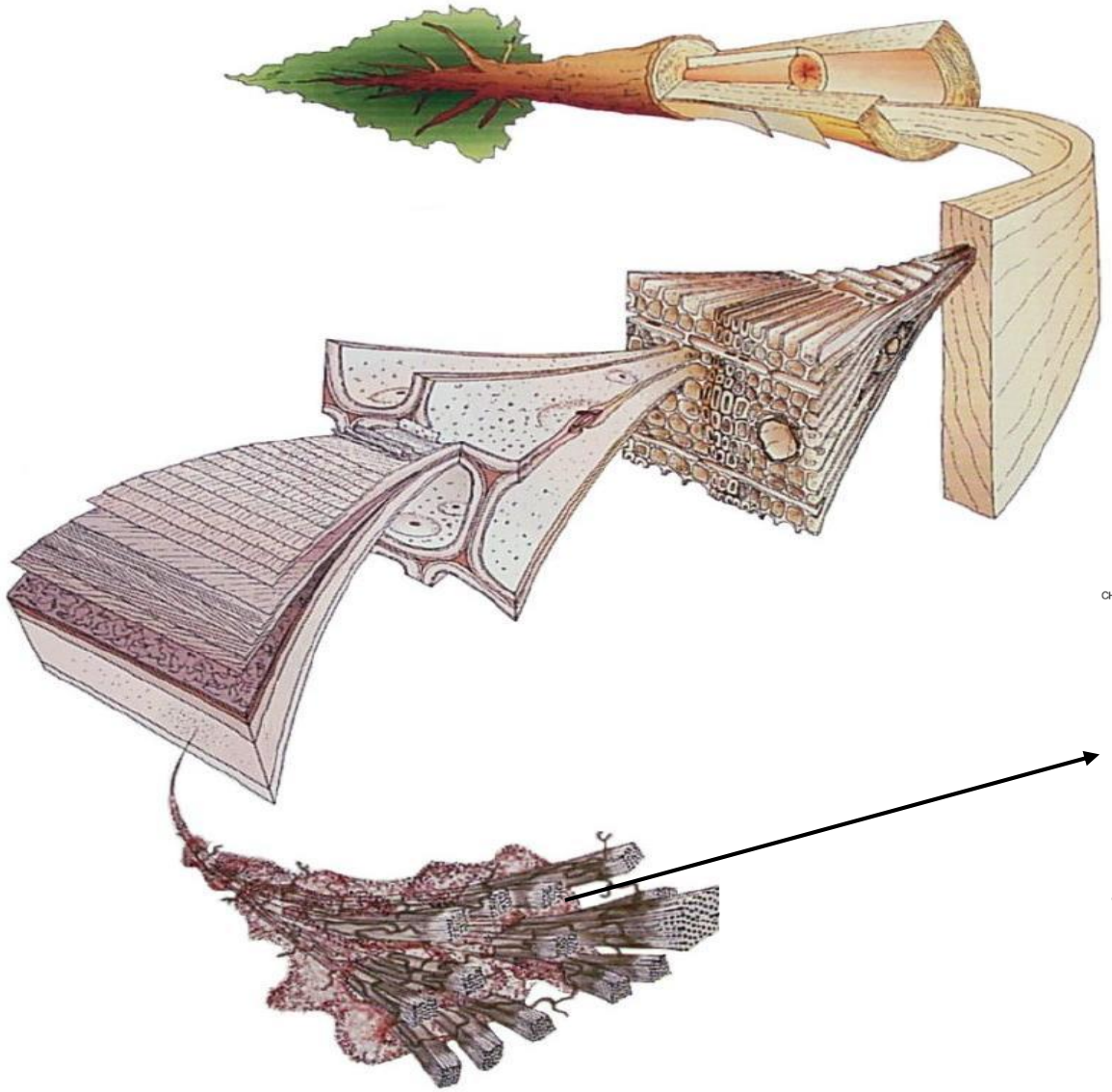
Research & Development

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

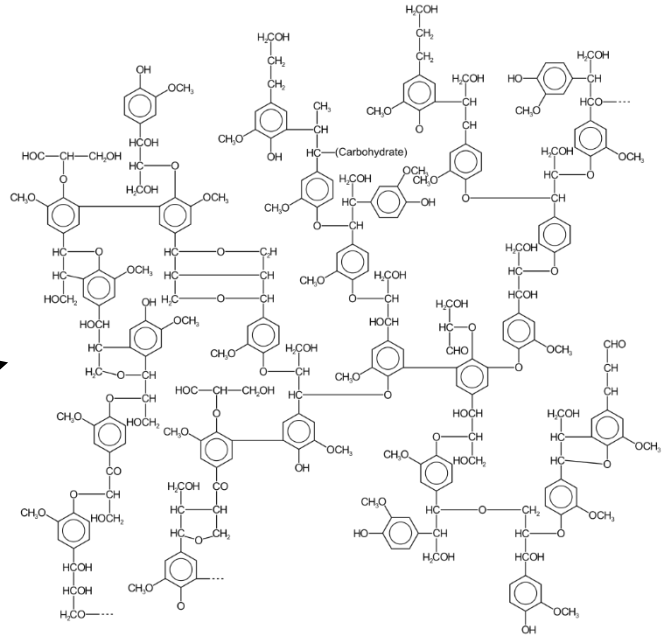
A significant part of R&D is devoted to development of lignin-based chemicals with laboratories and technical service centers at six different locations around the world:

- Sarpsborg, Norway
- Torrelavega, Spain
- Rothschild, Wisconsin, USA
- Mumbai, India
- Durban, South Africa
- Shandong, China

