
MANOJ SUKUMARAN

# FIBER ANALYSIS AND FREENESS ONLINE MEASUREMENTS HELP RECYCLED PAPER MILL ACHIEVE UNIFORM PRODUCT QUALITY AND ELIMINATE OVERREFINING

IPPTA REGIONAL SEMINAR – COIMBATORE 26-27 JULY, 2024

# Variations from raw material at OCC based paper mill

## FPC-Forestal y Papelera Concepción-Chile

**Objective:**

Produce uniform and high quality Testliner and Fluting grades meeting strength specifications

**Challenge:**

Large variations in properties of incoming fibers as the mill mainly use OCC (Old Corrugated Container) collected from 27 cities along the country and DLK (Double-Lined Kraft) from corrugating plants.

# Focus on Fiber

## Role of refining in product strength

**Ambition**

Quickly adapt the process to the changes or variations of the incoming fibers

Increase runnability and stabilize final product quality

Adapt the fiber refining process, to maximize the performance of the fiber in the papermaking process.

Refine just as much as each fiber needs, to both stabilize product quality and reduce costs

**Focus on refining**

**Strength of paper is built into the fibers by mechanical treatment**. Refining increases the strength of fiber-to-fiber bonds by increasing the surface area of the fibers and making the fibers more pliable to conform around each other.

**Runnability and productivity are directly related to refining** - gentle and fiber-saving refining develop the bonding ability of fibers with a minimum increase of drainage resistance and a minimum decrease of fiber length.

**Some refining is necessary** even if other fiber treatment stages can regenerate swelling and bonding ability to some extent.

**Refining is needed to redevelop the fibers**

# Focus on Fiber

## Optimum refining is the key

**Too much refining:**

- High energy usage – Refiner, Vacuum pump, steam
- Slower pm speed, Lower production (low drainage)
- Fiber cutting and fines

**Too little refining:**

- Web breaks
- Low strength
- Higher consumption strength chemicals

- Not damaging the fiber
- Making fewer unwanted cuts in the fiber
- Generating good fibrillation
- Obtaining more resistant interfibrillar connections
- Increasing paper strength
- Saving energy
- Improving the paper machine productivity

**Optimum refining of recycled fiber can increase bulk, better retention, increase sheet strength, lower energy usage and improve paper machine speed**

# Refining Strategy

Two parts - Freeness and Fiber

## Freeness

- Freeness is a result of refining energy and therefore a useful parameter to maintain
- Freeness correlates well with some of the strength and surface properties of the paper produced
- Drainage and consequently runnability is related to Freeness

## Fiber

- Understanding the condition of fibers in the raw material
- Optimize long / short fiber mix composition for each grade
- Find the optimum refining energy to improve critical strength properties for each grade
- Minimize usage of strength additives that result in cost escalation
- Pre-plan production batches to reduce bad quality and production interruption

# Freeness based strategy

# Refiner Optimization – 0 stage

## Refiner with power control

Basic operation method for refiner

Lab measurements taken once or twice a shift used to set refiner load

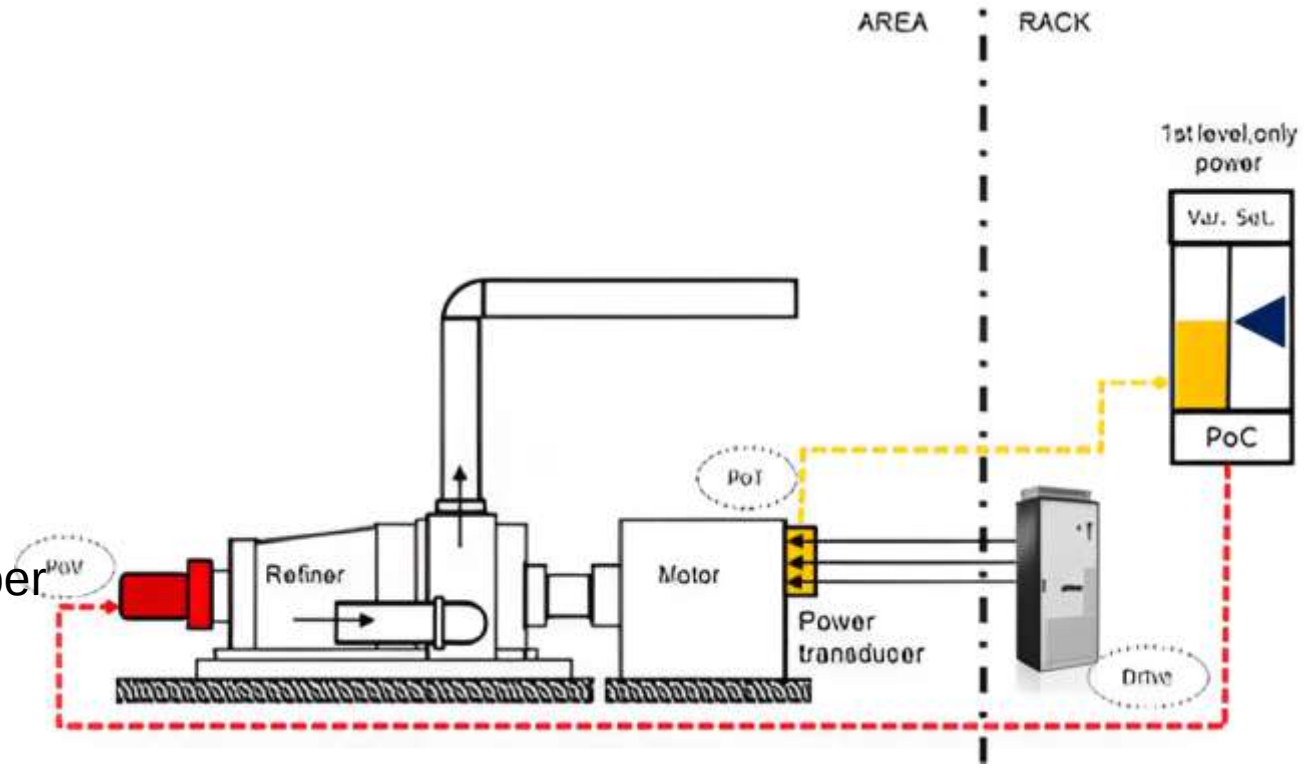
Set refining load in kWh is maintained by gap adjustment

