TAILORING EUCALYPTUS FIBRE FOR TISSUE PAPER PRODUCTION

5th International Colloquium on Eucalyptus Pulp
May 12, 2011
Porto Seguro – BA, Brazil

Paulo César Pavan
AGENDA

- Some Pictures “From the Beginning”
- The way out of an “exotic commodity” to become a “specialty”
- The Consequences... Current Role of Eucalyptus Pulp
- The Future to Come. Room to Increase Market Leadership
- Final Remarks
Some Pictures “From the Beginning”

• 1950s and early 1960s: disbelief in hardwood pulp;
• 1960s: **understanding over the properties of hardwood pulps grew**;
• 1970s and early 1980s: birch still priced above eucalyptus;
• First internationally sold Brazilian BEKP from Riocell/Unicell targeting tissue.
• 1970s: birch substitution by BEKP for quality reasons in many paper segments.
• Late 1970s: two large BEKP market pulp mills built in Brazil: Aracruz and Cenibra.
• 1980s and 1990s: new players, Jari, Suzano, Votorantim, Arauco and CMPC.
• In summary: **Improved knowledge** and new paper machine technology allowed an increased share of BHKP in virtually all P&W, tissue, cartonboard and specialty papers. Strength was no longer *the* quality criterion. Bulk and opacity became predominant in printing papers. In tissue products, softness, along with bulk, became the key quality features, obtained by an increased use of BHKP.

Sources: Happy and lasting marriage, *Timo Teras -Leading Advisor, Pöyry Forest Industry Consulting, Tissue World Magazine April/May 2009*  
Improving eucalyptus pulp and paper quality using genetic selection and good organization *Paul Cotterill and Sharmane Macrae,, Tappi J, June 1997*
Some Pictures “From the Beginning”

“Before the 60s, papermaking was considered an art. ... Softwood pulps were extensively used as the common denominator. ...Scandinavian birch, southern mixed hardwoods and northern hardwoods (all of them from native forests) completed the mixes”.

HILLMAN, D.C. Single Species: The world’s preferred market pulp.

World Fibre Consumption
Year: 1974

Total 18.3 MM ton

* Estimate
** Others BHKP include Birch, NMHW, SMWHW-US and Indonesian
Source: Hawkins Wright and Aracruz
Some Pictures “From the Beginning”
Forests Implementation:

BEKP Scenario

• Introducing eucalyptus in large-scale forests dedicated to pulp production

• Less than 20 species were suitable for pulp production among more than 700 species adapted to a wide variety of soil and climate;

• Conventional forest technology planting using non-improved seeds;

• Initial adaptation problems, diseases, pests, and low productivity.

Source: Desempenho da fibra de eucalipto na produção de papel tissue de alta qualidade, Braz Demuner, 1º Simp Lat-Americano de Tissue, October 2010
Some Pictures “From the Beginning”

Pulp and Tissue Production Technologies:

Pulp production

- Conventional pulping and bleaching technologies;
- Poor chip impregnation, selectivity and yield;
- Higher wood and chemical specific consumptions;

Tissue Paper production

- BEKP quality not known among papermakers;
- Conventional technologies, including refining – limited tools;

Source: Desempenho da fibra de eucalipto na produção de papel tissue de alta qualidade, Braz Demuner, 1º Simp Lat-Americano de Tissue, October 2010
Some Pictures “From the Beginning”

From the BEKP supplier perspective challenges could be thus summarized as:

• Focusing in high performance in cost and product quality (fibre uniformity and physical properties);

• Using planted forests with high potential of sustainable growth;

• Overcome initial forest adaptation problems, as well as diseases;

• Introducing a new pulp, demanding knowledge and dissemination of the advantages of BEKP for tissue and papermaking in general.

Source: Desempenho da fibra de eucalipto na produção de papel tissue de alta qualidade, Braz Demuner, 1º Simp Lat-Americano de Tissue, October 2010
Why Eucalyptus appears ideal for fine and tissue papers?

• Fibre **length** is relatively short (about 0.65 mm), while European species such as birch, aspen, beech and oak are 15 – 40% longer;

• Fibre **coarseness** is the lowest of the traditional market pulp fibres.

• **Number of fibres per gram** is consequently high (in the range of 20 million).

• Eucalypt fibres **resist collapse**: not only are they slender but also their wall thickness is relatively high.

• Fibre wall **microfibrils have a low winding angle** with fibre axis when compared with other hardwoods.

