Dissolving pulp

Manufacturing process:

Wood → Dissolving Pulp → Cotton Linters

Ethering → Ethers
- Binders
- Glues
- CMC
- Detergents
- Food
- Pharmacy
- Oil drilling mud

Nitration → Nitrates
- Explosives
- Lacquers
- Celluloid

Acetylation → Acetates
- Acetate tow
- Acetate filament
- Acetate mouldings
- Acetate films

Xanthation → Viscose
- Rayon staple
- Textile
- Non-woven
- Viscose filament
- Rayon cord
- Industrial yarn
- Cellophane film
- Sponge products
- Sausage skin

Others
- CuO/NH₄OH
- CuO
- ZnCl₂
- H₂SO₄
- Latex
- Resins
- Artificial leather
- Laminating papers
- Impregnation papers

Source: Metso, Pöyry
Dissolving pulp demand by end product and region 2008

Note: Includes about 1 million tons cotton linters pulp.
Dissolving pulp end use segments

- High-alpha/high grade pulps
  - 1.3 million tons
- Low-alpha pulps
  - 2.9 million tons
- Total 4.2 million tons (incl. cotton linters pulp)

**Common end uses**
- Acetate:
  - Cigarette tow
  - Films
  - High quality plastics
  - Acetate yarn, fibres
- Ethers/Others:
  - Explosives
  - Food industry
  - Pharmaceutical
  - Cosmetics
  - Special paints
  - Binders and glues
  - Artificial leather
  - Etc.

**Substituting products**
- Acetates:
  - Paper, cotton, synthetic fibre
  - Synthetic films
  - Plastic
  - Natural silk, cotton
- Ethers/Others:
  - Highly miscellaneous
  - Cotton linters pulp
  - Synthetic fibres, etc.
  - BHKP paper pulp (vs. low alpha CMC)
- Viscose:
  - Textile industry
  - Non-wovens
  - Cord and industrial yarn
  - Cellulose
  - Sausage skin
  - Sponges
- Viscose:
  - Cotton, wool
  - Synthetic fibres, fluff pulp
  - Steel and polyester
  - Polyethylene, polypropylene
  - Natural, collagen and plastic casings

**Source:** World Fibre Outlook, Pöyry
The world demand for dissolving pulp is expected to grow from 4.1 million ADt/a in 2008 to 6.3 million ADt/a by 2025.

Consumption of dissolving pulp by region – Medium scenario

Forecast
Demands for dissolving pulp

- End user is a chemical company – high requests for the quality on the pulp
- Uniform product
- High cellulose content
  - Controlled, adjusted viscosity (DP)
  - Viscosity adjustment over the whole fiberline -> viscosity control stages (Cooking, O2, H, P, Z)
- High purity
  - low, adjusted hemicellulose content
  - high brightness
  - low extractives content
  - low, adjusted metal ion profile
  - High brightness
  - Low brightness reversion
Cooking
Basics of dissolving pulp cooking

• Removal and/or adjusting the amount of hemicelluloses

• Alkaline kraft pulping is not able to make enough hemicellulose removal

• There is a need for acidic conditions, which results in hydrolysis, bonds between sugars are broken down and dissolved
Hydrolysis of hemicelluloses

• Prehydrolysis kraft cooking
• Removal of hemicelluloses in the prehydrolysis stage
• Removal of lignin in the cooking stage
• Degree of hydrolysis and the purity of hemicelluloses relatively freely adjustable
• Possibility to use hydrolysate
Prehydrolysis stage

• Liquid or steam phase
  - Liquid phase, easy to adjust the pH
  - use of different acids, sulphur dioxide
  - conditions (time, temp, pH) easy to vary
  - Drawback: high volume of hydrolysate, no use (value) today

=> Only steam phase as a prehydrolysis stage is economically viable
Steam hydrolysis

- Direct LP and MP steam
- 160-180 deg C
- No additional chemicals, water
- The effect comes from AUTOHYDROLYSIS
  - the acids from wood release protons during steaming creating acidic conditions

- The effect of steam hydrolysis depends on
  - wood species
  - wood age
  - moisture content
  - Temperature

- Control of prehydrolysis by P-factor
E. urograndis

/Sixta2006/
Displacement Batch Cooking

Chip Fill

Pump Discharge

Displacement

Liquor Displacement Technology for Batch Digesters

Impregnation Liquor Fill

Hot Liquor Fill

Cooking and Heat-up

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19.11.2009 Lari Lammi
Metso Batch Dissolving Cooking
Features

