Chemical Mechanical Pulping Of Eucalyptus
- Latest Development & Comparison

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Different Pulping Processes (For Virgin Fibers)

- Mechanical Pulping
  - Stone Ground Wood (SGW, PGW…)
  - Refiner Mechanical Pulping (RMP, TMP)
- Chemical Mechanical Pulping (CMP)
  - Chemical Pretreatment + Refining
- Chemical Pulping
  - Kraft (sulfate)
  - Sulfite
  - Others
Why CMP For Hardwoods? (1)

- Small - large capacity (100 to >500 t/d)
- Lower capital/investment cost
- Higher return from wood resource (higher yield…)
- Hardwoods are easy to react with chemicals
- Hardwoods need chemical treatment to develop strength
- Process is very flexible

“Flexible” means it can use different raw materials and produce different products
Why CMP For Hardwoods?(2)

- HWD CMP have been used in many applications:
  - Printing/Writing
    - coated papers
    - supper calendared
    - wood free grades
  - Paper Board
  - Tissue/fluff
  - Newsprint
CMP vs. CP from Aspen (pulp intrinsic property)

![Graph showing the comparison of CMP and CP](image)

- **CMP**
- **CP**

**Axes:**
- **Y-axis:** Tensile Index (Nm/g)
- **X-axis:** Handsheet Density (g/cm³)
CMP vs. CP from *e. grandis* (pulp intrinsic property)
## Synergy Between Aspen CMP and CP

<table>
<thead>
<tr>
<th>PULP SAMPLE</th>
<th>Aspen CP</th>
<th>Aspen CMP</th>
<th>Mixture</th>
</tr>
</thead>
<tbody>
<tr>
<td>PULP SAMPLE ID</td>
<td>K1</td>
<td>K2</td>
<td>H1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(HB)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FREENESS (CSF)</td>
<td>320</td>
<td>274</td>
<td>345</td>
</tr>
<tr>
<td>BULK (cm3/g)</td>
<td>1.47</td>
<td>1.43</td>
<td>2.35</td>
</tr>
<tr>
<td>TENSILE INDEX (N.m/g)</td>
<td>47.0</td>
<td>50.1</td>
<td>24.3</td>
</tr>
<tr>
<td>%STRETCH</td>
<td>2.1</td>
<td>2.2</td>
<td>1.0</td>
</tr>
<tr>
<td>T.E.A.(J/m2)</td>
<td>44.0</td>
<td>48.6</td>
<td>9.1</td>
</tr>
<tr>
<td>% OPACITY</td>
<td>73.0</td>
<td>72.3</td>
<td>83.6</td>
</tr>
<tr>
<td>SCATT. COEFF. (m2/kg)</td>
<td>33.0</td>
<td>32.3</td>
<td>50.0</td>
</tr>
</tbody>
</table>
Different CMP Technologies

- **P-RC APMP**
  - alkaline peroxide treatment before and during refining
  - Latest & most advanced technology

- **BCTMP (sulfite)**
  - sulfite pretreatment before refining + post bleaching
  - Old technology
Comparison Between P-RC APMP & BCTMP

**P-RC APMP:**

AP Chip Pretreatment → Pri. Refining (Atm. Inlet) → Interstage HC Tower → Press Washing → Sec. Refining → Screening and Cleaning

**BCTMP:**

Sulfite Chip Pretreatment → Press. Pri. Refining → Press. Sec. Refining → Screening and/or Cleaning → AP Post Bleaching + Washing

They use similar equipment and main chemicals (alkali + peroxide), but in different ways…

Mechanical Pulping Systems
My documents/Paper_1/Andritz conference/China_11-04/HYP/HYP of HWs

Slide No. 9
Intrinsic Property: *P-RC APMP pulps are better*…

**Graph**

- **Y-axis:** Tensile Index (N.m/g)
- **X-axis:** Handsheet Density (g/cm³)

- **Lines and Data Points:**
  - Aspen P-RC APMP
  - Aspen BCTMP
  - Birch P-RC APMP
  - Birch BCTMP

The graph shows a comparison of different wood species and processing methods in P-RC APMP pulps, indicating better performance in terms of tensile index with increasing handsheet density.
Light Scattering: *P-RC APMP pulps are higher...*

- all pulps at 300 mL CSF (from mixed NA HWD)
Energy: *P-RC APMP uses much less...*
## Chemical Consumption: *P-RC APMP uses less...*  
(birch from Europe)