**Cons:**

Condition of fibre treatment (defibrillation) not known

Condition of refining tackles/blades not known

Process variations – from consistency, flow, fiber quality etc.  Not known or compensated



# Refiner Optimization - 1 stage

## Refiner with specific energy control

Specific energy is calculated based on fiber mass flow (Flow x Consistency).

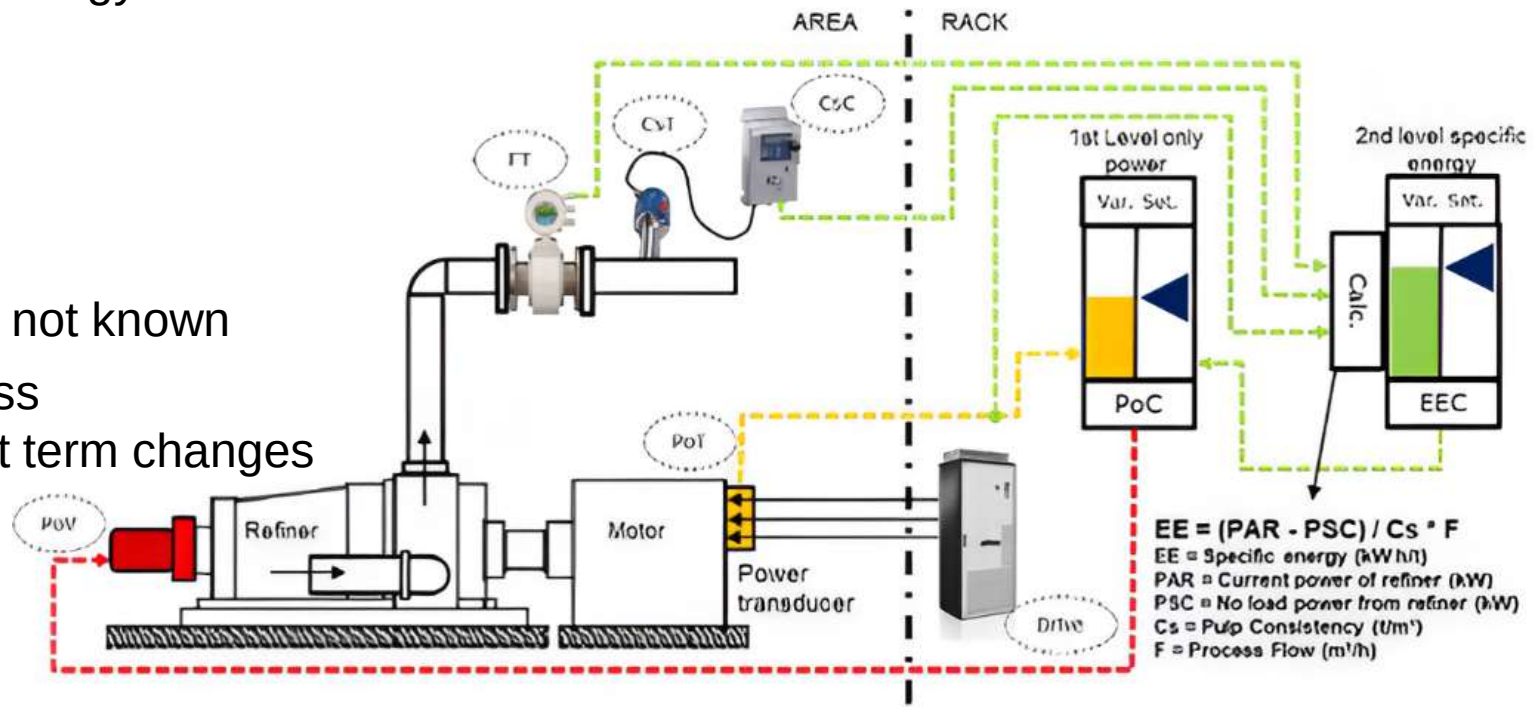
Lab drainage (freeness) measurements taken once/twice a shift and Specific energy is manually set

