ULTRA LOW INTENSITY REFINING OF EUCALYPTUS PULP

Braz Demuner – Aracruz Celulose S.A
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David Robinson – NIC Finebar®

8th Pira International Refining Conference
Barcelona – Spain – March 2005

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aft FINEBAR®

AGENDA

- ✓ Introduction
- ✓ New refining plate technology
- ✓ Experimental Design
- ✓ Pilot trial results: Impact of ultra low intensity refining
- ✓ Paper machine trials
- ✓ Final Remarks

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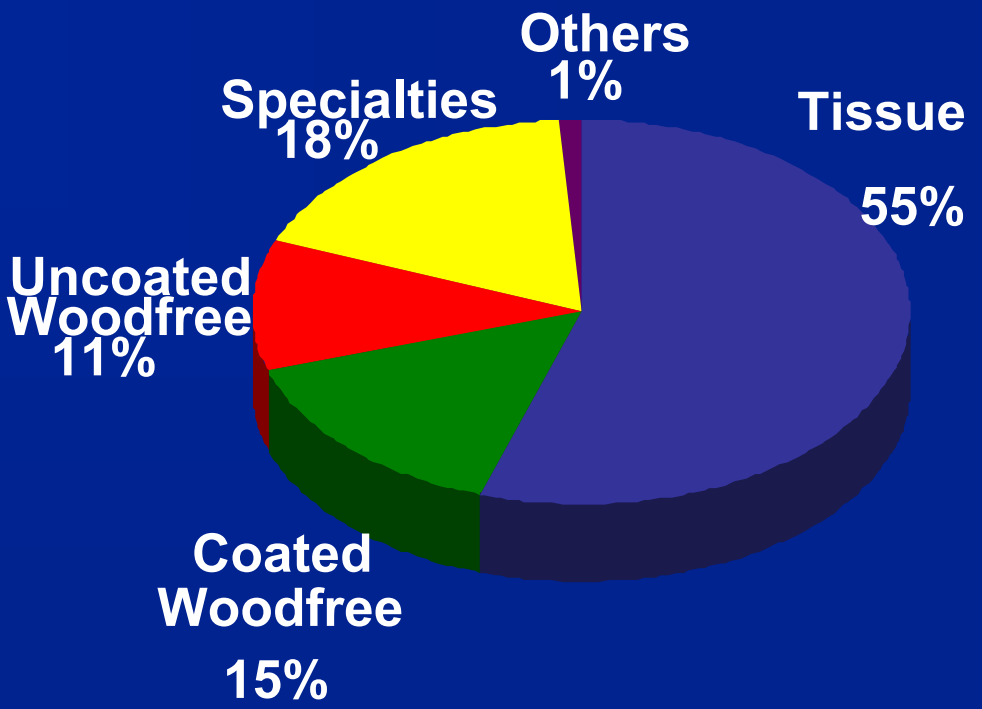
Aracruz is leading the Eucalyptus market pulp production

Where in Brazil

Aracruz Market by End Use - 2003



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EUCALYPTUS FIBER MORPHOLOGY

1. Short and thin fibers.
2. Large number of fibers per gram of pulp.
3. Stiff fibers (i.e. - difficult to bend and difficult to collapse)
4. Very uniform fibers, in length and width.

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And as a consequence of these unique morphological features...

When compared to the most available hardwood pulps, eucalyptus fibers usually display:

- ✓ faster drainage
- ✓ higher bulk/stiffness, porosity & opacity at given strength
- ✓ much better formation / smoothness (tissue)
  - ✓ excellent printability
- ✓ superior combination between strength/stiffness bulk/opacity,

when refined properly

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Refined properly... What does it mean?

According to Nissan (1977) the theoretical maximum intensity **limit** to modify the hardwood fiber (like eucalyptus) to its elastic limit, without rupturing is **5.4 kJ/kg . Impact**, which corresponds to **SEL=0.1 W.s/m** (Kerekes' model, 1990) !

Let´s present how short fibers have been treated…

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Current refining conditions: best industrial practice

	Eucalyptus: fiber length < 0.75mm
Bar width	>2 mm
Groove width	>3 mm
Refining System	Mixed pulp
SEL	>0.7 W.s/m

So, there is opportunity for improvement !

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What may happen if refining is not optimized?

- ✓ Expend more energy than needed
- ✓ Poor key paper properties development
- ✓ Fiber cutting
- ✓ Fines generation

Ultra low intensity refining, on the other hand, promotes mainly fiber straightening and fiber cell wall hydration.

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Industrial Ultra Low Intensity Refining

Process Requirements:

- ✓ Narrow bar-groove patterns (high CEL)
- ✓ Good capacity
- ✓ Good energy efficiency

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Industrial Ultra Low Intensity Refining

Past Limitations:

- Casting Technology
  - ✓Fine bar-groove geometry limited in depth (capacity)
- Fabricated Technology
  - ✓High cost of manufacturing
- Over-sized plate diameter or high refiner speed
  - ✓Very high circulating load – poor efficiency

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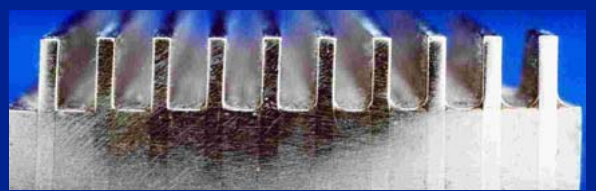
New Manufacturing Approach

- Novel Fabrication Process
  - ✓ Laser cutting of stainless steel plate
  - ✓ Diffusion bonding metal joining technology
- Benefits
  - ✓ Very narrow high strength bars
  - ✓ Superior groove geometry



AFT Finebar® Plate

Cast Plate

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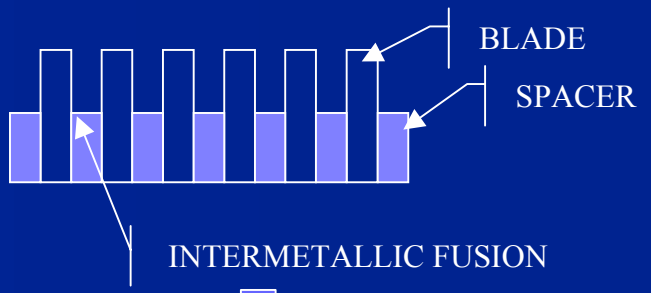
Finebar® Manufacturing Technology

