New high volume fibre products by foam forming: thermal insulation and sound absorption materials

European Paper Week, CEPI and EFPRO Open Seminar “New ideas for the paper industry – Young researchers presentations”

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Content

- New possible markets for natural fibre products
- Foam forming as a tool for creating new fibre products
- Properties of foam formed demonstrator materials in comparison with commercial products
- Conclusions
In many application areas there is a need for replacing materials like

- Glass fibres
  - Large carbon footprint in manufacturing
  - Respiratory/handling issues
  - Non biodegradable

- Polyester fibres
  - Price dependency on oil and availability of cotton
  - Non biodegradable

- Polyurethane foams
  - Health issues in production
  - Non biodegradable

Compare:
SW kraft ~ 0.7 €/kg
HW kraft ~ 0.6 €/kg

~1.2-1.5 €/kg

~1.5 €/kg
High loft insulation materials

Acoustic control products
- Provide comfort and safety
- Market restraints: increase in raw material prices, weight reduction, recycling of materials
- Large and growing markets in many applications (automotives, construction, office partition)

Thermal insulation products
- Provide comfort and energy savings
- Legislative drivers: passive housing, increasing insulation thicknesses
- Natural fibre solutions not efficient enough to compete with less sustainable competitors
- Large markets, growing with GDP and urbanization
From dense and flat paper to high loft materials: FOAM FORMING

Raw materials we have used:
- Mechanical pulps
- Chemical pulps
- Fillers
- Nanofibrillated cellulose
- Regenerated cellulose fibres

Thermal insulation

Acoustic properties: sound absorption
Foam forming of fibres

- Aqueous foam is an excellent suspending medium
  - Fibres and other raw materials are mixed with foam instead of water
  - Foam consists of water, foaming agent and air. Typical air content 50 – 70 %
  - Foam allows utilization of raw materials from long fibres to nanoscale particles
  - Adjustable material density and thickness range

- SDS (sodium dodecyl sulfate) was used as surfactant

- Foamed materials were dried in oven at 70°C
## Properties of thermal insulation materials

<table>
<thead>
<tr>
<th>Sample</th>
<th>Thickness mm</th>
<th>Grammage g/m²</th>
<th>Density kg/m³</th>
<th>Bulk cm³/g</th>
</tr>
</thead>
<tbody>
<tr>
<td>50/50 CTMP/Pine kraft</td>
<td>40</td>
<td>835</td>
<td>22.2</td>
<td>45</td>
</tr>
<tr>
<td>80/20 CTMP/PCC</td>
<td>59</td>
<td>760</td>
<td>12.9</td>
<td>78</td>
</tr>
<tr>
<td>80/20 CTMP/NFC</td>
<td>32.5</td>
<td>830</td>
<td>24.9</td>
<td>40</td>
</tr>
<tr>
<td>100% Pine kraft</td>
<td>33.5</td>
<td>870</td>
<td>27.7</td>
<td>36</td>
</tr>
<tr>
<td>100% CTMP</td>
<td>33</td>
<td>770</td>
<td>26.1</td>
<td>38</td>
</tr>
</tbody>
</table>
## Comparison to commercial products

<table>
<thead>
<tr>
<th>Trade name</th>
<th>Material</th>
<th>Density kg/m³</th>
<th>Thermal conductivity $\lambda_{10}$ W/(m·K)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isover KL-33</td>
<td>Glass</td>
<td>21.8</td>
<td>0.033</td>
</tr>
<tr>
<td>Knauf Space Slab 035</td>
<td>Glass</td>
<td>23.1</td>
<td>0.035</td>
</tr>
<tr>
<td>Paroc eXtra</td>
<td>Stone</td>
<td>31.1</td>
<td>0.035</td>
</tr>
<tr>
<td>Hunton Flex</td>
<td>Wood</td>
<td>62.2</td>
<td>0.038</td>
</tr>
<tr>
<td>Ekovilla</td>
<td>Recycled paper</td>
<td>38.6</td>
<td>0.038</td>
</tr>
<tr>
<td><strong>Foam formed demonstrator</strong></td>
<td><strong>100% pine kraft</strong></td>
<td><strong>27.7</strong></td>
<td><strong>0.035</strong></td>
</tr>
</tbody>
</table>

Source: TM Rakennusmaailma 06/2012

(Smaller the better)
### Acoustic sound absorber materials

<table>
<thead>
<tr>
<th>Sample</th>
<th>Thickness (mm)</th>
<th>Grammage (g/m²)</th>
<th>Density (kg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100% Pine kraft</td>
<td>8.4</td>
<td>212</td>
<td>25.4</td>
</tr>
<tr>
<td>50/50 Pine kraft/ PCC</td>
<td>1.2</td>
<td>181</td>
<td>153.8</td>
</tr>
<tr>
<td>50/50 Pine kraft /regenerated cellulose fibres</td>
<td>18.8</td>
<td>447</td>
<td>23.7</td>
</tr>
</tbody>
</table>

Acoustic properties were measured from stacks (total grammage 800 g/m²)

1) 4x 100% pine kraft
2) 1x 50/50 pine kraft/PCC + 3x 100% pine kraft
3) 2x 50/50 pine kraft/regenerated cellulose fibres
Sound absorption at 500 Hz frequency

Absorption coefficient 0 = no absorbance, 1 = full absorbance
Measurements without air gap
Conclusions

- New forming technologies allow the development of natural fibre products for new high volume markets
- We believe that after optimization the high loft foam formed materials will be able to compete in the high performance category
- Papermaking fibres are cost competitive raw materials
- Possibility to replace materials based on synthetic and glass fibres, even foamed plastics

- Development of needed functional requirements (e.g. fire safety)
- Up-scaling of manufacturing technique
VTT creates business from technology