• Steam hydrolysis
  - LP + MP steam for hydrolysis

• Strong alkali neutralization
  - WL pad

• Modern kraft cooking
  - HBL treatment
  - Cooking liquor addition
  - Uniform cooking
  - Gentle discharge
  - Low emissions
# Typical operating figures for market pulp Metso Batch cooking

<table>
<thead>
<tr>
<th></th>
<th>HARDWOOD</th>
<th>SOFTWOOD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LP-steam consumption</strong></td>
<td>120-160</td>
<td>120-160</td>
</tr>
<tr>
<td><strong>MP-steam consumption</strong></td>
<td>400-500</td>
<td>400-550</td>
</tr>
<tr>
<td><strong>Power consumption</strong></td>
<td>20-25</td>
<td>25-30</td>
</tr>
<tr>
<td><strong>Alkali consumption</strong></td>
<td>17-19</td>
<td>20-22</td>
</tr>
<tr>
<td><strong>Yield</strong></td>
<td>51-53 (@kappa 18)</td>
<td>47-48 (@kappa 30)</td>
</tr>
</tbody>
</table>
Operating values dissolving pulp - examples

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>LP-Steam</td>
<td>400-500 kg/Adt</td>
</tr>
<tr>
<td>MP-Steam</td>
<td>550-750 kg/Adt</td>
</tr>
<tr>
<td>Prehydrolysis temperature</td>
<td>160-170 deg C</td>
</tr>
<tr>
<td>Prehydrolysis time</td>
<td>20-60 min</td>
</tr>
<tr>
<td>Total sequence time</td>
<td>300-350 min</td>
</tr>
<tr>
<td>Cooking yield</td>
<td>35-39 % on wood</td>
</tr>
<tr>
<td>Pulp viscosity</td>
<td>600-1200 ml/g</td>
</tr>
<tr>
<td>Pentosan in pulp</td>
<td>As low as 1.5% on pulp</td>
</tr>
</tbody>
</table>

Factors affecting the values
- Wood quality (species, moisture…)
- Dissolving pulp quality (rayon, acetate…)
Brown Stock Washing
Brown stock washing and screening

- No major differences with kraft pulping
- One important thing is that the knot/reject amount is lower than in kraft pulping
- Carry over to O$_2$-stage could be higher than in normal kraft pulp – however depending on the end-product viscosity level
- Barrier washing – good control for conditions to O$_2$-delignification and bleaching -> stable and controllable pulp quality
Oxygen delignification
Oxygen delignification

• Single, two-stage or no O₂
• Decision based on the following:
  - End-product viscosity – required viscosity loss in O₂-stage
  - Softwood / hardwood
  - Only dissolving grade / also kraft pulp
• Pulp viscosity can be controlled by temperature and alkali charge in the oxygen stage
Bleaching
Bleaching

• There should be a possibility to control the viscosity in 1-2 stages (Oxygen delignification/bleaching) depending on the request for end-product quality
• Normally a sequence for high brightness is needed
• Normally a sequence for low brightness reversion is needed
• Demineralized wash water needs normally to be used in the last washing after bleaching
Possible bleaching sequences

• In the past:
  - C-E-H-D
  - C/D-EO-H-D

• Future
  - D-EOP-D-D
  - D-EOP-D-P
  - O-D-EOP-D-D
  - O-D-EOP-D-P
  - O-A-Zq-P
Fiberline for Dissolving Pulp - ECF bleaching
Fiberline for Dissolving Pulp - TCF bleaching
Bahia Pulp experiences

• Metso Cooking and Fiberline gives good opportunities to produce different qualities of dissolving pulp

• Knowledge comes only with hands on practice
  - Different pulp behavior in the digester than with normal kraft pulp
  - How to control the viscosity in the whole fiberline

• Lot of issues which may be “small” during design phase but have a significant influence on the operation if not correct

• Very much different approach to quality than producing market paper pulp

• More requirements for preventive maintenance

• Metso has a running reference and hands on practice of designing and producing dissolving pulp – with excellent quality (according to end-user requirement)
Process differences

- Kraft and Dissolving pulping have different yields, charging and other results. Some key data for both market pulp and dissolving pulp are shown in the table below.