<table>
<thead>
<tr>
<th></th>
<th>P-RC APMP</th>
<th>BCTMP</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Total NaOH</td>
<td>6.0</td>
<td>6.5</td>
</tr>
<tr>
<td>% H₂O₂</td>
<td>5.0</td>
<td>5.0</td>
</tr>
<tr>
<td>% Na₂SO₃</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FREENESS (CSF, mL)</td>
<td>301</td>
<td>308</td>
</tr>
<tr>
<td>BULK (cm³/g)</td>
<td>2.22</td>
<td>2.18</td>
</tr>
<tr>
<td>TENSILE INDEX (N.m/g)</td>
<td>46.8</td>
<td>48.7</td>
</tr>
<tr>
<td>%ISO BRIGHTNESS</td>
<td>86.4</td>
<td>87.1</td>
</tr>
</tbody>
</table>
### Different CMP: P -RC APMP vs. BCTMP (HWD)

#### Pulp Quality
- **Strength:** equal or higher
- **Bulk:** equal or higher
- **LSC:** same or better
- **Bleachability:** same or better

#### Process
- **Capital Cost:** lower *(no post bleaching)*
- **Energy:** lower *(normally by 30% or more)*
- **Chemical Cost:** same or lower
- **Yield:** higher
- **Effluent:** easier to treat
Global Total APMP Design Capacity


Total Designed Capacity (ADMT/Y x 1,000,000)
Example of P-RC APMP System (1)
Example of P-RC APMP System (2)

Chip Washing

- From Woodyard
- Chip Pre-Steaming Bin
- Chip washer
- Chip Pump Sump
- Washwater Tank

Impregnation Stage

- OPTION: Chip Washing System
- Dewatering Screw
- Hydra Screen
- Hydra Screen
- MSD
- Impregnator

Mainline Refining

- Reaction Bin
- Cyclone with PSD
- SEPF1
- SEPF2
- 1st Stage HC Refiner
- 1st Stage HC Refiner

Bleaching & Washing

- OPTION: 1st Stage MC-Bleaching
- Screw Press
- MC Tower
- MC Stock Pump 1
- HC Tower
- OPTION: MC Stock Pump 1
P-RC APMP: pulp development

**Preconditioning**

- Chip conditioning

**Refiner Chemical treatment**

- Pulping process

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**Mechanical Pulping Systems**

My documents/Paper_1/Andritz conference/China_11-04/HYP/HYP of HWDS
Pulp Property Development of Different Eucalyptus Woods From South America
e. *grandis* from different countries in S.A.

- *e. grandis* from different countries were similar in tensile/density property development
- They all can develop high tensile strength from HYP
e. grandis from different countries in S.A.

Figure 10. T.E.A./Tensile Properties

- E. Grandis

- e. grandis from different countries were mostly also similar in “Tensile Energy Absorption” development.
- They all can develop high T.E.A. properties from HYP.
Different eucalyptus species from S.A.

- Different eucalyptus species from S.A. were similar in tensile/density development
  - e. grandis & e. saligna
  - e. pilularis, e. dunny and e. urophylla were similar in their tensile/density development
  - They all can develop high tensile properties from HYP
  - e. grandis & e. saligna had better intrinsic property than the others

FIGURE 11. TENSILE/DENSITY PROPERTIES
- Different Eucalyptus

- e. grandis & e. saligna were similar in tensile/density development
- e. pilularis, e. dunny and e. urophylla were similar in their tensile/density development
- They all can develop high tensile properties from HYP
- e. grandis & e. saligna had better intrinsic property than the others
Different eucalyptus species from S.A.

They all seemed to have similar T.E.A. property development

They all can develop high T.E.A. properties from HYP

FIGURE 12. T.E.A./TENSILE PROPERTIES
- Different *Eucalyptus*

![Graph showing T.E.A. vs tensile index for different eucalyptus species.](image)
CMP vs. chemical pulps from *eucalyptus*

- CMP have lower density (higher bulk) at same tensile or
- higher tensile at same density or bulk
**eucalyptus HYP vs. aspen market BCTMP**

- eucalyptus CMP have higher tensile at same density/bulk or
- higher bulk at same tensile than aspen market pulps
**Table 1. Eucalyptus P-RC APMP versus Aspen BCTMP Market Pulps**