Lignin



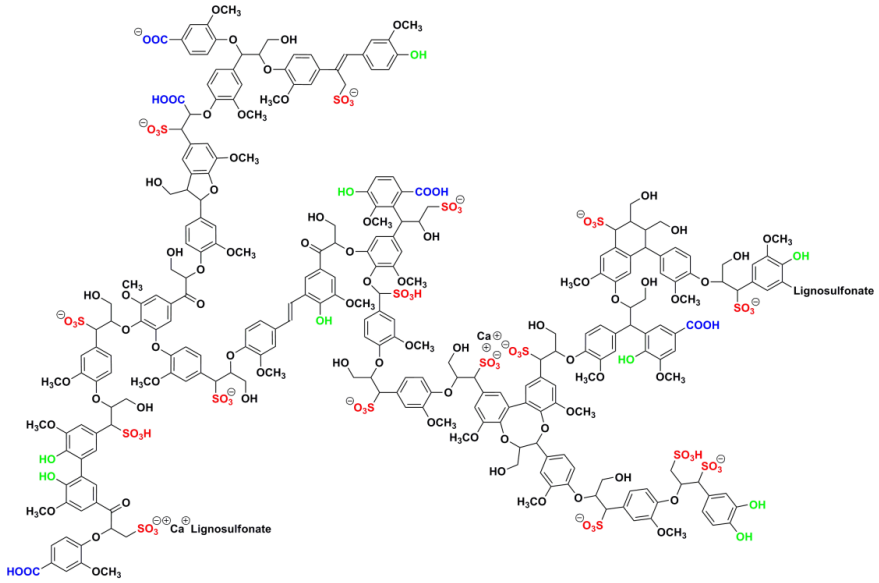
Lignin is nature’s own binding aid



Lignin-based chemicals from Borregaard

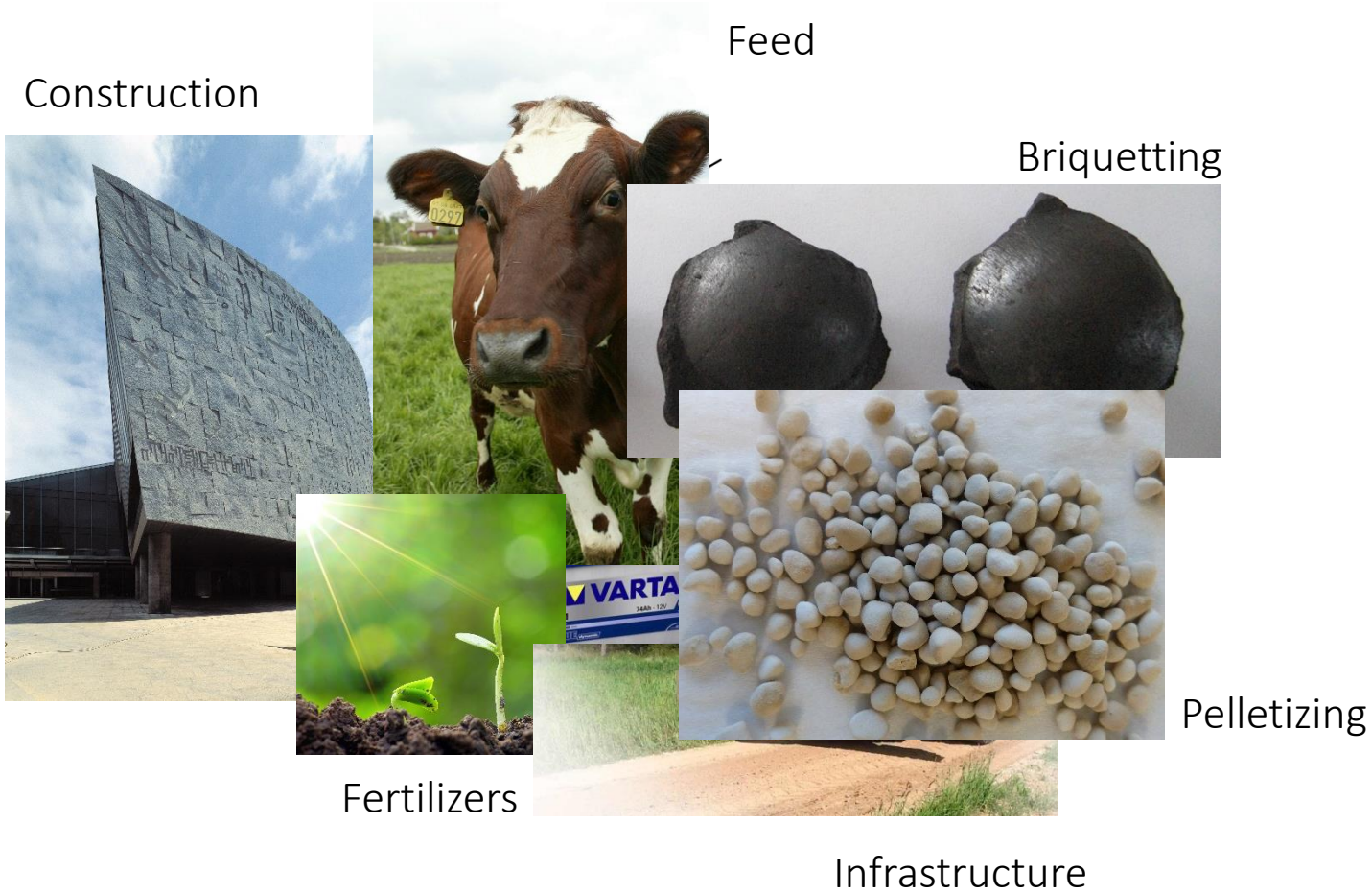
Choice of raw material and processing steps define the type of product

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



…and more.