**Cons:**

Extent of fibrillation unknown

Fines generation /fiber damage not known

Long delay between lab freeness measurements do not see short term changes in the process

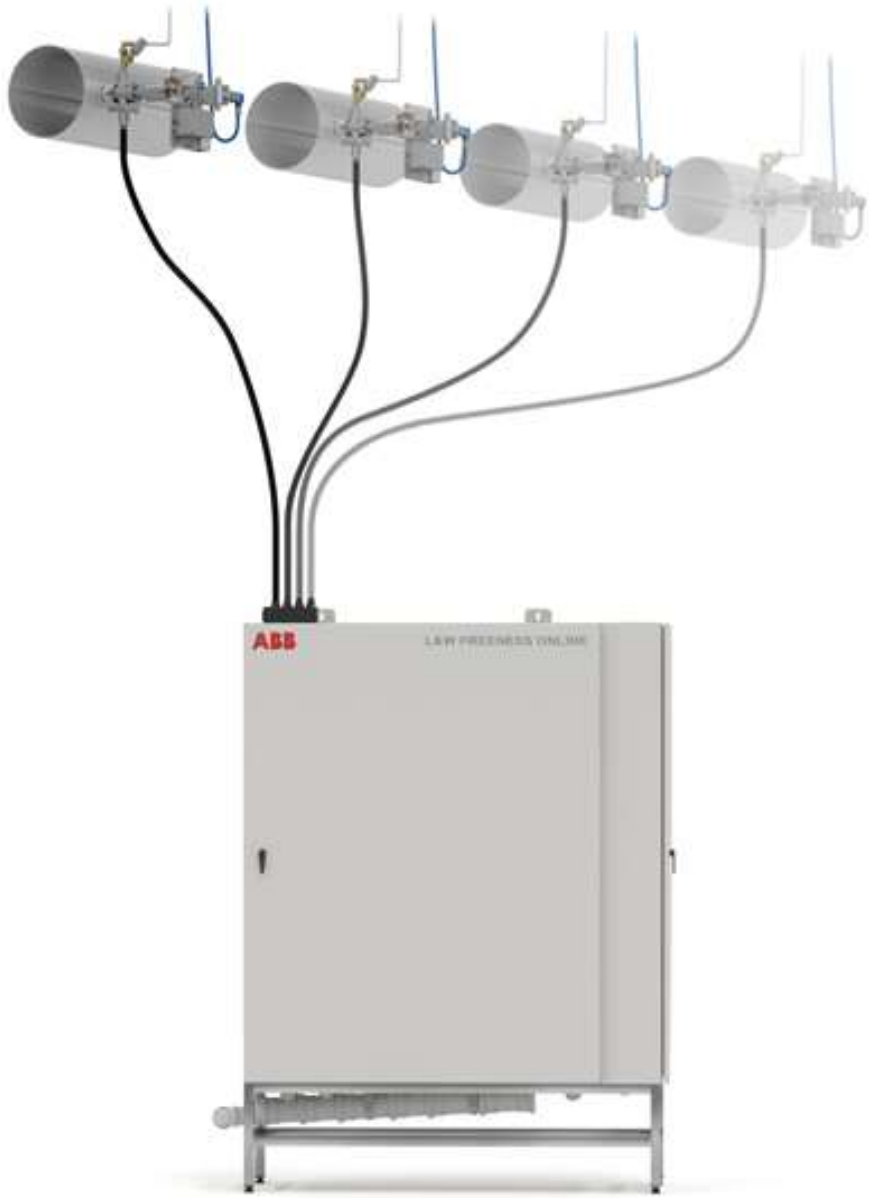


# Online freeness measurement

It was understood that there was indeed frequent fiber variations and need for an on-line freeness measurement system was justified.

ABB/Lorentzen & Wettre Freeness On Line (FOL) system equipped with two samplers was installed.

This would measure freeness at the output of the two refining circuits in the stock preparation area