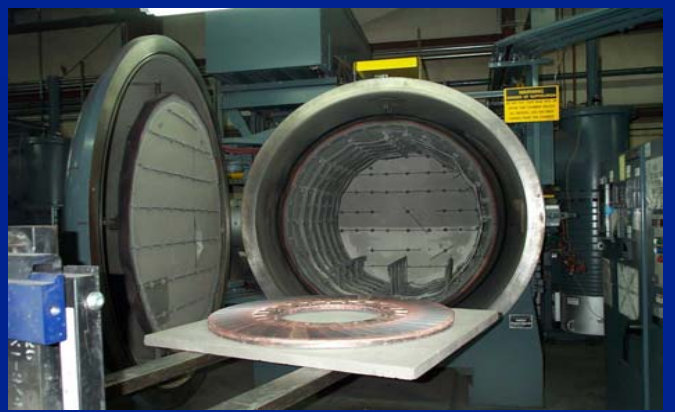
VIRTUAL TOOLING

CNC LASER

FABRICATION PROCESS



DIFFUSION BONDING



AFT FINEBAR® PLATES

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Ultra Low Intensity Plates for Eucalyptus Pulp What are the possibilities?

- Typical Cast/Fabricated Refiner Plates:
  - ✓ Bar width – 2.4 mm
  - ✓ Groove Width – 2.4 mm
- AFT FINEBAR® Plates:
  - ✓ Bar width –1.3 mm
  - ✓ Groove Width – 1.6 mm

Greater than 2.75 times increase in CEL !

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Pilot Refining: Single Disc 12”

- ✓**Aracruz ECF Pulp**
- ✓**Two disc patterns** (AFT Finebar ®):
  - 1.3x1.6mm – CEL 2.23 km/rev → For LOW intensity
  - 3.2x3.2mm – CEL 0.47 km/rev → For HIGH intensity
  - Single pass refining
  - Bar angle 15º

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Aracruz Pilot Refining Plant
12” single disc
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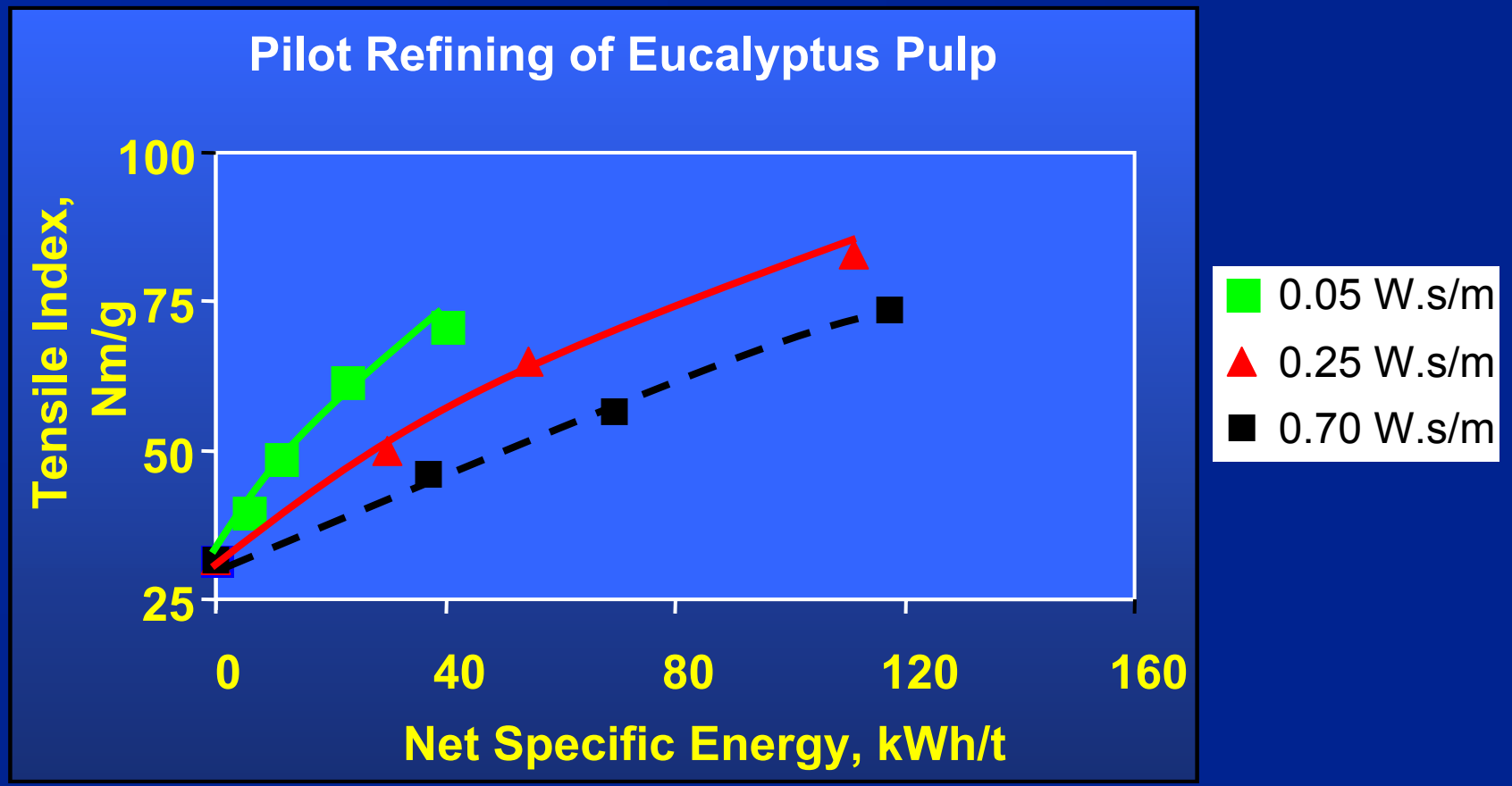
Pilot Plant ULTRA LOW intensity (SEL 0.05 W.s/m) was achieved, with very good tensile development



Ultra low intensity presents a potential of 60% energy savings to reach tensile 70 Nm/g when compared to normal low intensity (SEL 0.70 W.s/m)