The way out of an “exotic commodity” to become a “specialty”

Comparison among usual BHKP (weighted averages):

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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Width, µm</td>
<td>12 – 16</td>
<td>18 – 30</td>
<td>17 – 20</td>
<td>19 – 24</td>
</tr>
<tr>
<td>Wall Thickness, µm</td>
<td>2.0 – 3.0</td>
<td>2.5 – 4.0</td>
<td>2.5 – 3.0</td>
<td>4.0 – 6.0</td>
</tr>
<tr>
<td>Length, mm</td>
<td>0.65 – 0.75</td>
<td>0.80 – 1.30</td>
<td>0.60 – 1.10</td>
<td>0.85 – 1.00</td>
</tr>
<tr>
<td>Fibre Count, million/g</td>
<td>22 – 26</td>
<td>8 – 9</td>
<td>11 – 36</td>
<td>19 – 25</td>
</tr>
<tr>
<td>Coarseness, mg/100m</td>
<td>7 – 9</td>
<td>9 – 12</td>
<td>8 – 10</td>
<td>10 – 13</td>
</tr>
<tr>
<td>Fibre/Vessel ratio</td>
<td>130 – 150</td>
<td>40 – 50</td>
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Why Eucalyptus appears ideal for fine and tissue papers?

Those distinguished morphological characteristics provide:

- **Uniform paper formation and high opacity**: important for *all grades of fine papers*. BEKP: high number of fibres per gram and short fibre length.

- **High Bulk and stiffness**: critical for *board or printing papers*, and kept when eucalyptus pulp is used.

- **Smoothness**: one of the most sought property in *coated papers*, especially *art papers* having a matt finish. BEKP: Low coarseness.

- **Softness**: unquestionably the most desirable characteristic in *tissue papers*. BEKP: high fibre count and low coarseness.

The way out of an “exotic commodity” to become a “specialty”

“I believe firmly that in the future ... homogeneity of fibres will become increasingly important to the quality and efficiency of pulp and paper process, thus finally leading to lower costs.

Accordingly, planted forests apart from giving low costs wood will also lead to better quality at lower cost.

And through more uniform fibres homogeneity due to shorter rotations, these properties can in the future be even better designed ...”

CLAES HALL, 1987

The way out of an “exotic commodity” to become a “specialty”

Comparison between Eucalyptus and Birch:

Source: Desempenho da fibra de eucalipto na produção de papel tissue de alta qualidade, Braz Demuner, 1º Simp Lat-Americano de Tissue, October 2010
The way out of an “exotic commodity” to become a “specialty”

Forest Development/Improvement

Under the same climate conditions!

MILESTONES

- Genetic Improvement
- Clonal Propagation
- Forest Management (BAT)

Adt/ha* year

70's 80's 90's 00's 2010-20 Plantation

6 8 10 11 13

Source: Fibria
The way out of an “exotic commodity” to become a “specialty”

Evolution of Pulp Production Technologies

Fiberline - Continuous Cooking Process

- 1950: Conventional cooking + Cold blow
- 1960: CC + High Heat
- 1970: CC + Mod Cont Cooking + High heat + Isothermal
- 1980: CC + MCC + Isothermal + Black liquor impregnation + MCC + ITC
- 1990: Compact cooking G1 + Lo-Solids Down Flow
- 2000: Compact cooking G2 + Lo-Solids Down Flow

Increasing Selectivity and Yield

Source: Metso and Fibria
The way out of an “exotic commodity” to become a “specialty”

Evolution of Pulp Production Technologies

Fiberline – Bleaching Stages / Sequence

- CEH
- O₂ des lignification
- ClO₂
- Longer sequences
- H₂O₂
- ECF & TCF Elemental chlorine substitution

Optimized/Current Sequences:
A/Do-EoP-D-P
Dhot-EoP-D-P

More Efficient, Higher Brightness and Greener


Source: Fibria
The way out of an “exotic commodity” to become a “specialty”

Evolution of Pulp Production Technologies

Fiberline - Capacity Evolution of Cooking and Bleaching Single Lines

Source: Fibria
The way out of an “exotic commodity”
to become a “specialty”

Evolution of Pulp Production Technologies

Contracted Performance Assurance (actual numbers)

<table>
<thead>
<tr>
<th></th>
<th>1990s</th>
<th>2000s</th>
<th>2010s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production Capacity ADtB/day</td>
<td>1150</td>
<td>2400</td>
<td>3920</td>
</tr>
<tr>
<td>Chemical Consumption kg act.Cl/ADtB</td>
<td>40.9</td>
<td></td>
<td>34.0</td>
</tr>
<tr>
<td>Effluent Generation (Bleaching) m³/ADtB</td>
<td>18</td>
<td></td>
<td>15</td>
</tr>
<tr>
<td>Brightness Target % ISO</td>
<td>90.8</td>
<td>92.0</td>
<td>92.0</td>
</tr>
<tr>
<td>Brightness Reversion % ISO</td>
<td>&lt; 2.0</td>
<td></td>
<td>1.6</td>
</tr>
<tr>
<td>Bleached Pulp Viscosity dm³/kg</td>
<td>680</td>
<td>850</td>
<td>900</td>
</tr>
</tbody>
</table>