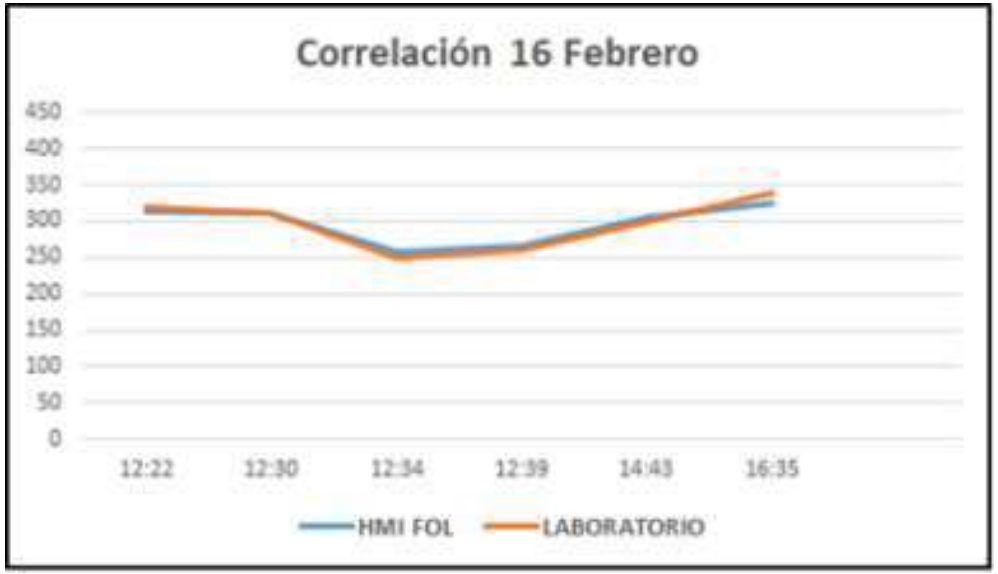


# Online freeness measurement

## Verification

After installation, the first step was to validate the FOL. Therefore, for 2 months validation process was performed by routinely comparing and correlation of FOL with lab readings.

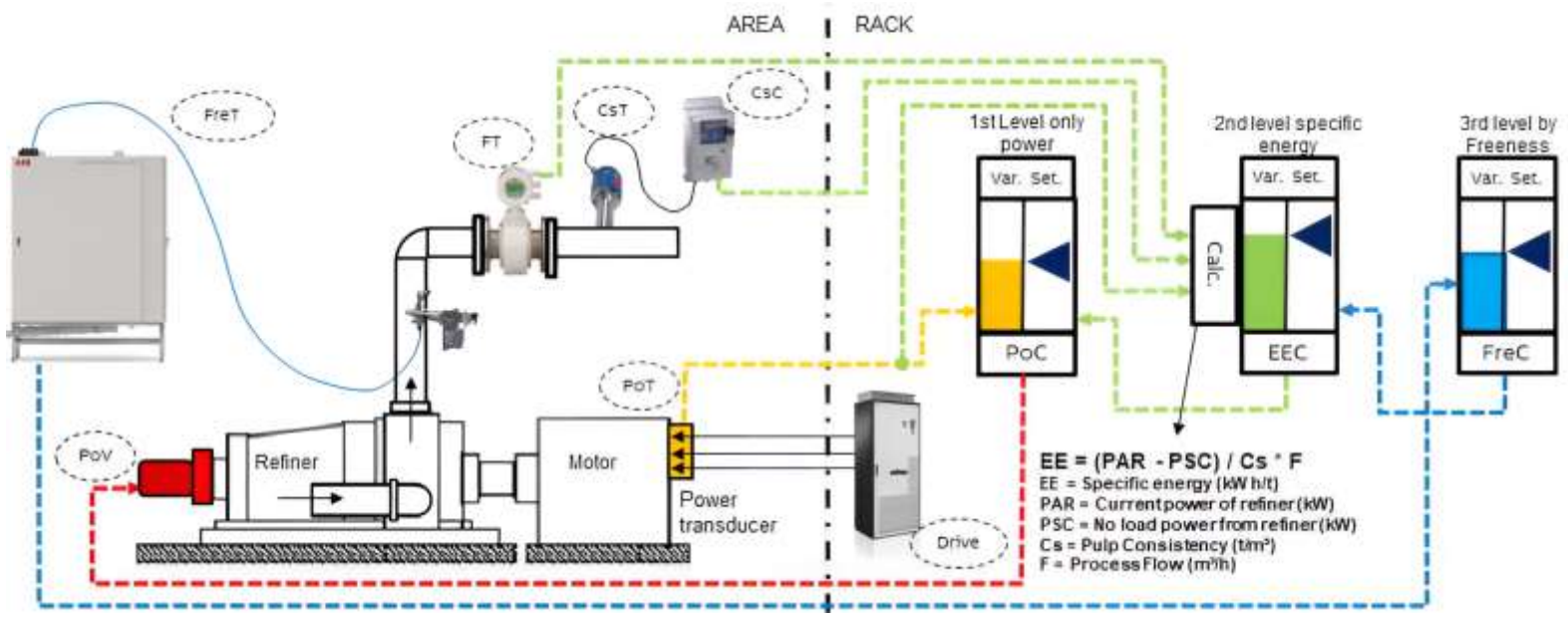
Once confidence in the Online freeness measurement was established, it was time to use the desired freeness as set point to recalculate specific energy.



