Developments for boosting the implementation of microfibrillated cellulose in papermaking

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SPCI Convention
September 26, 2013
Nomenclature

- Microfibrillated cellulose (MFC)
  - Original name since the 1980’s

- Nanocellulose = Collective name for all types of nanocellulose. Used for this material the last 6 years.
  - Other nanocelluloses are NanoCrystalline Cellulose (NCC) and Bacterial NanoCellulose (BNC)

- Nanofibrillated cellulose (NFC) = new name started to be used 4-5 years ago
Elementary fibril aggregates in wood-fibres

Organisation of cellulose in fibres

Adapted from: Rowland and Roberts 1972
Why is it interesting?

Cellulose crystallite

E\approx 140 \text{ GPa}

MFC in the 1980’s

Energy consumption = 30000 kWh/tonne

Our solution – pre-treatments

Energy consumption = 1000-2000 kWh/tonne
Energy reduction = 93-97 %
Example of an MFC gel from Innventia

MFC gen. 1
2 w-%
Cryo-TEM Image of Innventia’s MFC

The Innventia lab-scale nanofacility
Innventia’s pilot plant for MFC production (100 kg/day)
Innventia’s pilot scale nanofacility
Standard process layout

Pulp → Enzyme → MFC
Innventia’s stock-prep system for FEX
Stress-strain curves for films of different MFCs

<table>
<thead>
<tr>
<th>Pulp</th>
<th>Stress at brake [MPa]</th>
<th>Young’s Modulus [GPa]</th>
<th>Strain at break [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nanopaper</td>
<td>~200</td>
<td>10-20</td>
<td>6-12</td>
</tr>
<tr>
<td>Unbl. kraft</td>
<td>64</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Bl. kraft SW</td>
<td>54</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Bl. kraft HW</td>
<td>34</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Newsprint</td>
<td>16</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Ground wood</td>
<td>6</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

”Nanopaper”: Strongest cellulose-based material made by man


MFC has interesting for paper applications

- As a dry strength agent enabling e.g.
  - Increased filler content in publication papers
  - Weight-reduction in board
- As an oxygen barrier material for packaging
- As an additive in coatings
- As a surface strength agent to reduce linting and dusting
MFC used as dry strength agent – old news

MFC wet-end *addition* to CTMP

Pilot trial outline

Goal
- Use MFC as additive in the FEX-system in order to identify possible weaknesses/needs

Set-up
- Fine paper pulp composition 80/20 (short/long)
- STFI-former (roll-blade)
- Valmet 7-row headbox
- Speed 600 m/min and slice opening 14 mm
- Press loads 60/500/700 kN/m
- Innventia’s pilot MFC generation 1
- PCC as filler @ 20%-35%
- Retention system from Eka
FEX pilot paper machine

Fourdrinier former

Shoe presses

Roll-blade former

Conventional press
Conclusions

- No major processing issues!

- Positive effects can be seen

- In order to perform trials and compare effects to what can be achieved by chemical additives:
  - Dosage strategy should be developed
  - Effects of process units (screens, pumps, pipes etc.) need to be considered since the physics will be different compared to polymer additives
  - Innventia is equipped to study these effects
Our goal

- To assist industrial partners to produce and use MFC in industrial scale
- To further improve the MFC product and its processes
- With the aid of the FEX-pilot paper machine, optimise the use of MFC in paper applications
- Targeted applications:
  - Strength additive for paper and board
  - Barrier material for replacement of aluminium foils
  - Bio-nanocomposites
  - Nanopapers
- Also:
  - High-tech materials
  - Aerogels
  - Food applications
  - Misc.
The next step…
The next step…

- Development of a demonstration scale movable MFC factory to enable full scale trials at e.g. paper mills
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