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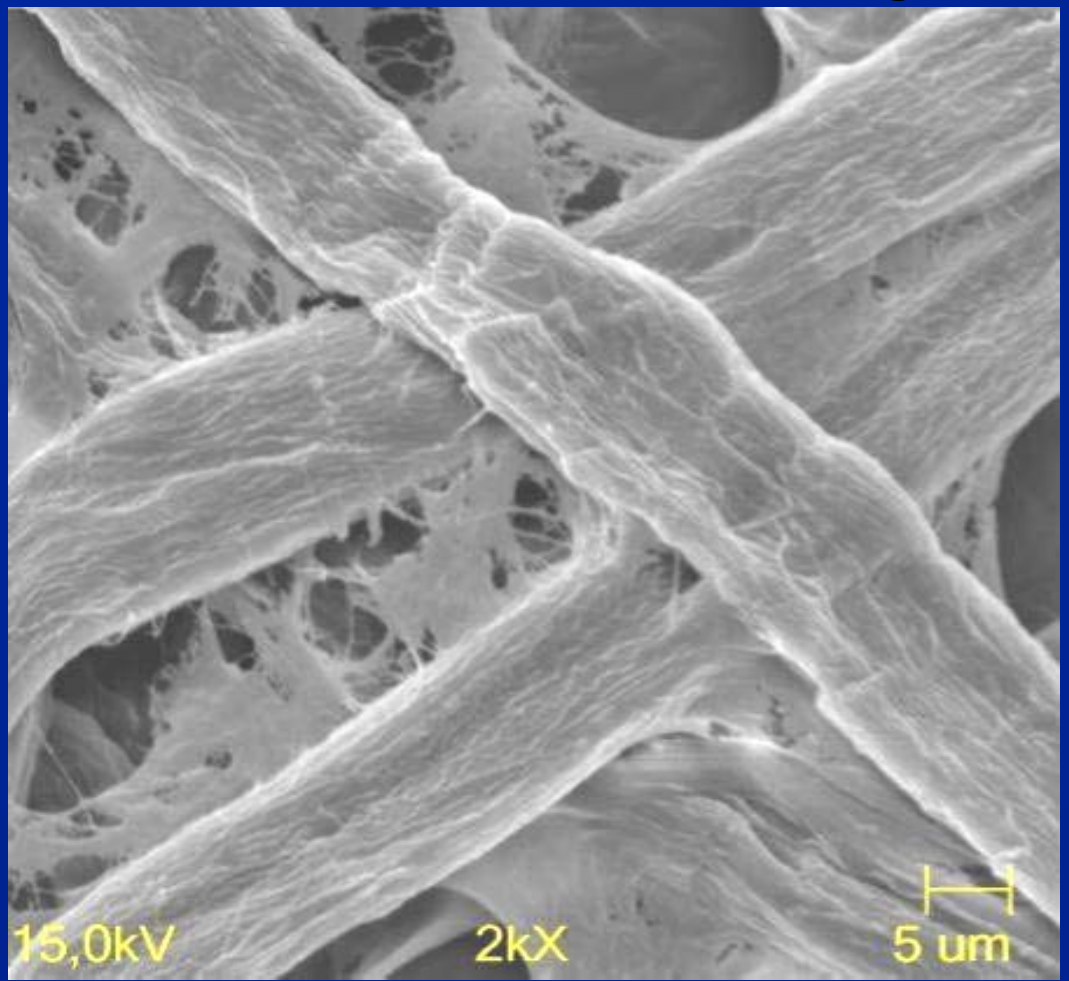
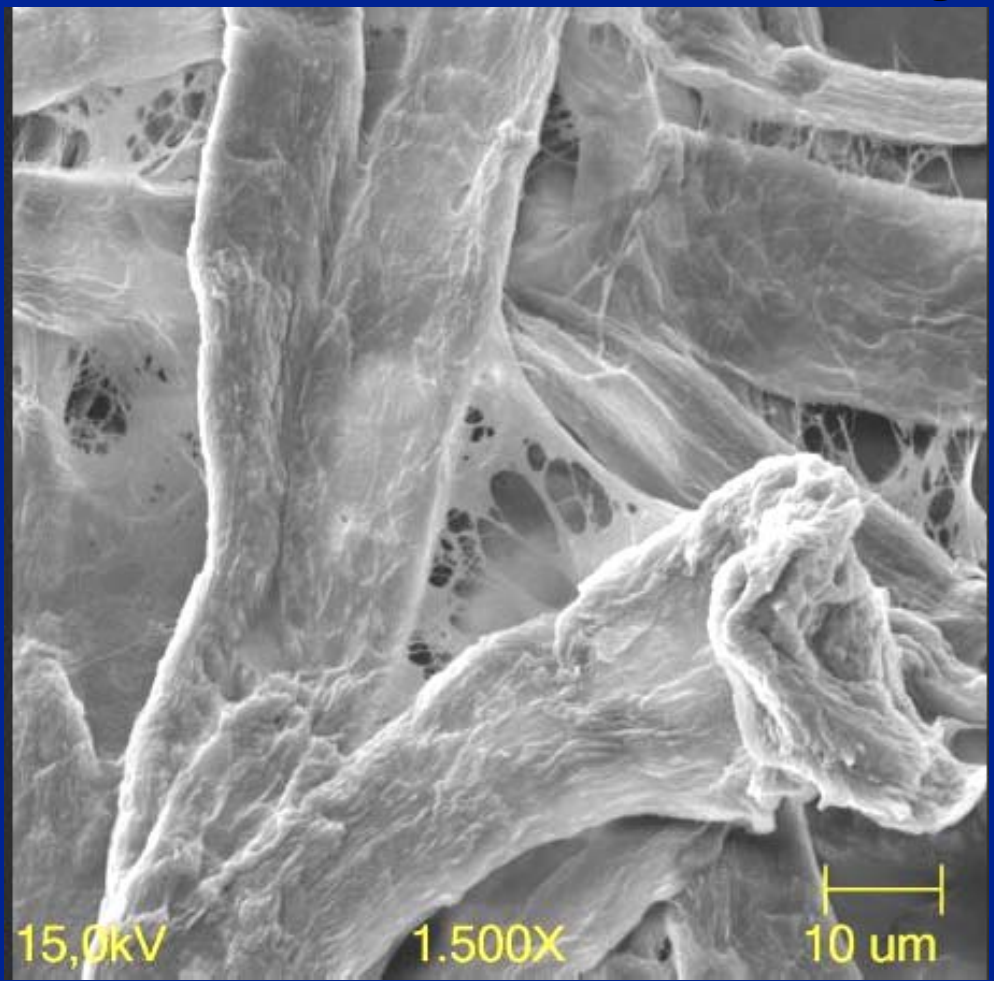
ULTRA LOW intensity