Source: Paulo Aguiar - Fiber Business Line Metso Paper South America
The way out of an “exotic commodity” to become a “specialty”

Evolution of Tissue Papermaking – Refining

- Refining energy savings (over 50%)
- Reduction in the long fibres in the furnish. Figure shows an increase of BEKP/BSKP ratio from 50/50 to 85/15 with no loss in quality or runnability
- Better paper quality without jeopardizing the runnability.

Source: Fibria and Eucalyptus Pulp for Tissue Making: A winning design, Tissue World 2009 Nice, France - Fernando S. Lafraya, AFINA Consulting
Evolution of Tissue Papermaking – Forming

Multi-layered Headboxes

Developed in the 70s it is still today the best headbox concept for premium tissue.

With the appropriate allocation of BEKP and BSKP the process/product get the benefit of runnability and handfeel simultaneously.

Source of the Pictures: Voith Paper and Metso Paper
The way out of an “exotic commodity” to become a “specialty”

Evolution of Tissue Papermaking – Forming Concept

Fourdrinier:
in the earlier times...
a survivor

Suction breast roll forming
Used until late 1970s. The fibre orientation could not be adequately controlled at high speeds.

Twin wire formers
For better influence on the MD/CD ratio, C-wrap or S-wrap.

Crescent Former
It uses a wire at the drainage side and a felt at the inside which transfers the paper web directly to the drying cylinder and the press nip. Still the most used technology.

Max speed 1000m/min
Max speed 1500m/min
Max speed 2000m/min
Max speed 2400m/min

Sources: Holik, H. Faster, wider, better – progress in paper machinery in the last 100 years, O PAPEL vol. 71, num. 8, pp. 66 - 93 Sep t 2010
1958: plastic wire started to replace the (single layer) bronze wires

During the 1970s and 1980s: polyethylene or polyamide wires optimized with 2 - 3 layers and different yarn dimensions at the paper and the running side. This resulted in a smoother paper surface and better fibre support (retention).

Source: Holik, H. Faster, wider, better – progress in paper machinery in the last 100 years, O PAPEL vol. 71, num. 8, pp. 66 - 93 Sept 2010
The way out of an “exotic commodity” to become a “specialty”

Evolution of Tissue Papermaking – Drying

• Contact drying: Cylinders (Yankee) from 3.6 m diameter to 5.5 m currently.

• High efficiency drying hoods operate at air velocities of up to 210 m/s and air temperatures up to 700°C. Since the 1980s sectioned hoods for control of moisture CD profile were more frequently used.

• **Through air drying (TAD):** Used since the 1960s (P&G patent). The formed sheet is not pressed; the water is evaporated by hot air sucked (or blew) through the web up to a dry content of about 70%. Final drying and creping occur on a (small) Yankee dryer. *The disadvantage is high energy consumption.* Accounts for 10% of the world tissue capacity (2008).

Source: Holik, H. Faster, wider, better – progress in paper machinery in the last 100 years, O PAPEL vol. 71, num. 8, pp. 66 - 93 Sep t 2010
RISI OWTB 2008
The way out of an “exotic commodity” to become a “specialty”

Evolution of Tissue Papermaking – State of the Art

**CONVENTIONAL TISSUE – DC/DCT**

**PREMIUM STRUCTURED TISSUE – TAD**

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**ATMOS**

*Easy swing: DC to/from ATMOS*

*Up to 55% energy savings versus TAD*

*Source: Voith and Metso*

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**NTT Technology**

*Swing capability between textured and DCT*

*Investment cost about 10% higher than for DCT tissue line running on virgin fibre*
There is no single fibre which would provide the best solution for all the requirements: softness / smoothness / absorption / fluffiness / bulk / strength.

**Alternatives:**

A) **FURNISH:** Use a very diverse combination of raw materials - desired product properties, availability and cost, are the main drivers to decide the blend; and/or

B) **PROCESS:** Minimal or no BHKP refining, creping, embossing, etc.

**Drawbacks:** Technical problems of mixing typically raises the cost of production.

BHKP in general - and BEKP in particular - fulfils well most of the key quality demands.