# Refiner Optimization – 2 stage

## Refiner with freeness cascade control to set specific energy

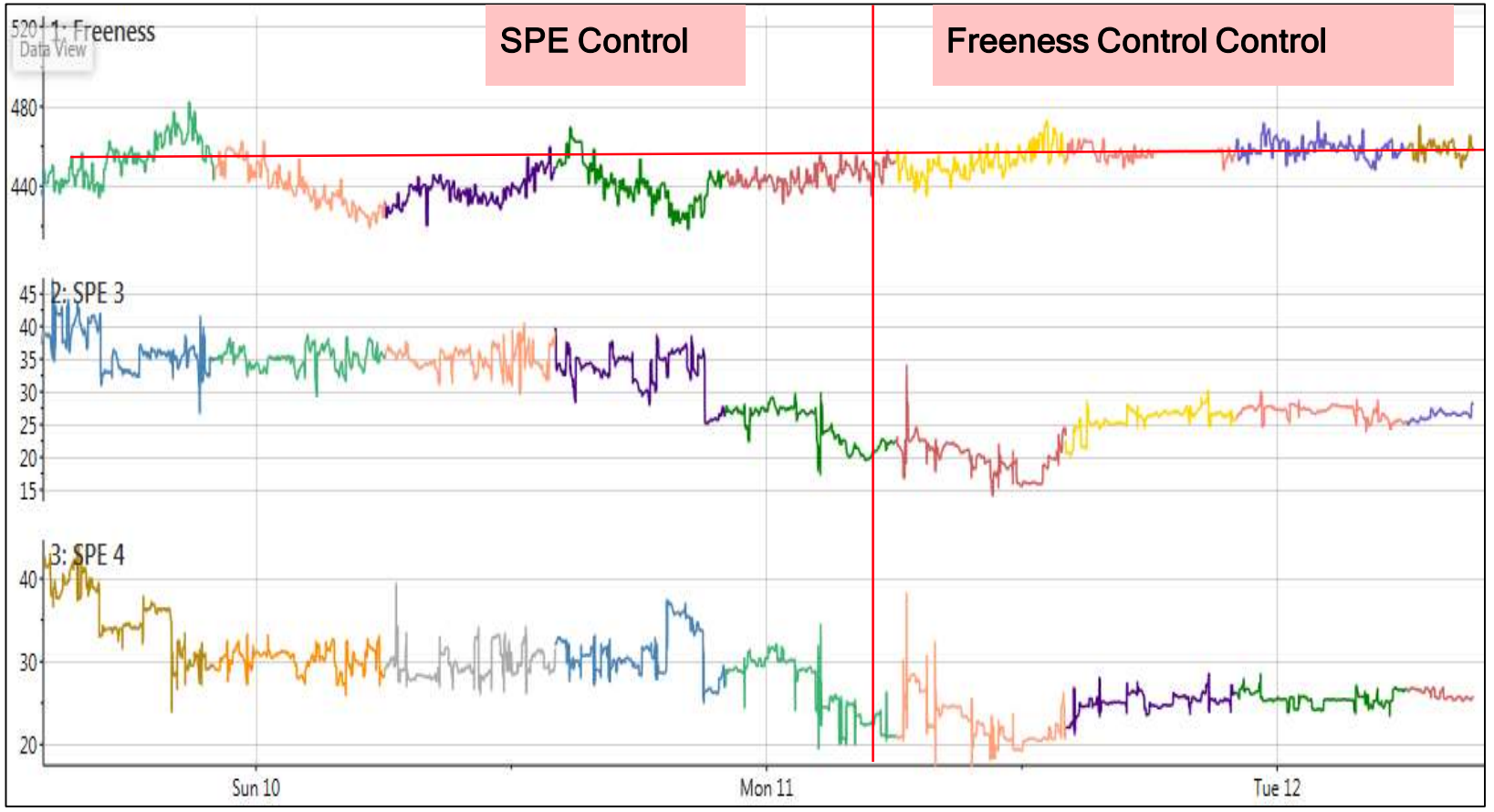
A Freeness control module that compares the target freeness with process freeness being used to calculate correction to Specific Energy set point which will in turn control power of the refiner




**Before Online Freeness measurement was installed, it would take the mill up to six hours to achieve uniform paper production during grade change to meet the required specs. Now it takes less than an hour**

# Implemented Freeness control Mode in stage 2

## Freeness variation has reduced by 70% and Energy reduced by 20%




- Implemented Refiner Freeness Control mode in stage 2
- Significant energy reduction from 80 Kwh/T to approx. 65 Kwh/T after implementing Freeness Control
- Then the Freeness variation reduced up to 70% (Peak to Peak 15 csf)

# Refining control by freeness

## Energy Improvement example – Typical ROI (From other sources)*

| | | |
|---|---|---|
| Example of energy savings by moving from Specific energy mode to closed loop control | | |
| | | |
| Refiner energy | 80 | kWh/t running refiner control on constant SE |
| Refiner energy | 65 | kWh/Ton after refiner control with Freeness in closed loop |
| Energy savings | 15 | kWh/Ton |
| Production PM | 100,000 | ton/year |
| Energy cost | 7.66 | US cent per kWh |
| Savings | 114,900 | USD / year |
| Investment | 150,000 | USD |
| ROI | 15.7 | months |

* Does not belong to this case study

# Freeness Control Benefits

## Production and Energy Improvement

**Reduced Freeness Variation –.** Freeness variation reduction (50CSF to 15 CSF) helped to improve paper quality and specific energy set point target shifts as well.

**Less wet-end breaks –** One goal of the Specific Energy control strategy was to stabilize the dry-line position in forming section in order for uniform dewatering and reduce the number of wet-end breaks.

**More stable MD caliper and surface properties –** Freeness control has also stabilized MD caliper, smoothness and air permeance.