Fibers refined at 20 kWh/t, SEL 0.05 W.s/m

NORMAL LOW intensity



Fibers refined at 65 kWh/t, SEL 0.70 W.s/m

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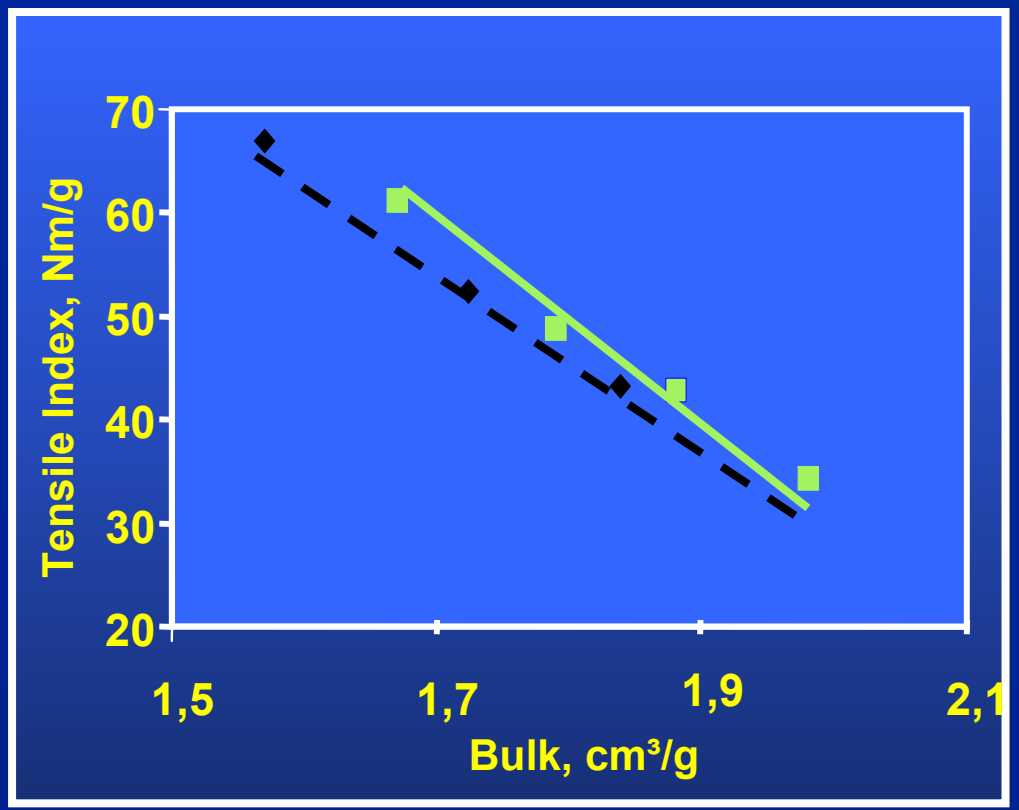
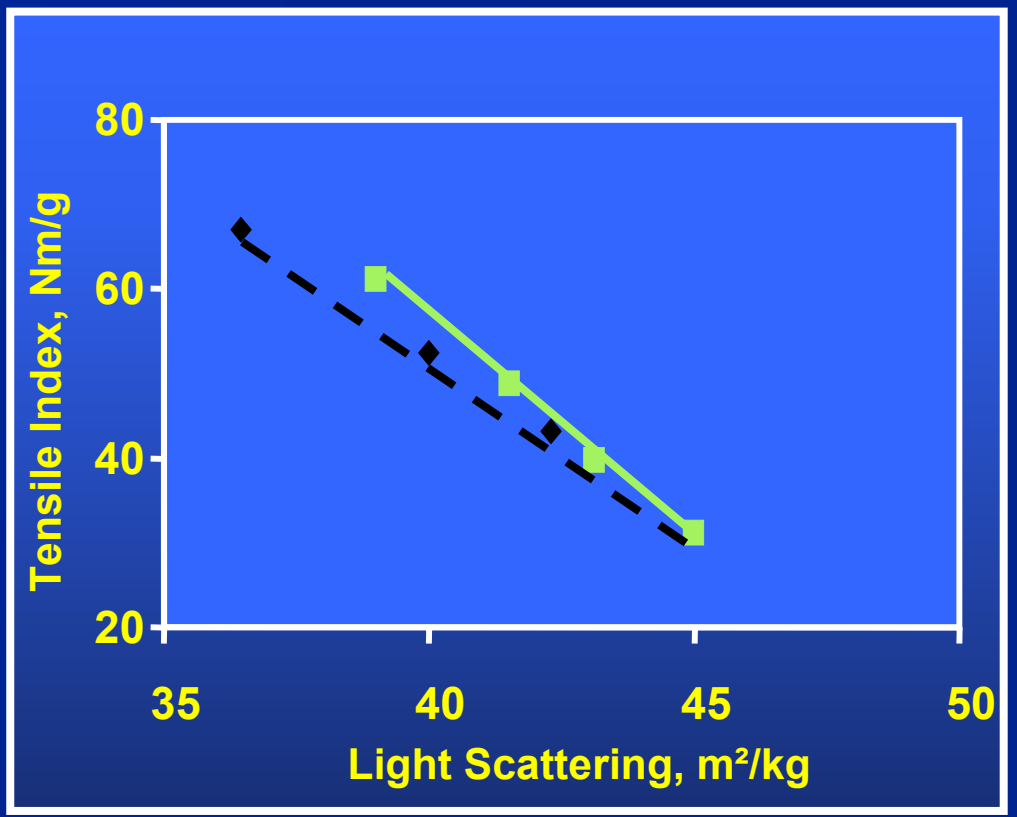
Pilot Refining of Eucalyptus Pulp





ULTRA LOW intensity refining displayed higher bulk and opacity at a given tensile level, which is desirable for P&W paper grades

