FiberLean™

natural strength

Efficient raw material resource utilization for paper through use of micro fibrillated cellulose (MFC)

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Per Svending
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Microfibrillated cellulose (MFC)

- First made in the 80’s
  - Very high energy demand (25-30 MWh/ton)
  - Using expensive and sophisticated grinding equipment
  - Expensive and very high capex/capacity ratio

- Conventional state of the art
  - Pulp pre-treatment for to soften up the fibers
  - Significantly reduced energy demand
  - Still using expensive and sophisticated grinding equipment
  - Still very high capex/capacity ratio
  - Low solids product in gel form, often with high surface charge
  - Scale limitations are preventing large volume applications

In practice ”conventional” MFC is still restricted to high value applications.
The FiberLean™ microfibrillated cellulose process

- Co-grinding of pulp to MFC in the presence of minerals.
  - The mineral acts as a very fine grinding media
- Robust and reliable equipment of relevant industrial scale.
- On-site manufacturing, using a minor side stream of mill pulp.
- No pre-treatment of fiber required.
- The FiberLean product is a MFC/mineral composite.
- FiberLean is used to increase filler loading in paper without sacrificing paper quality or paper machine efficiency.
An industrial scale, MFC process for on-site installation

Example of on-site installation with 2,000 dry ton per year capacity.
FiberLean™ is made out of filler and fiber
Picture of paper surface with FiberLean™ MFC
Note the similarity between the original FiberLean™ composite and the product as retained in the paper.

The association between the filler and the MFC remains through the paper making process.
Filler increase with GCC without strength additives
impact on paper properties when going from 20% to 30% filler

- ~26% tensile loss
- ~38% Scott Bond loss
- ~1,4 units opacity gain
- ~3% bulk loss

Lab study Mesmer recirculating hand sheets (12 sheets)
70% Eucalyptus, 30% NBSK, 550 CSF Intracarb 60 filler
The impact of increasing filler loading

<table>
<thead>
<tr>
<th>Impact on:</th>
<th>+10% filler</th>
<th>Comments:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost savings:</td>
<td>+++</td>
<td>Filler is cheaper than pulp</td>
</tr>
<tr>
<td>Opacity:</td>
<td>++</td>
<td></td>
</tr>
<tr>
<td>Brightness:</td>
<td>++</td>
<td></td>
</tr>
<tr>
<td>Smoothness:</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Drainage:</td>
<td>++</td>
<td>Less fiber to drain</td>
</tr>
<tr>
<td>Strengths:</td>
<td>---</td>
<td>Wet-strength – runnability, dry strength – quality</td>
</tr>
<tr>
<td>Porosity:</td>
<td>-</td>
<td>Higher porosity depending on filler type</td>
</tr>
<tr>
<td>Bulk:</td>
<td>-</td>
<td>Depending on filler type</td>
</tr>
</tbody>
</table>

Loss of strength is typically the show stopper.
Impact of MFC on paper strength

It is possible to increase filler by 10% or more and suffer no strength loss.

Lab study
Mesmer recirculating hand sheets (12 sheets)
70% Eucalyptus, 30% NBSK, 550 CSF
Intracarb 60 filler
Impact of MFC on paper tensile

**Tensile**
- Tensile Index (Nm/g)
- Paper filler content (%)
  - No MFC
  - 3% MFC
  - 5% MFC

**Elongation**
- Breaking elongation (%)
- Paper filler content (%)
  - No MFC
  - 3% MFC
  - 5% MFC

**TEA**
- Tensile Energy Absorption (J/kg)
- Paper filler content (%)
  - No MFC
  - 3% MFC
  - 5% MFC

**Modulus**
- Youngs modulus (GPa)
- Paper filler content (%)
  - No MFC
  - 3% MFC
  - 5% MFC

Lab study
Mesmer recirculating hand sheets (12 sheets)
70% Eucalyptus, 30% NBSK, 550 CSF
Intracarb 60 filler
Impact of MFC on optical properties

Brightness

Opacity

Scattering

Absorption

Lab study
Mesmer recirculating hand sheets (12 sheets)
70% Eucalyptus, 30% NBSK, 550 CSF
Intracarb 60 filler
The porosity impact can be important for hold-out of ink or coating colour.