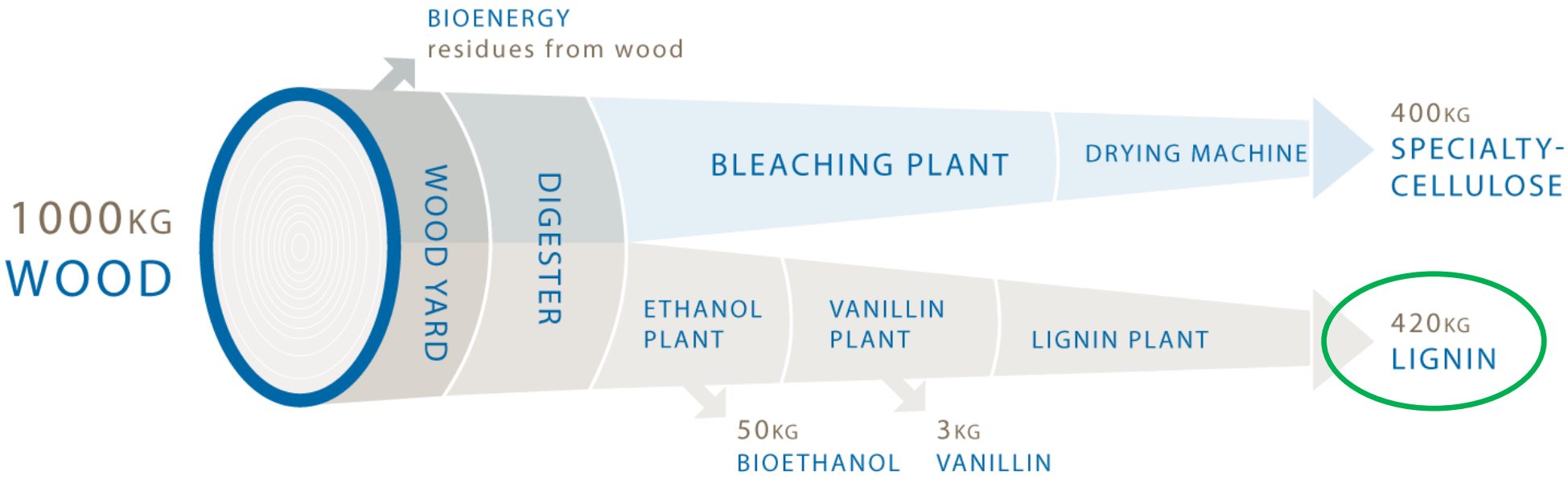
Industrial binders for briquetting, pelletizing, granulation and compaction is one of the main application areas for lignin-based chemicals

Business model

Borregaard use wood to produce chemicals

Borregaard

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

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Borregaard's sustainable solutions

Life cycle analysis show that the biorefinery concept is sustainable

RAW MATERIALS

Natural, renewable, sustainable

energ

PRODUCTS

Biochemicals replace petrochemicals

Borregaard biorefinery

400 kg firewood or…

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

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Lignin-based chemicals as binding aid
Example 1: Feed binder