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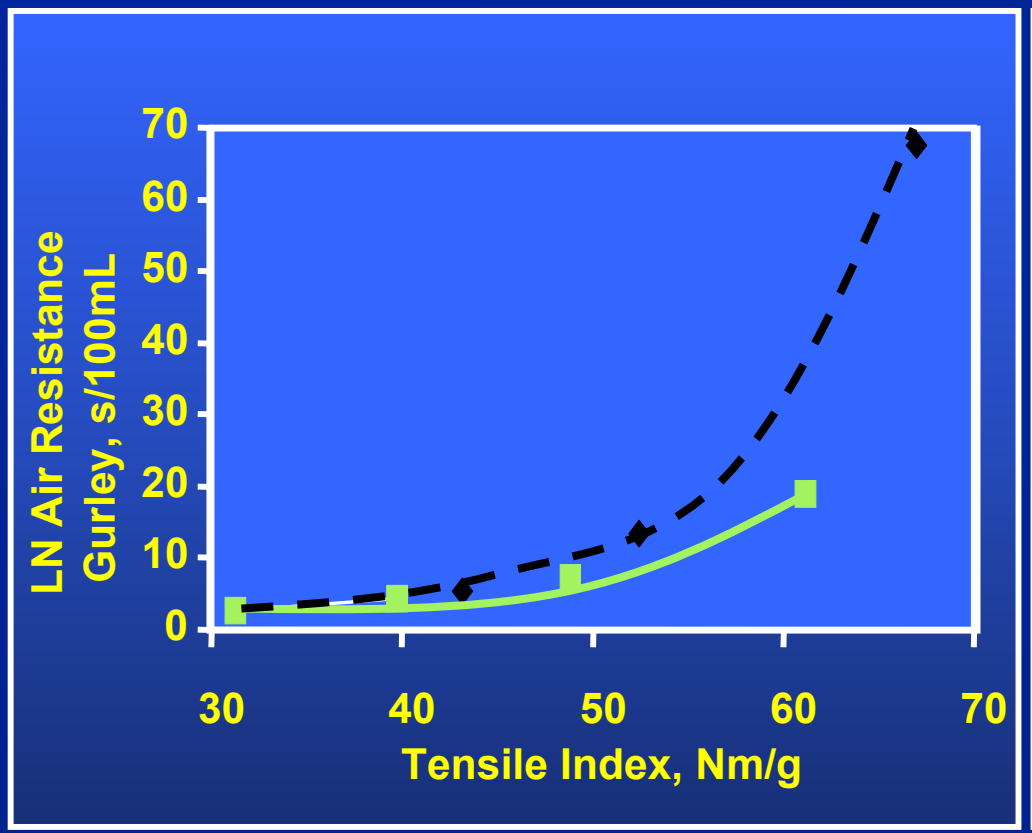
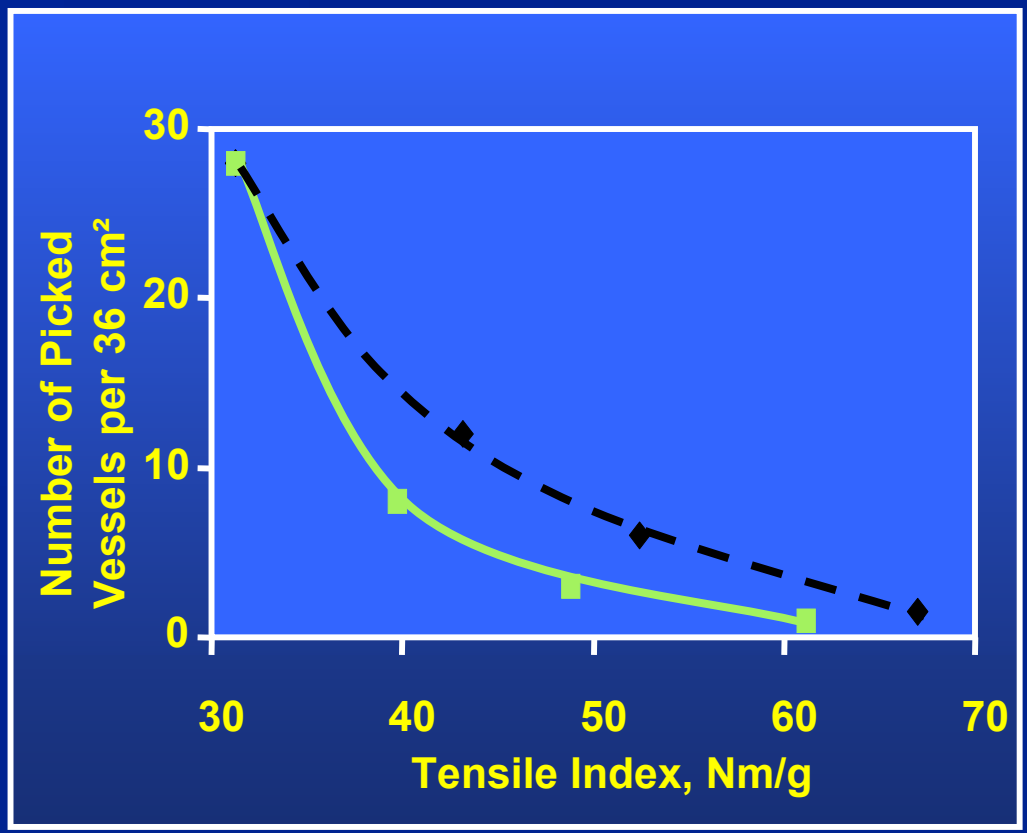
Pilot Refining of Eucalyptus Pulp





ULTRA LOW intensity refining displayed higher porosity and lower number of picked vessels (IGT), at a given tensile level

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Summary of Pilot Trials

- ✓Successful ultra low intensity refining (0.05 W.s/m)
- ✓ Large energy savings potential observed
- ✓ Improved properties combination obtained (tensile/bulk/opacity/porosity/vessel picking)

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The achievement of ultra low intensity (0.05 W.s/m) in pilot plant, with high energy savings and key paper properties improvement, encouraged Aracruz to proceed with the trials in order to get optimum intensity levels in a mill application

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Experimental Design

- ✓ **Mill Trial: Double Disc 30”**
- ✓ **Aracruz ECF Pulp**
- ✓ **Disc patterns:**
  - AFT Finebar® 1.3x2.0x4.8 mm average bar angle 15º – CEL 62 km/rev ➡ For LOW intensity
  - Cast 2.4x2.4x6.4 mm was replaced - CEL 33 km/rev
  - Single pass refining
  - Paper grade: PW 56 g/m² (100% eucalyptus)

