DUSTEX – A SUSTAINABLE, EFFECTIVE BINDER FOR FDR

Lloyd Sundstøl, Steve Dickman
Outline

• Who is Borregaard?
• What differentiates DUSTEX?
• What is DUSTEX?
• What value does DUSTEX Offer?
• How is DUSTEX used in FDR?
• Is this an opportunity?
Takeaways

• Borregaard is the world most advanced “biorefiner”.
• DUSTEX is a sustainable, Safe and Environmentally Friendly.
• DUSTEX densifies and binds road base to improve road structure.
• DUSTEX has been used in some form for a very long time.
• DUSTEX is proven as indicated by extensive use in Norway.
• DUSTEX is cost effective.
• DUSTEX is easy to use with current equipment per Crusher.
• Endorsed by Rune Kilen, Manager of Road department at Lindås municipality, Norway (Bergen Area)
An international business with global customers

- LignoTech USA; Rothschild, WI
  - Capacity 75,000 MTDS
- LignoTech Florida; Fernandina Beach, FL
  - Capacity 150,000 MTDS
- All locations
  - 700,000+ MTDS
The world’s most advanced biorefinery

Integrated production system serving diverse markets

WOOD YARD

1000 KG WOOD

WOOD

BIOENERGY
residues from wood

BLEACHING PLANT

ETCHALON PLANT

VANILLIN PLANT

LIGNIN PLANT

400 kg
SPECIALTY-CELLULOSE

120 kg
LIGNIN

SPECIALTY CELLULOSE
Construction materials
Filters
Inks and coatings
Casings
Food/Pharma/Personal care
Textiles

LIGNIN
Concrete additives
Animal feed
Agrochemicals
Batteries
Briquetting
Soil conditioner

VANILLIN
Food
Perfumes
Pharmaceuticals

BIOETHANOL
Pharmaceutical industry
Bio fuel
Paint/varnish
Car care
EHS of DUSTEX Dust Suppressant

- Is Non-Toxic according to OSHA
- No dioxins, trace minerals below EPA limits
- Not Harmful to Aquatic Species (Fish, Daphnids, Algae, Etc.)
- Not Harmful to Terrestrial Species (Rat, Earthworm, Plant, Etc.)
- Not a skin irritant
- Not classified as dangerous according to GHS
- REACH Exempt
Sustainability - Overview

Product
• Natural, Renewable
• 92% of raw materials certified
• Positive LCA

Production
• Direct CO2 Contribution reduced by 40% - last 10 Years
• 17% Energy Reduction – 2017 to 2018
• SO2 Emissions reduced by 90% - last 8 years

People
• Diverse work force
• Sustainable wages

https://www.borregaard.com/Sustainability/Sustainability-Report
Sustainability of DUSTEX

- Biobased
- Based on the earth’s second most abundant biopolymer*
- It is derived from the process of photosynthesis, where CO$_2$ and sunlight are converted into organic material
- 1.5 kg CO$_2$ are withdrawn from the atmosphere when 1 kg of lignin is produced in the photosynthesis
- Not derived from food sources.

*Cellulose being number 1
LCA – DUSTEX for road stabilization

- The graphic shows the results for comparison of lignin from Borregaard with bitumen and cement for road stabilization, incl. dosage.
  - Relative environmental performance since the different indicators have different units.
DUSTEX – Other Certifications

- Biopreferred – Volunteer Labelling in Process

- MNDOT Special Provision for FDR
Lignosulfonate – multifunctional molecule

Functional groups
Phenolic OH
Aliphatic OH
Sulfonate
Methoxyl
Carboxyl

Hydrophobic
Hydrophilic
Charged (pH-dependent)
Charged
How does DUSTEX Work?

1. Spray & get mix in DUSTEX
2. Disperse, Compact & allow to dry
How does DUSTEX Work?

The chemical and physical Binding action is as a result of strong intermolecular and adhesive forces of the molecule.
DUSTEX – Something New?

Not Completely...
To all whom it may concern:

Be it known that I, CARLETON ELLIS, a citizen of the United States, and resident of Montclair, in the county of Essex and State of New Jersey, have invented certain new and useful Improvements in Concentration of Waste Sulfite Liquor, of which the following is a specification.

This invention relates to the treatment of waste sulfite liquors from paper mills more particularly with reference to the production of a concentrated liquor suitable as a binding material in the treatment of road surfaces.

The sulfite liquor is treated with sulfurous acid and again used 55 in the manufacture of sulfite powder.