**Reduced energy usage –** The refiner controlled with specific energy set point automatically to obtain the target freeness resulting the reduced overall power load.

# Summary of controlling freeness online

## Situation

- Mill works with a wide variation in the properties of incoming fibers, which they acquire from 27 cities and five grades
- Long delay between lab freeness measurements
- Wanted to produce uniform quality

## Solution

- Mill defined a fiber-to-fiber refining strategy (achieving uniformity in a cost-effective way without compromising quality)
- Purchased ABB - L&W Freeness Online system with two samplers to reduce time for lab feedback
- Optimized refining load control based on freeness

## Benefit

- ✓ Increased production and lesser web breaks
- ✓ Reduced grade change time
- ✓ Lower energy consumption
- ✓ Reduced freeness variation
- ✓ Faster and accurate measurements

**FPC Papeles Chile broke production milestone of 100,000 TPA after this project**

# Fiber based strategy

# Fiber Morphology to improve process quality

## Strategies planned

- **Understand incoming raw material –** All the grades of incoming raw material need to be understood in terms of fiber value so that a useful mix can be selected.
- **Understand action of refining on fiber–** Understand the action of refining on fibers and how different load affect the fibers.
- **Determine life of refiner discs –** What benefit can be derived  understanding the effectiveness of the refiner discs at various stages of its life cycle
- **Maximize product strength by optimizing the refiner load –** Find out the optimum points in terms of energy spent and  product strength

**L&W Fiber Tester Plus will be used for making morphology studies**

# Understanding the raw material

## Classification of incoming fibres

Four raw material sources:

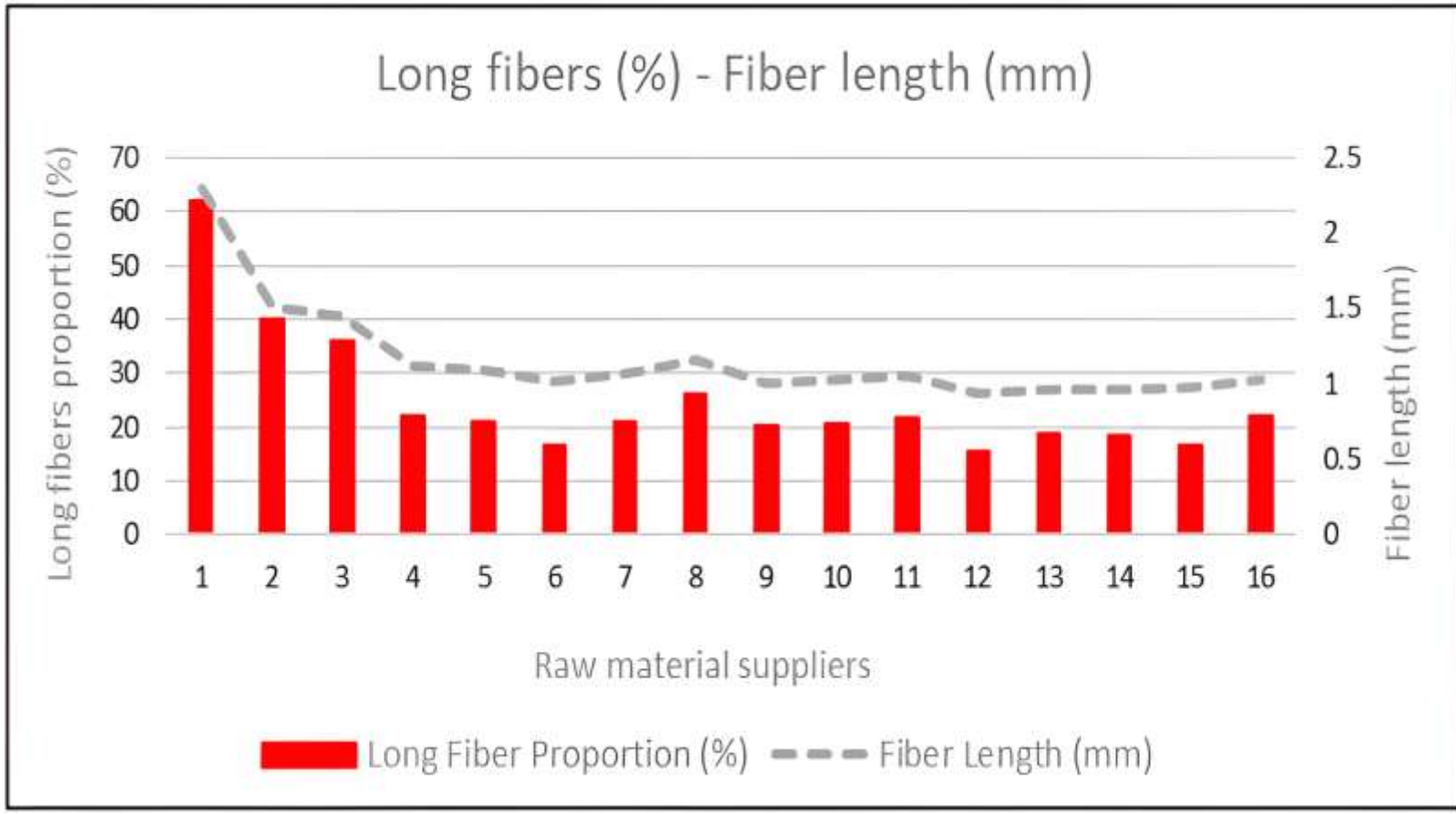
a) Domestic double-lined kraft corrugated cuttings (DLK),

b) Imported DLK,

c) Old Corrugated Carton (OCC), and

d) Kraft Liner Board (KLB).