Density can be regained by trading the positive impact on smoothness and bond strength with less intense calendering and/or use of coarser fiber, such as CTMP.

While initial drainage slows down there is a positive impact on couch and press solids.
The impact of increasing filler loading with the help of MFC

<table>
<thead>
<tr>
<th>Impact on:</th>
<th>+10% filler</th>
<th>+10% filler with MFC</th>
<th>Comments:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost savings:</td>
<td>+++</td>
<td>+</td>
<td>Cost of MFC…</td>
</tr>
<tr>
<td>Opacity:</td>
<td>++</td>
<td>+++</td>
<td>Even higher with MFC</td>
</tr>
<tr>
<td>Brightness:</td>
<td>++</td>
<td>+</td>
<td>A little less improved</td>
</tr>
<tr>
<td>Smoothness:</td>
<td>+</td>
<td>++</td>
<td>Better with MFC</td>
</tr>
<tr>
<td>Drainage:</td>
<td>++</td>
<td>+</td>
<td>MFC holds back some of the benefit</td>
</tr>
<tr>
<td>Strengths:</td>
<td>---</td>
<td>+/-</td>
<td>Wet-strength – runnability, dry strength – quality</td>
</tr>
<tr>
<td>Porosity:</td>
<td>-</td>
<td>+++</td>
<td>Much lower porosity with MFC</td>
</tr>
<tr>
<td>Bulk:</td>
<td>-</td>
<td>--</td>
<td>MFC doesn’t help. Needs paper making trade off’s</td>
</tr>
</tbody>
</table>
Selecting correct filler loading - simplified example

- No filler - minimum sheet weight for required strength
- No filler - minimum sheet weight for required opacity

Ideal strength and opacity
Selecting correct filler loading and sheet weight with FiberLean
Pilot paper machine data

![Graph showing the relationship between Total Filler Loading and g/m² for target opacity with different filler loadings.](image-url)
Selecting correct filler loading and sheet weight with FiberLean
Pilot paper machine data
Selecting correct filler loading and sheet weight with FiberLean
Pilot paper machine data

- 84% Opacity no mfc
- 84% Opacity 2% mfc
- 84% Opacity 3% mfc
- 84% Opacity 4% mfc
- 1.5 kN/m tensile strength no mfc
- 1.5 kN/m tensile strength 2% mfc
- 1.5 kN/m tensile strength 3% mfc
- 1.5 kN/m tensile strength 4% mfc
Selecting correct filler loading and sheet weight with FiberLean
Pilot paper machine data

- 84% Opacity no mfc
- 84% Opacity 2% mfc
- 84% Opacity 3% mfc
- 84% Opacity 4% mfc
- 1.5 kN/m tensile strength no mfc
- 1.5 kN/m tensile strength 2% mfc
- 1.5 kN/m tensile strength 3% mfc
- 1.5 kN/m tensile strength 4% mfc

Paper with no MFC
63 g/m² 58 g/m²
8% filler Fiber
84% opacity 1.5 kN/m tensile

Paper with 2% MFC
53 g/m² 44 g/m²
17% filler Fiber
84% opacity 1.5 kN/m tensile

Paper with 4% MFC
48 g/m² 38 g/m²
21% filler Fiber
84% opacity 1.5 kN/m tensile
Conclusions

- Converting a small part of the pulp to MFC opens up new opportunities.
- The traditional idea of replacing pulp with filler and MFC is exciting and can offer nice cost savings.
- The idea of using MFC to tailor a paper grade to meet required opacity and strength targets with minimum raw material use is even more exciting!
- There could be major fiber savings!
  - The example given suggests:
    - 24% fiber savings from 2% MFC
    - 34% fiber savings from 4% MFC
Thank you!