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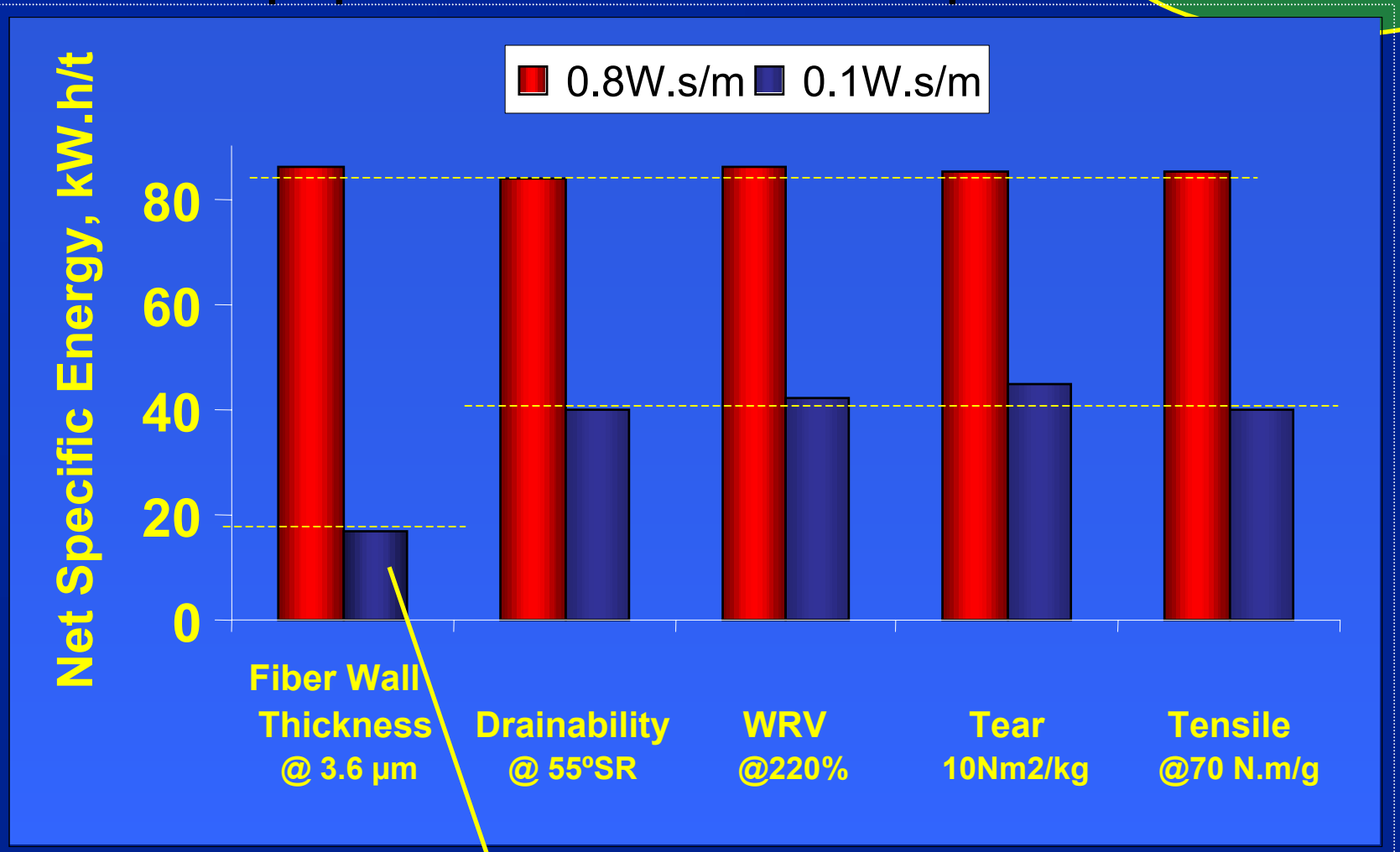
Paper Machine - 30” Refiner

single-pass-energy curves interpolation

to evaluate pulp with maximum fiber development

>50% net energy reduction at the trial run



Four times more efficient to hydrate the fiber wall

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What can explain the energy savings?

From the conventional wisdom:

- ✓ The probability of fibers treatment in a single-pass refiner is poor
- ✓ 99% of the energy is wasted, mainly as elastic shocks

The present data suggest that:

- ✓ Improved hydraulic flows have promoted better fiber treatment
- ✓ Repeated near-elastic shocks may contribute for fiber straightening
- ✓ Increase in efficiency as a result of the increased edge crossings

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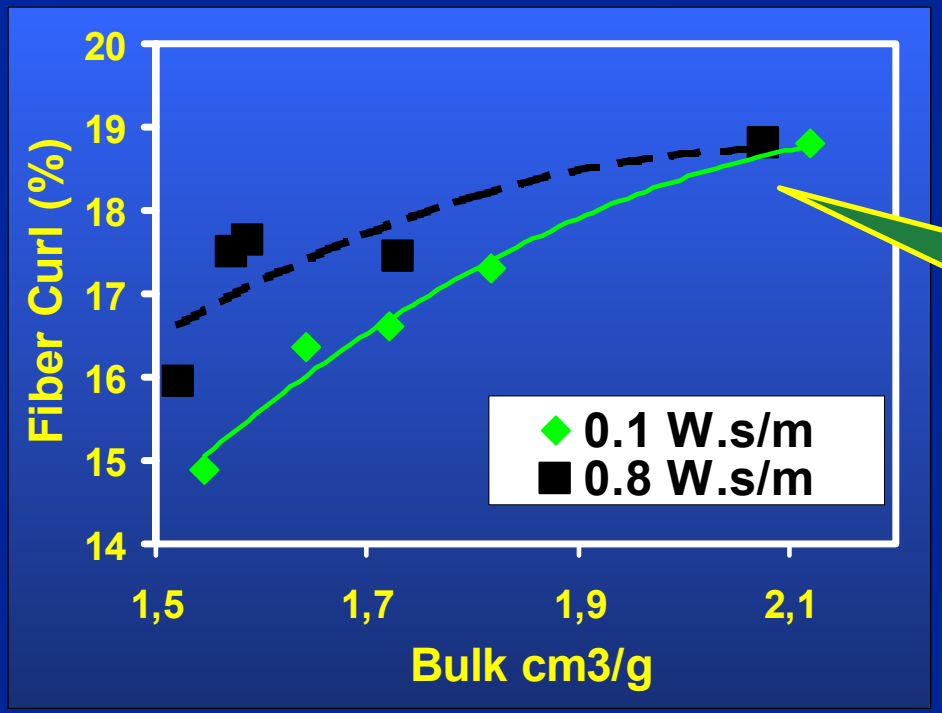
Paper Machine 30” Refiner