In order to remove to a large extent the sugary matters from the liquor, I subject it to fermentation. This is conveniently done in the neutralized liquor which may be concentrated more or less if desired prior to the fermentation treatment. In order to conduct the fermentation properly, the neutralized liquors should be cooled and aerated. Yeast or malt extract or other fermenting material is then added and the liquor allowed to stand under suitable fermenting conditions for several days until
To all whom it may concern:

Be it known that I, Henry Hicks Hurt, a citizen of the United States, residing at Yonkers, in the county of Westchester and State of New York, have invented certain new and useful improvements in Processes of Making Roads, of which the following is a specification.

This invention relates to processes of making roads; and it comprises a method of making a road bed wherein old asphaltic paving material is ground to a fine or sand-like character, admixed with clay and with waste sulfite liquor and applied as a paving material on a road, in some cases this application being followed by that of a layer of asphalt surfacing material; all as more fully hereinafter set forth and as claimed.

The amount of sulfite waste liquor solids necessary as an auxiliary binder may be reduced by using a certain proportion of clay therewith; clay and sulfite waste liquor preparations developing a binding power which is more than the sum of their separate binding powers.

With this sandlike material I usually mix about 15 per cent (by volume) of powdered dry clay and then add concentrated waste sulfite liquor in the amount of about one part by volume to, say, twenty five parts by volume. While the mixture of disintegrated old pavement and clay may be laid and leveled up in the pavement and then the concentrated waste sulfite liquor sprinkled on the road in about the proportions stated, I find it generally better to make the mix-
Overview:

- Norwegian Road Authority stabilized 5 roads with DUSTEX between 2002 and 2006.
- The roads were re-examined in the summer of 2017 by the Norwegian Road Authorities.
- Road materials were sub-par
### Summarized Data From Study

<table>
<thead>
<tr>
<th>Road</th>
<th>Year</th>
<th>Traffic</th>
<th>Length</th>
<th>Asphalt Layer thickness</th>
<th>DUSTEX application method</th>
<th>Projected lifespan versus N200 Standard</th>
</tr>
</thead>
</table>
| Fv324-01 | 2002 | AADT: 250, with 6% heavy vehicles | 1800 m | 5 cm                    | Milling machine with spray nozzles      | 19 years  
  Standard: 16 ± 2 years                  |
| Fv181-01 | 2002 | AADT: 100, with 10% heavy vehicles | 772 m  
(1900 m)^3 | 6 cm                    | Milling machine with spray nozzles      | 21 years  
  Standard: 16 ± 2 years                  |
| Fv302-01 | 2005 | AADT: 430, with 10% heavy vehicles | 7880 m | 6 cm                    | Milling machine with spray nozzles      | 21 years  
  Standard: 13 ± 2 years                  |
| Fv160-01 | 2005 | AADT: 250, with 6% heavy vehicles | 900 m  | 6 cm                    | Milling machine with spray nozzles      | 9 years   
  Standard: 16 ± 2 years                  |
| Fv285-02 | 2005 | AADT: Approx. 200        | 4890 m | 7 cm                    | Grader and sprayer                     | 14 years  
  Standard: 13 ± 2 years                  |

Table 1: Road data & expected surface lifespan

Increase in road life estimated at 20-30%  
...likely more
## DUSTEX – Cost Savings Estimates

### Scenerio 1
No additive + 4 inches of Asphalt

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milling</td>
<td>$1.50</td>
<td>SY</td>
</tr>
<tr>
<td>Asphalt/inch</td>
<td>$3.50</td>
<td>SY</td>
</tr>
<tr>
<td># of inches</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>$15.50</td>
<td>SY</td>
</tr>
</tbody>
</table>

### Scenerio 2
DUSTEX + 4 Inches of Asphalt

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milling</td>
<td>$1.50</td>
<td>SY</td>
</tr>
<tr>
<td>Mixing</td>
<td>$1.00</td>
<td>SY</td>
</tr>
<tr>
<td>Dustex (6&quot;)</td>
<td>$2.00</td>
<td>SY</td>
</tr>
<tr>
<td>Asphalt/inch</td>
<td>$3.50</td>
<td>SY</td>
</tr>
<tr>
<td># of inches</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>$18.50</td>
<td>SY</td>
</tr>
<tr>
<td>Life Increase (%)</td>
<td>25</td>
<td>SY</td>
</tr>
<tr>
<td><strong>Dustex Savings</strong></td>
<td>$0.87</td>
<td>SY</td>
</tr>
</tbody>
</table>
**DUSTEX – Cost Savings Estimates**

### Scenerio 1
No additive + 4 inches of Asphalt

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost (SY)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milling</td>
<td>$1.50</td>
</tr>
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<td>Asphalt/inch</td>
<td>$3.50</td>
</tr>
<tr>
<td># of inches</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$15.50</strong></td>
</tr>
</tbody>
</table>