<table>
<thead>
<tr>
<th>Wood</th>
<th>Aspen Process</th>
<th>South American Eucalyptus Process</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freeness (CSF) (ml)</td>
<td>110-350</td>
<td>110-350</td>
</tr>
<tr>
<td>Bulk (cm³/g)</td>
<td>1.6-1.8</td>
<td>2.1-2.3</td>
</tr>
<tr>
<td>Density (g/cm³)</td>
<td>0.63-0.56</td>
<td>0.48-0.44</td>
</tr>
<tr>
<td>Tensile Index (N.m/g)</td>
<td>48-52</td>
<td>50</td>
</tr>
<tr>
<td>Tear Index (mN.m²/g)</td>
<td>5.0-5.3</td>
<td>5-6.5</td>
</tr>
<tr>
<td>Burst Index (kPa.m²/g)</td>
<td>2.4-2.7</td>
<td>2.4</td>
</tr>
<tr>
<td>Brightness (% ISO)</td>
<td>85</td>
<td>85</td>
</tr>
<tr>
<td>Opacity (%)</td>
<td>76-77</td>
<td>80-85</td>
</tr>
<tr>
<td>LSC (m²/kg)</td>
<td>&lt; 40 B</td>
<td>&gt;45</td>
</tr>
</tbody>
</table>
| NOTE: a From extrapolation  
  b Estimated numbers |  

**eucalyptus vs. aspen – printing/writing grades**

Eucalyptus gave better overall pulp handsheet properties.
eucalyptus vs. aspen – paperboard grades

Table 2. *Eucalyptus* P-RC APMP versus Maple BCTMP

<table>
<thead>
<tr>
<th></th>
<th>Maple&lt;sup&gt;a&lt;/sup&gt;</th>
<th>South American <em>Eucalyptus</em> P-RC APMP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood Process</td>
<td>BCTMP</td>
<td>P-RC APMP</td>
</tr>
<tr>
<td>Freeness CSF (ml)</td>
<td>380-400</td>
<td>380-400</td>
</tr>
<tr>
<td>Bulk (cm&lt;sup&gt;3&lt;/sup&gt;/g)</td>
<td>3.0-3.2</td>
<td>3.4-4.1</td>
</tr>
<tr>
<td>Density (g/cm&lt;sup&gt;3&lt;/sup&gt;)</td>
<td>0.31-0.33</td>
<td>0.245-0.295</td>
</tr>
<tr>
<td>Tensile Index (N.m/g)</td>
<td>15-18</td>
<td>15-18</td>
</tr>
<tr>
<td>Tear Index (mN.m&lt;sup&gt;2&lt;/sup&gt;/g)</td>
<td>3.0</td>
<td>2.5-3.0</td>
</tr>
<tr>
<td>Burst Index (kPa.m&lt;sup&gt;2&lt;/sup&gt;/g)</td>
<td>0.8-1.0</td>
<td>0.4-0.6</td>
</tr>
<tr>
<td>Brightness (% ISO)</td>
<td>78-80</td>
<td>78-80</td>
</tr>
<tr>
<td>% Opacity</td>
<td>80-83.5</td>
<td>84-90</td>
</tr>
<tr>
<td>LSC (m&lt;sup&gt;2&lt;/sup&gt;/kg)</td>
<td>-</td>
<td>&gt; 50</td>
</tr>
</tbody>
</table>

Note: <sup>a</sup> from Reference [UDY, (1996)]

*eucalyptus* gave better overall pulp handsheet properties
Summary (1)

- CMP proven to be important pulping technology for hardwoods in paper and paperboard industry

- Hardwood CMP has better pulp intrinsic property than its CP (higher tensile at same bulk, or higher bulk at same tensile)

- There is synergistic effects between hardwood CMP and CP pulps

- Among CMP technologies, P-RC APMP is more efficient and provides same or better pulp quality
Summary (2)

- Good tensile strength properties can be developed from *eucalyptus* CMP

- Among eucalyptus species investigated, *e. grandis* and *e. saligna* have better intrinsic properties than the others

- eucalyptus CMP pulps also have better overall pulp properties than aspen market BCTMP pulps

- eucalyptus CMP pulps have good potential for paper and paperboard applications
Future Trends

- Reduce energy consumption by
  - Combination with different chemical and biological treatment
  - Combination of different refining strategies

- Simplify P-RC APMP system even more

- Combination with chemical pulping system to maximize synergies between two systems