Fractionation and business potential from sludge
PAFRAK

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Background
Million tons of sludge is produced in Europe in municipalities and industry. Organic based wet sludge is not allowed to be disposed in landfills. In forest industry the sludge (P&P sludge) is finally incinerated and/or used as soil conditioner. Municipal wastewater sludge in Finland is mainly composted whereas in other countries it is incinerated and the ash is disposed or recycled. Sludge contains valuable components which could be recycled and converted to secondary raw material. However, high water content of sludge can hinder the further processing.

Objectives of the project
The aim of this project was with better knowledge of sludge and fractionation techniques to generate potential business ideas for different sludges.

Materials and methods
The sludges under examination were primary sludge from pulp and paper (P&P) industry, waste activated sludge (WAS) from municipal and P&P wastewater treatment plants named bio sludge in this study, flotation froth reject named deinking sludge in this study, and flotation sludge from tertiary treatment of P&P industry named tertiary sludge in this study.

The composition of sludge for raw materials at biorefineries was examined by VTT. Wood-based components were determined in co-operation with University of Jyväskylä using the analysis methods for the characterisation of wood materials.

The sludge fractionation techniques used in this study were hydrocyclone separation (10-60 mm), centrifuging, belt filtration, sieve bend separation (50 µm), and occasionally suitable combinations of them (Fig. 1).

Main results
Sludges have raw material/product potential (Table 1), and commercial processes to utilise them are available.

It is not easy to produce pure products from sludge while they are mixtures of various components. Fractionation with or without pretreatment and further cleaning are usually complicated and money consuming. Sludge from pulp and paper industry can contain significant amount of useful fibres/fillers. If raw materials/products are wanted, the purest reject near the generation should be taken, not the sludge in which the rejects have already mixed together (Fig. 2). Although low quality fibres could be used in biorefinery-products, the best value was supposed to be achieved directly in dewatering as filter aids with no fractionation requirements.

Filter aids enhance sludge dewatering and they can be processed from different fibrous rejects originating from the mill site (Fig. 3). Filter aids raise the energy content of sludges and lower the chemical costs in dewatering.

Table 1. Chemical composition of WAS or tertiary sludge samples from different origin. Proportion of ash, fibres/organic particles larger than 74 µm (FA), organic part of the precipitated lignin like materials (LLMs P), acid soluble lignin like materials (LLMs S), extractives (Extract) and carbohydrates (CH) in dry solids content.

<table>
<thead>
<tr>
<th>Sludge</th>
<th>Raw materials at mill plant</th>
<th>Ash %</th>
<th>FA %</th>
<th>LLMs P %</th>
<th>LLMs S %</th>
<th>Extract %</th>
<th>CH %</th>
</tr>
</thead>
<tbody>
<tr>
<td>WAS 1</td>
<td>TMP (spruce) and chemical sulphate pulp sourced from other mills.</td>
<td>23</td>
<td>49</td>
<td>28</td>
<td>4</td>
<td>2</td>
<td>13</td>
</tr>
<tr>
<td>WAS 2</td>
<td>TMP pulp (spruce) and recycled paper.</td>
<td>20</td>
<td>84</td>
<td>33</td>
<td>4</td>
<td>2</td>
<td>14</td>
</tr>
<tr>
<td>WAS 3</td>
<td>ECF bleached softwood and hardwood sulphate pulp.</td>
<td>40</td>
<td>38</td>
<td>21</td>
<td>5</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>WAS 4</td>
<td>Municipal wastewater. Replaced softwood and hardwood sulphate pulp, TMP and groundwood pulps. Recycled fibres and liquid packaging board, corrugated board and wrappings.</td>
<td>30</td>
<td>3</td>
<td>&lt;7.5</td>
<td>12</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>Tertiary sludge</td>
<td></td>
<td>37</td>
<td>9</td>
<td>23</td>
<td>8</td>
<td>4</td>
<td>9</td>
</tr>
</tbody>
</table>

Figure 1. Separation devices (hydrocyclone, belt filter, centrifuge and sieve bend) used in sludge fractionation studies.

Figure 2. Process scheme after suggested modifications.

Figure 3. The effects of filter aids on the dewatering properties.

Commercialisation and impacts of the results
Evaluation of material potential for biorefinery processes helps to estimate usability of different material fractions from P&P industry. When materials/products are wanted, the purest reject near the production should be taken, not the sludge in which the rejects have already mixed together. Fibre based filter aids originating from the mill site can be used to improve dewatering properties, raise the energy content and lower chemical costs in sludge dewatering.

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