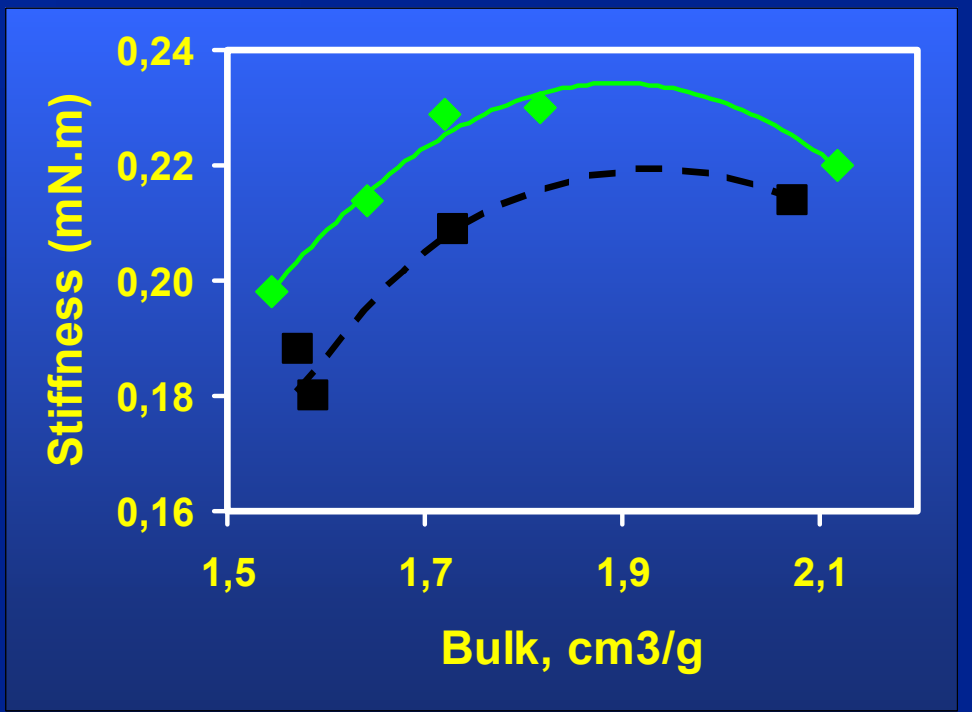
single-pass-energy curves

Significant findings



Efficient
(fiber collapse+ curl reduction)
change some properties

Improved Stiffness



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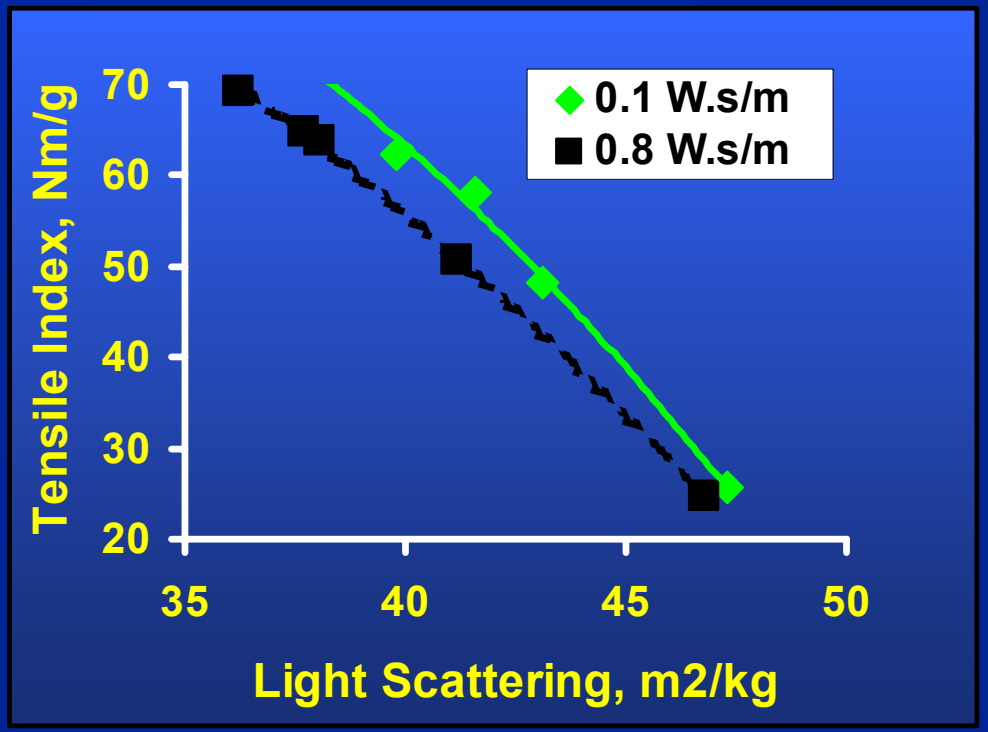
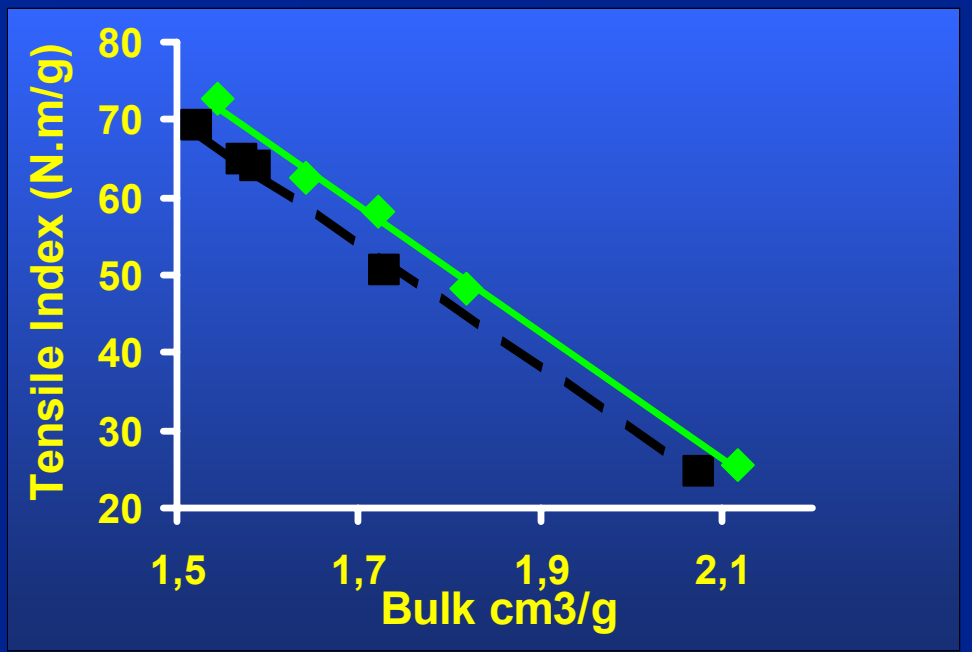