Animal feed often in the form of pellets

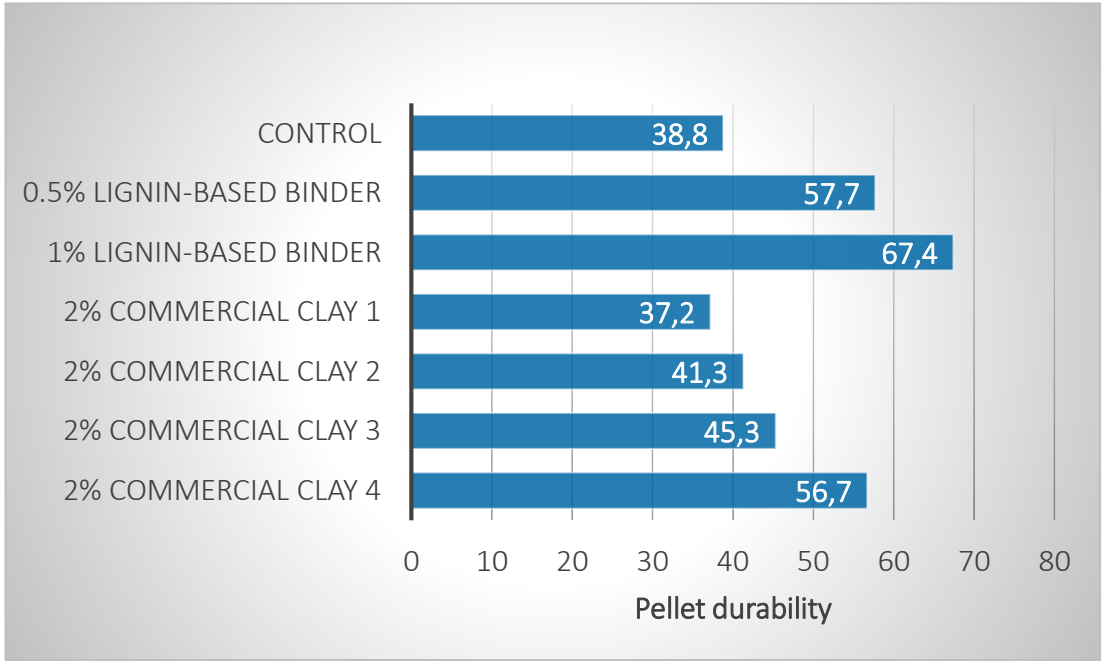
- Increased bulk density
- Prevents de-mixing of ingredients
- Increased feed intake

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



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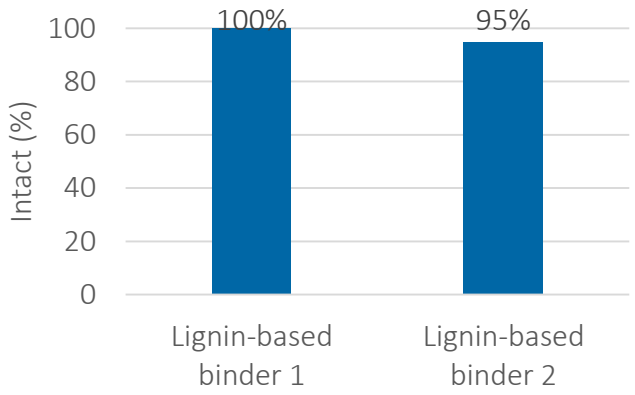
Lignin-based chemicals as binding aid
Example 2: Copper briquetting

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)



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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

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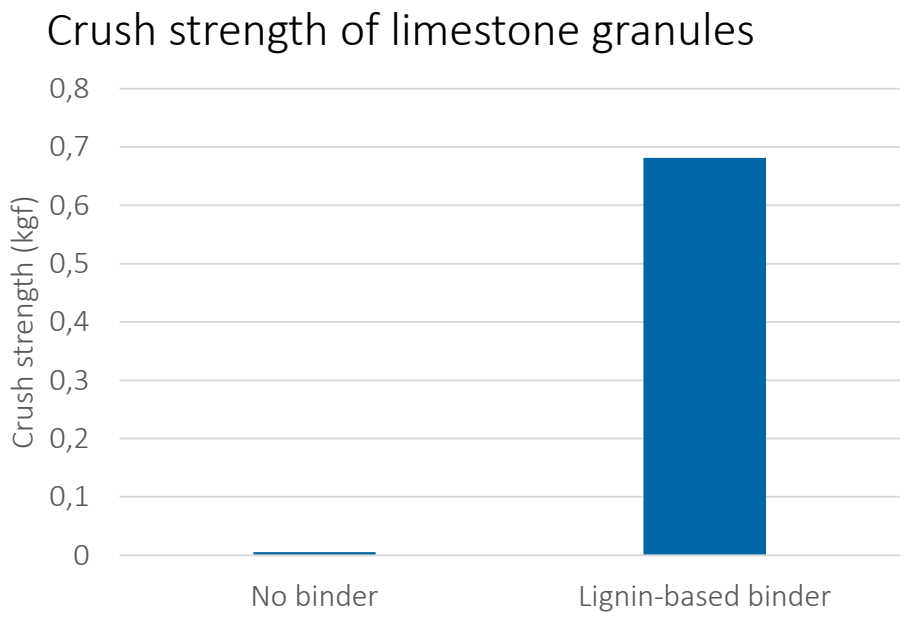
Lignin-based chemicals as binding aid