<table>
<thead>
<tr>
<th></th>
<th>Kraft SW</th>
<th>Diss SW</th>
<th>Kraft EUC</th>
<th>Diss EUC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digester Kappa number</td>
<td>Ref</td>
<td>-</td>
<td>Ref</td>
<td>-</td>
</tr>
<tr>
<td>Digester yield</td>
<td>% Ref</td>
<td>-</td>
<td>Ref</td>
<td>-</td>
</tr>
<tr>
<td>Charge</td>
<td>% EA as NaOH</td>
<td>Ref</td>
<td>+</td>
<td>Ref</td>
</tr>
<tr>
<td>Steam cons</td>
<td>kg/Adt</td>
<td>++</td>
<td>Ref</td>
<td>++</td>
</tr>
<tr>
<td>Oxygen kappa number</td>
<td>- Ref</td>
<td>--</td>
<td>Ref</td>
<td>--</td>
</tr>
<tr>
<td>Oxygen delign yield</td>
<td>% ref</td>
<td>+/-</td>
<td>ref</td>
<td>+/-</td>
</tr>
</tbody>
</table>
Specific loads for key departments

- Specific data are given below for SW / HW used for kraft and dissolving pulp.
- However, the numbers will vary depending on raw material and product quality. Done for general dissolving pulp.

<table>
<thead>
<tr>
<th></th>
<th>Kraft SW</th>
<th>Diss SW</th>
<th>Kraft EUC</th>
<th>Diss EUC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood consumption</td>
<td>M3 SUB/ADt</td>
<td>5.0</td>
<td>6.1</td>
<td>3.6</td>
</tr>
<tr>
<td>WBL conc</td>
<td>% DS</td>
<td>18</td>
<td>20</td>
<td>17</td>
</tr>
<tr>
<td>Evap need</td>
<td>t evap/Adt</td>
<td>7.1</td>
<td>9.3</td>
<td>6.7</td>
</tr>
<tr>
<td>Spec DS-flow</td>
<td>T DS/Adt</td>
<td>1.8</td>
<td>2.5</td>
<td>1.6</td>
</tr>
<tr>
<td>Spec WL flow</td>
<td>M3/Adt</td>
<td>3.7</td>
<td>5.4</td>
<td>3.4</td>
</tr>
</tbody>
</table>
Heat values

• Dissolving pulping have lower yield – more organic part to BL.
• But also the white liquor charge is higher.
• Without splitting the wood into different carbohydrates the organic part in the black liquor will be slightly reduced. Calculated to be reduced with 1 %.
• The heat value for dissolving pulp is estimated to be about the same or slightly below for kraft pulp liquor.
• Very much dependent on extractive level in the wood and can vary much.
Reference for EUC – Kraft Process 1000 ADt/d

3614 m³ SUB/d

1037 ADt/d

1000 ADt/d

3360 m³/d

260 t/d

280 t/h

1541 t DS/d
Dissolving pulp EUC 1000 ADt/d (balance / % of Kraft)

- 4528 m³SUB/d, +25%
- 1037 ADt/d
- 5168 m³/d, +53%
- 403 t/d, +55%
- 378 t/h, +35%
- 2309 t DS/d, +49%
Reference for SW – Kraft Process 1000 ADt/d

- 5015 m³ SUB/d
- 1045 ADt/d
- 1000 ADt/d
- 3727 m³/d
- 289 t/d
- 295 t/h
- 1741 t DS/d
Dissolving pulp SW 1000 ADt/d (balance / % of Kraft)

6075 m3SUB/d +21 %

1037 ADt/d

1000 ADt/d

5407 m3/d +45%

388 t/h +31 %

422 t/d +46 %

2435 t DS/d +40 %
Conclusions on department sizing

• Dissolving pulp will require much bigger recovery area compared to normal kraft pulp – reason is lower yield and higher charging in cooking.

• The organic portion of the dry solids to the recovery boiler is slightly lower when producing dissolving pulp. Resulting is somewhat lower heat value.
Typical DP Fiberline
Summary

• End-product specifications determine the design
• Cooking with steam prehydrolysis
• Washing in brown stock with presses in order to control the carry-over to \( \text{O}_2/\text{bleaching} \) thus control the viscosity drop
• Barrier washing in bleaching to get sharp controllable stages – control the viscosity drop
• ECF/TCF solutions possible – Ozone one alternative for viscosity control
• Decisions regarding kraft/dissolving pulp ratios and raw material have an impact on the design