Raw material from various suppliers for these grades are evaluated using the L&W Fiber tester™ and classified according to fiber length and % of long fibers



# Understanding the raw material

## Segregation at source - Raw material yard and loading

With the ability to accurately classify the fibers, the raw material yard was segregated with the aim of using the best quality raw materials.

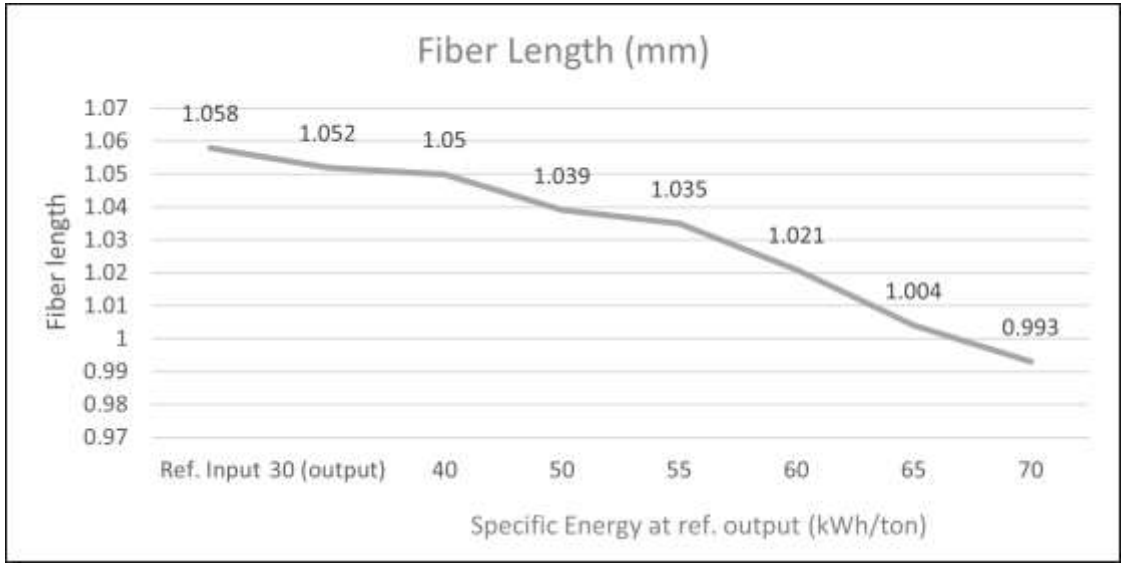
Loading of the pulper is scheduled in accordance with corresponding manufacturing recipe based on fiber properties

# Understanding refining action on fibres

## Effect of refining

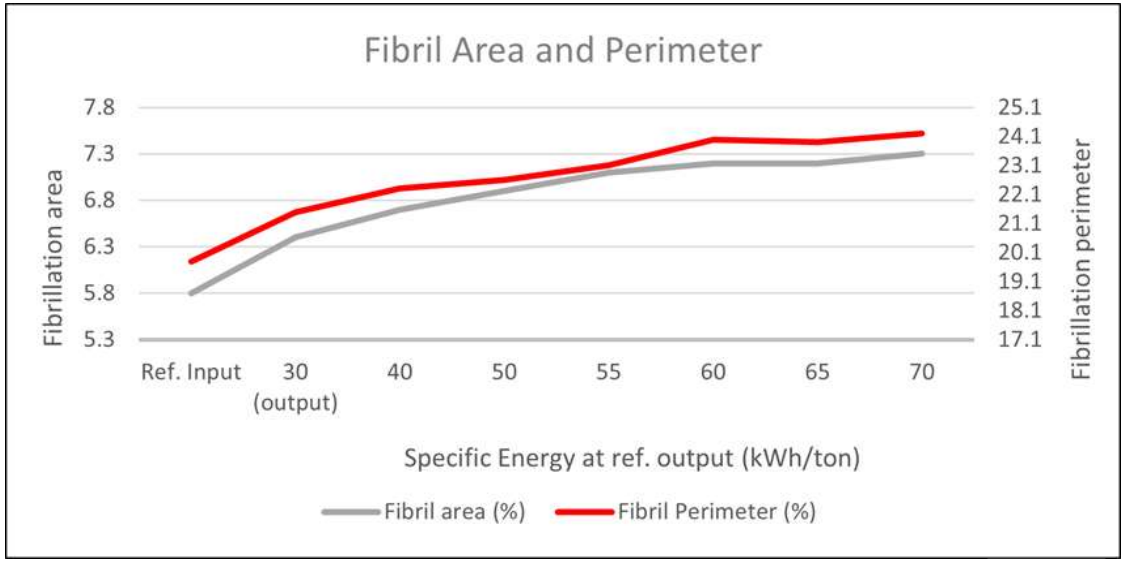
### Effect on Fiber length:

Fiber Length decreases when applying greater refining intensity. This means the higher the specific energy, the greater the fiber cut.




