Process Integration of waste water treatment technique

A way of decreasing the energy and resource use in the pulp & paper industry

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Partners in the study

HOLMEN

SÖDRA

Swedish Energy Agency

Rottneros Bruk
Hypothesis

The work hypothesis behind this desk-top study was that by developing ways to integrate the effluent treatment methods in the pulp and paper process systems it will be possible to develop more resource efficient activities to reach a desired level of effluent impact.
The Task

- Process streams from different types of Pulp and paper mills were tested
- Combination of membrane methods and anaerobic treatment
- Recycling of the membrane permeate to the mill process and sending the membrane concentrate to anaerobic treatment
- All treatment should be performed at the actual mill process temperature
- Comparison with the base case: Total effluent to biological treatment
- The same or slightly decreased discharges to the receiving waters
Mills studied

- Bleached TMP, integrated Paper mill, 300,000 tpy
- Bleached CTMP, 100,000 tpy
- Bleached Sulphate, anaerobic pre-treatment, 500,000 tpy
- Bleached Sulphate, anaerobic and membrane technique as pre-treatment, 500,000 tpy
- Bleached Sulphate, integrated Paper mill, 600,000 tpy
- Recycled fibre, integrated Paper mill, 300,000 tpy
The studied concept

Pulp mill
- Streams to membrane separation
- Streams to anaerobic treatment
- Other streams
- Permeate for reuse in the mill

Membrane filtration

Anaerobic treatment
- Streams to anaerobic treatment
- Sludge

Aerobic treatment
- Other streams
- Recipient

Paper mill
- Streams to membrane separation
- Other streams
- Permeate for reuse in the mill

Membrane filtration

Biogas

Other streams
# Treated streams

<table>
<thead>
<tr>
<th></th>
<th>Membrane</th>
<th>Anaerobic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bark press</td>
<td>(X)</td>
<td>(X)</td>
</tr>
<tr>
<td>Chip wash</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Bleaching</td>
<td>X</td>
<td>(X)</td>
</tr>
<tr>
<td>Evaporation condensates</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Collected spills</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>White water</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Sizing effluents</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Deinking rejects</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Secondary sludge</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>
Results from the study

- The PI case proved to be superior to the base case in almost all aspects

- Compared to base case
  - Decreased electrical power consumption in the effluent treatment, 15 to 30 MWh per day
  - Decreased cooling need up to 850 MWh per day
  - Biogas production corresponding to 35 och 90 MWh per day.

- Lower effluent flow and lower discharge (COD, TSS, N and P) to the receiving water

- Flow up to 15 m$^3$/t lower

- Bio sludge 5-12 tonnes/day lower
# Electric power, MWh/d

<table>
<thead>
<tr>
<th></th>
<th>PI</th>
<th>Bas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bl TMP, int P-bruk</td>
<td>15</td>
<td>43</td>
</tr>
<tr>
<td>Bl CTMP</td>
<td>5</td>
<td>33</td>
</tr>
<tr>
<td>Bl Sulfat, An</td>
<td>17</td>
<td>46</td>
</tr>
<tr>
<td>Bl Sulfat, An+MF</td>
<td>27</td>
<td>46</td>
</tr>
<tr>
<td>Bl Sulfat, int P-bruk</td>
<td>38</td>
<td>65</td>
</tr>
<tr>
<td>Retur, int P-bruk</td>
<td>12</td>
<td>29</td>
</tr>
</tbody>
</table>
## Bio sludge production, t/d

<table>
<thead>
<tr>
<th></th>
<th>PI</th>
<th>Bas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bl TMP, int P-bruk</td>
<td>1,2</td>
<td>9,9</td>
</tr>
<tr>
<td>Bl CTMP</td>
<td>0,9</td>
<td>6,8</td>
</tr>
<tr>
<td>Bl Sulfat, An</td>
<td>1,8</td>
<td>10,7</td>
</tr>
<tr>
<td>Bl Sulfat, An+MF</td>
<td>1,7</td>
<td>10,7</td>
</tr>
<tr>
<td>Bl Sulfat, int P-bruk</td>
<td>2,3</td>
<td>14,6</td>
</tr>
<tr>
<td>Retur, int P-bruk</td>
<td>1</td>
<td>6,4</td>
</tr>
</tbody>
</table>
Costs

• The Investment varies from 10 to 30 MUSD
• The saving in operational costs is 1.2 to 2.5 MUSD/year
• Calculating with a straight depreciation the PI concept yields a pay-back in 4-12 years
• Not considered savings from reduced water consumption and recovered heat from saved raw water
• Costs are of course very much dependent on the situation at each site
• OP cost does not include final sludge handling and the purchase of CO$_2$ emission rights (If considered an estimated saving of 0.3-0.5 MUSD/year in favour of the PI case is reached)
Final comments and future work

- The PI concepts evaluated have so far found limited use in the P&P Industry
- Practical and long term experiences are therefore lacking
- Considering the promising results in this study it is suggested that such approaches could lead to more resource and cost efficient treatment plants
Future work

- A new project has been started with focus on the membrane filtration with pilot testing on mill sites
- Also some focus will be put on the demand on the quality of the water (permeate) to be recycled
- Project time schedule is two years
- This study will be sponsored by the Swedish Energy Agency and Swedish pulp mills
Acknowledgements

The following has colleagues contributed to this study

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Thank you for listening

QUESTIONS?