Paper Machine 30" Refiner

single-pass-energy curves

Significant findings

Improved Bulk and Opacity



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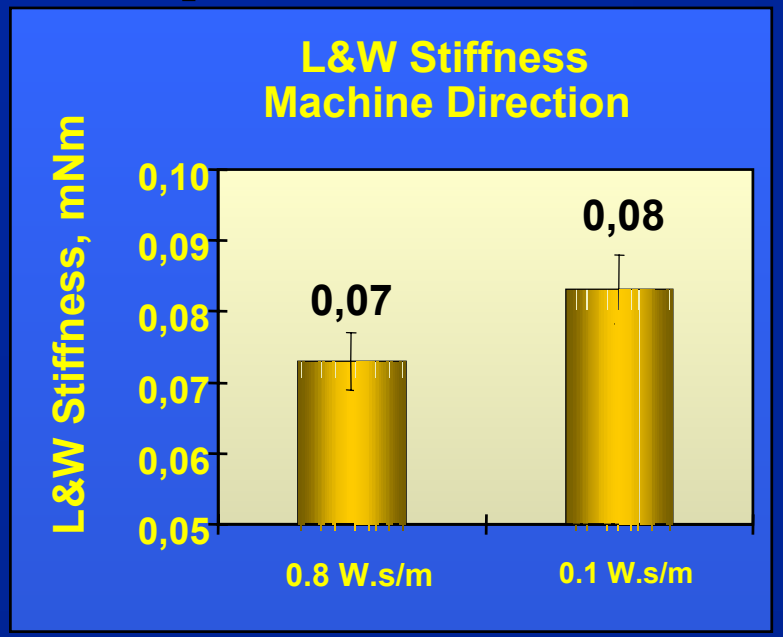
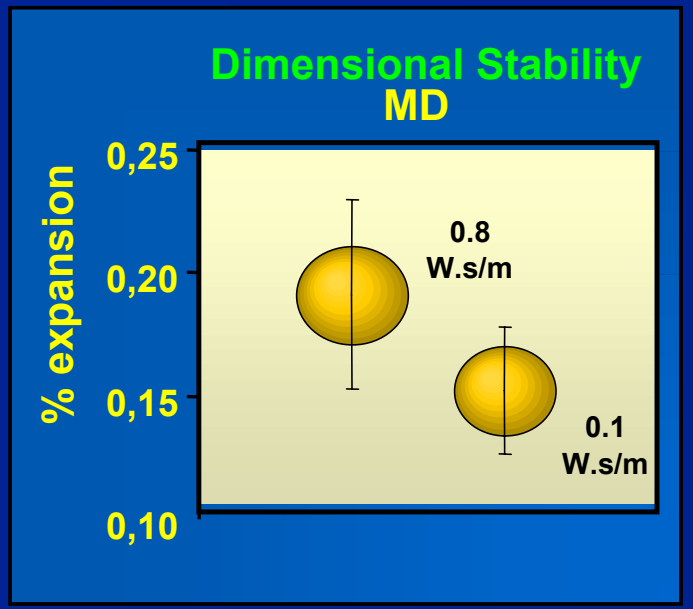
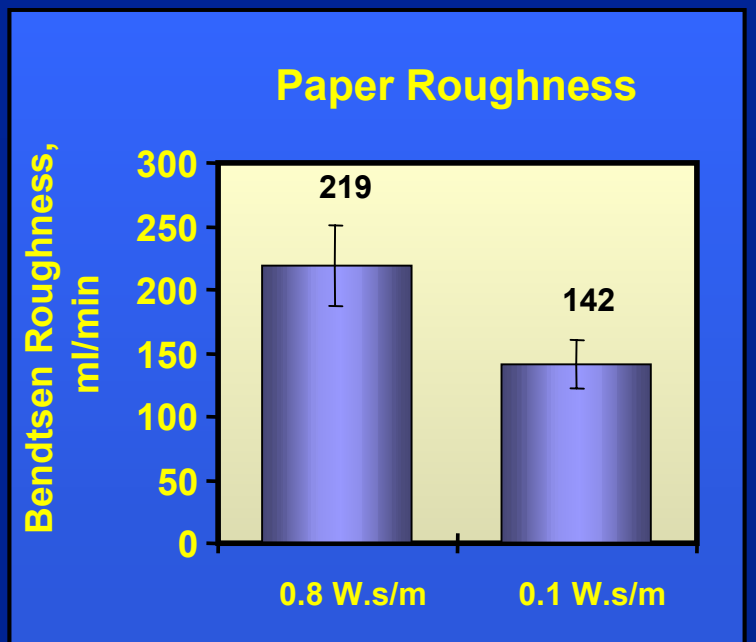
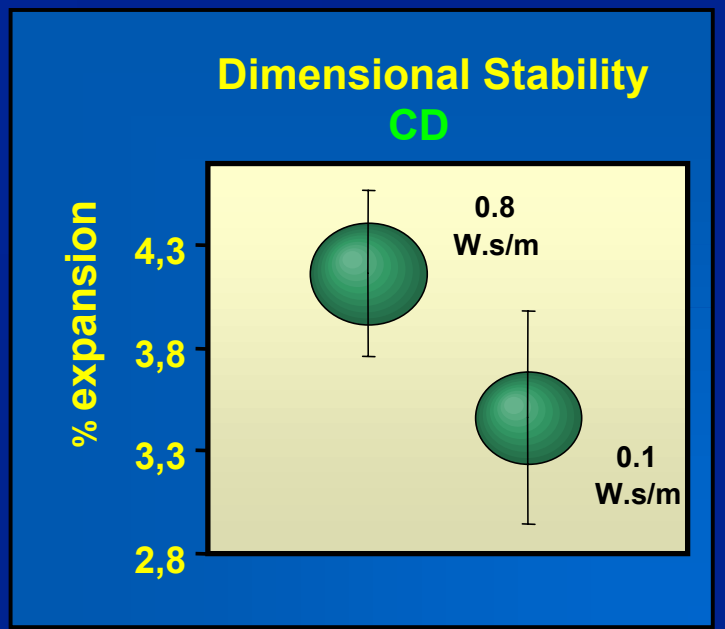
Paper benefits









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Possible explanation for the benefits observed with the application of ultra low intensity refining

- ✓ More homogeneous treatment
  - ✓ Larger number of fibers being treated with low intensity impacts
- ✓ Higher efficiency for fiber straightening
  - ✓ Faster reduction of fiber curl
- ✓ Faster fiber cell wall hydration
  - ✓ with minimum fines formation – emphasis on major refining effect

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Final Remarks

Ultra Low Intensity Refining of 0.1 W.s/m, which is today's maximum intensity limit to modify one hardwood fiber, has been successfully achieved in a mill application, for P&W paper grade with 100% eucalyptus

We expect to evaluate lower than 0.1 W.s/m in a paper machine trial

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Acknowledgments

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- ✓ Dr. Ergilio Claudio-da-Silva Jr. is also gratefully acknowledged indeed for motivating us to carry on these trials and also for his most valuable suggestions and comments.

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Thank You !

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