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

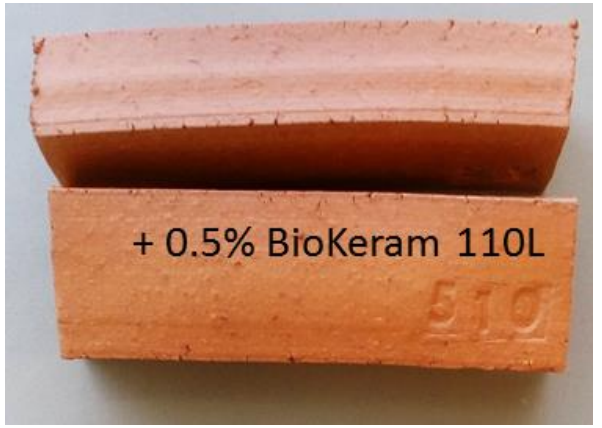
Wet ⟶ Dry ⟶ Fired

A high dry strength minimizes damage of tiles during processing before and during firing

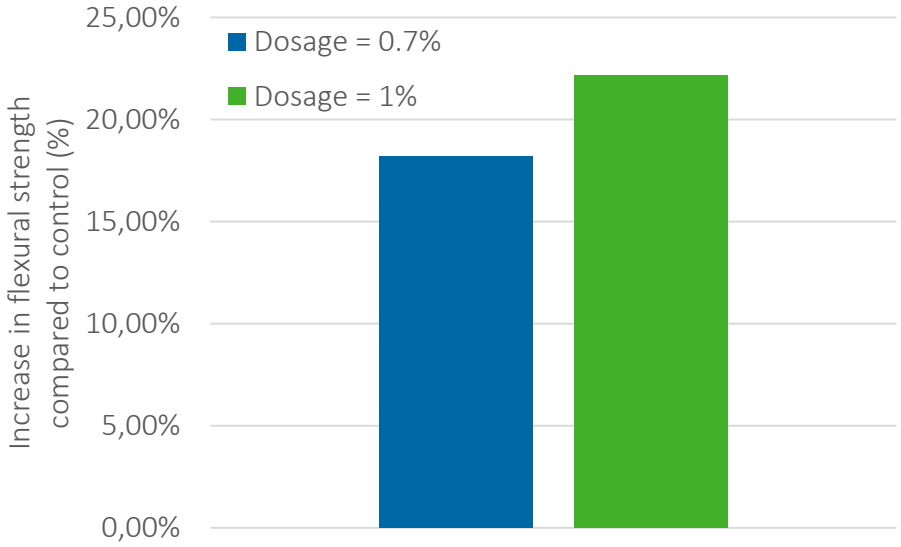
Lignin-based chemicals as binding aid

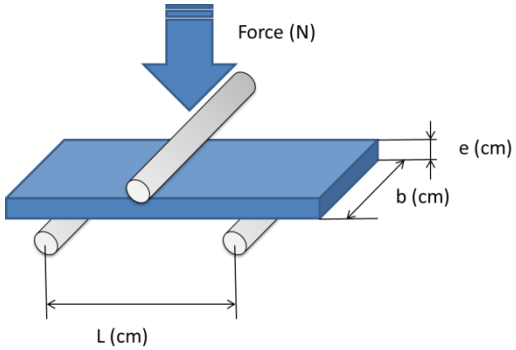
Example 4: Ceramics

Lignin-based binders give excellent dry strength of ceramic tiles



Increase in dry-strength when using lignin-based binders





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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