The use of BHKP in tissue can be further enhanced through:

- wood supply management, with the selection of most suitable species or combinations
- differentiate cooking
- tricks to manage fines or fibre deformation.
- genetic improvement, specifically BEKP. This is a slow and costly process but can in the long term lead to an improved generation of BEKP.

However, most producers make just one product, considering too costly to differentiate.

The way out of an “exotic commodity” to become a “specialty”

Recognition – The very special fibre for Tissue application

• Latin American BEKP is especially suitable and fine tuned for tissue.
• BEKP increases especially tissue softness.
• Many tissue producers and BEKP producers have strong partnerships.
• Latin American pulp producers are well positioned to supply the global tissue industry.
• Developments of the paper fibre furnish are used to fight for the margins. Increasing share of short fibre pulp has an impact due to both lower fibre and refining energy costs.

This strategic positioning complements and is part of the technology to BEKP tailoring

Source: PÖYRY, October, 2010.
The Consequences...  
Current Role of Eucalyptus Pulp

World Market Pulp Consumption

Year: 1974

- Sulphite*: 21%
- UKP*: 10%
- BSKP 42%
- BEKP 2%
- Others

Total 18.3 MM ton

Year: 2008

- Other BSKP 21%
- BHKP** 22%
- NSKP 26%
- Birch 3%
- BEKP 28%
- Other

Total 40.5 MM ton

* Estimate

** Others BHKP include Birch, NMHW, SMWHW-US and Indonesian

Source: Hawkins Wright
The Consequences...
Current Role of Eucalyptus Pulp

Destination of the most common HWKP ...
... where they have been used

Source: Typical end uses for market hardwood pulps, Pirkko Petäjä, Pöyry, 1º Simp Lat-Americano de Tissue, October 2010
The Consequences...
Current Role of Eucalyptus Pulp

Market BEKP Consumption for Tissue Applications

World Operacional Tissue Capacity in 2008 (3068 Machines) = 29.5 MMton/year
COMPRISING AN AVERAGE OF 17.6% OF BEKP IN THE FURNISH.

Source: Pöyry, January 2011; RISI, 2008
The Consequences...
Current Role of Eucalyptus Pulp

MARKET PULP FOR TISSUE
2008 - 10.2 MM ton

North America 38%
Europe 37%
Asia 25%

Tissue Furnish:
Market Pulp, a 2008 Picture

“Other BHKP” includes European birch, Indonesian acacia, and mixed hardwoods from Northern hemisphere

Source: End use markets for bleached kraft market pulp, April 2009, Hawkins Wright Ltd.
The Consequences... Current Role of Eucalyptus Pulp

Tissue Furnish over the last 50 years on the North American premium tissue market*

* Average for all companies for consumer products in NA.
Survey accounts for 70% of the premium NA tissue market

The Future to Come
Room to Increase Market Leadership

Tissue market has been consistently growing, and shall still grow in importance inside the overall paper market!

Source: Happy and lasting marriage, Timo Teras, Pöyry Forest Industry Consulting, Tissue World Magazine April/May 2009
The Future to Come
Room to Increase Market Leadership

Long Term Forecast (2008-2025) – BRIC Effect
Best figures for Russia and Asia (> 4%/year)!

Source: PÖYRY, October 2010.
The Future to Come
Room to Increase Market Leadership

Tissue growth in China demands the equivalent of a new pulp mill every 2 years!

Source: Hawkings Wright
The Future to Come
Room to Increase Market Leadership

Still much room to be occupied!
Per Capita Consumption of Tissue by World Region 2007

Source: RISI, 2008

N. America: 24 kg/person
W. Europe: 15.5 kg/person
Japan: 14.5 kg/person
Oceania: 10.5 kg/person
L. America: 5 kg/person
E. Europe: 4 kg/person
China: 3 kg/person
Africa: 1 kg/person
The Future to Come
Room to Increase Market Leadership

Major Capacity Expansions
Market Pulp Supply and Demand (2010-2025)

Source: RISI and Fibria

DEMAND GROWTH:
+2.5% /y or
1,8MM tons/y
Final Remarks

Developing, improving and applying knowledge and technology on what and how to plant, how to pulp, and how to apply BEKP in tissue making, is a consistent and successful “tailoring route”.

Or, as Timo Teras had acutely stated:

“Eucalyptus market pulp and tissue paper production met in the late 1960s. They engaged in the early 1970s and got married soon thereafter. It took a few years to really get to know each other in mutual recognition, respect and commitment. This is a happy and long-lasting marriage with no risk of a divorce in sight.”

... a growing, consistent, knowledge and technology-based relationship.

Acknowledgements

For the kind and special attention special thanks to:

YOU