### Scenerio 3
DUSTEX + 3 inches of Asphalt

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost (SY)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milling</td>
<td>$1.50</td>
</tr>
<tr>
<td>Mixing</td>
<td>$1.00</td>
</tr>
<tr>
<td>Dustex (6&quot;)</td>
<td>$2.00</td>
</tr>
<tr>
<td>Asphalt/inch</td>
<td>$3.50</td>
</tr>
<tr>
<td># of inches</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$15.00</strong></td>
</tr>
<tr>
<td>No Treatment</td>
<td>$15.50</td>
</tr>
<tr>
<td><strong>Dustex Savings</strong></td>
<td><strong>$0.50</strong></td>
</tr>
</tbody>
</table>
### Scenerio 3
**DUSTEX + 3 inches of Asphalt**

<table>
<thead>
<tr>
<th>Task</th>
<th>Cost ($)</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milling</td>
<td>1.50</td>
<td>SY</td>
</tr>
<tr>
<td>Mixing</td>
<td>1.00</td>
<td>SY</td>
</tr>
<tr>
<td>Dustex (6&quot;)</td>
<td>2.00</td>
<td>SY</td>
</tr>
<tr>
<td>Asphalt/inch</td>
<td>3.50</td>
<td>SY</td>
</tr>
<tr>
<td># of inches</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>15.00</td>
<td>SY</td>
</tr>
<tr>
<td><strong>No Treatment</strong></td>
<td>15.50</td>
<td>SY</td>
</tr>
<tr>
<td><strong>Dustex Savings</strong></td>
<td>0.50</td>
<td>SY</td>
</tr>
</tbody>
</table>

### Scenerio 4
**Cement/Oil + 3 inches of Asphalt**

<table>
<thead>
<tr>
<th>Task</th>
<th>Cost ($)</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milling</td>
<td>1.50</td>
<td>SY</td>
</tr>
<tr>
<td>Mixing</td>
<td>1.00</td>
<td>SY</td>
</tr>
<tr>
<td>Cement/Oil (6&quot;)</td>
<td>5.00</td>
<td>SY</td>
</tr>
<tr>
<td>Asphalt/inch</td>
<td>3.50</td>
<td>SY</td>
</tr>
<tr>
<td># of inches</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>18.00</td>
<td>SY</td>
</tr>
<tr>
<td><strong>Dustex Treated</strong></td>
<td>15.00</td>
<td>SY</td>
</tr>
<tr>
<td><strong>Dustex Savings</strong></td>
<td>3.00</td>
<td>SY</td>
</tr>
</tbody>
</table>
Roads with low stability which contain larger stones and solid mountain in the top 250 mm of the road construction.
Tractor with the crushermiller mountad.
Crushermiller in action.
The crushermiller handles the materiae 250 mm into the road.
Soil problems in the road.
Asphaltmiller in action.
The asphaltmiller and the cushermiller work together and the traffic can still pass.
Mixing DUSTEX into the road.
This example shows the effect of the DUSTEX.
The new material needs to be compacted and documented.
The materiale needs to be graded.
Edge stabilization in action.
Road witch is stabilized, and ready for asphalt.
After 2-6 weeks the road is ready for asphalt.
Ved spørsmål ta kontakt med

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Lars
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Rune Kilen – Biography (highlights)

• 60 years old
• **Manager for the Road department at Lindås municipality, Norway (Bergen Area)**
• **Base education as Engineer on subjects in Geology and Geophysics**
• Started career at Norwegian Road department in Bergen as a laboratory engineer and manager for the quality control
• **Worked 15 years at Bergen municipality as Asphalt engineer / Project manager; pavement management systems, planning and management for the asphalt program**
• Project manager / Avalanche protection at the Norwegian railway
• NCC Roads as Quality / HSE engineer, laboratory at NCC Roads as - a asphalt / aggregate company
• Contact - [rune.kilen@gmail.com](mailto:rune.kilen@gmail.com) (private email); +47 47 48 03 11
SUMMARY

- Borregaard is the world most advanced “biorefiner”.
- DUSTEX is a sustainable, Safe and Environmentally Friendly.
- DUSTEX densifies and binds road base to improve road structure.
- DUSTEX has been used in some form for a very long time.
- DUSTEX is proven as indicated by extensive use in Norway.
- DUSTEX is cost effective.
- DUSTEX is easy to use with current equipment per Crusher.
- Endorsed by Rune Kilen, Manager of Road department at Lindås municipality, Norway (Bergen Area)
Thank you!

DUSTEX stabilized road in Lindås, Norway