### Effect on Fibrillation:

Perimeter and area of fibrils (%): these two variables increase when applying more refining energy. This means, the higher the specific energy, the greater the fibrillation.



# Determine life of refiner discs

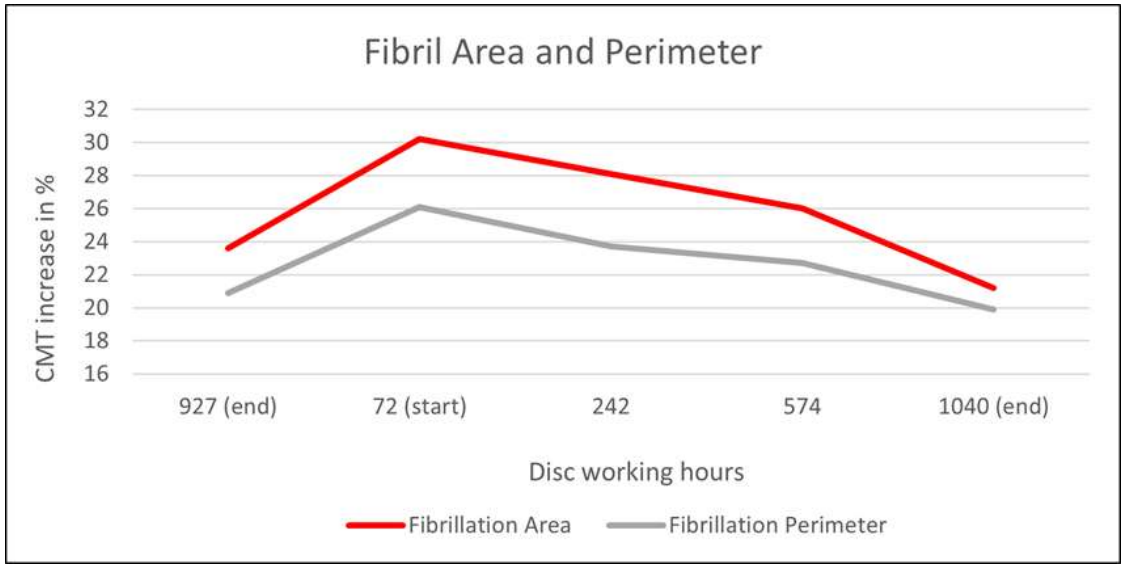
## Best active life

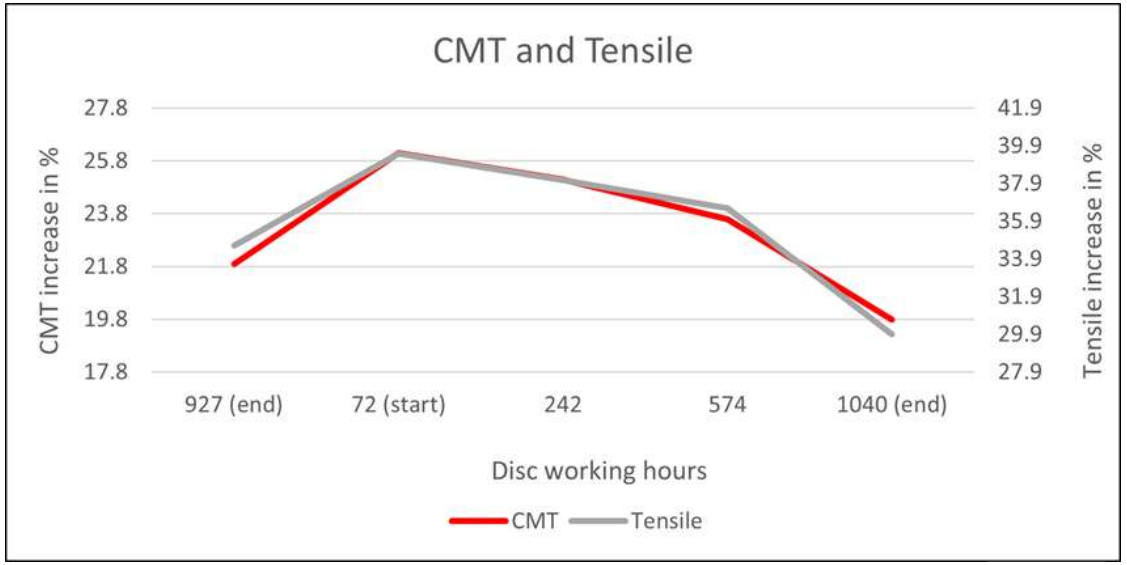
### Disc life on  fibrillation:

Fibrillation area and perimeter were monitored on how it develops according to the refining segment life cycle to find an optimum timing for replacing it.

### Disc life on product properties:

The same was done monitoring critical properties such as CMT and Tensile for the finished paper.



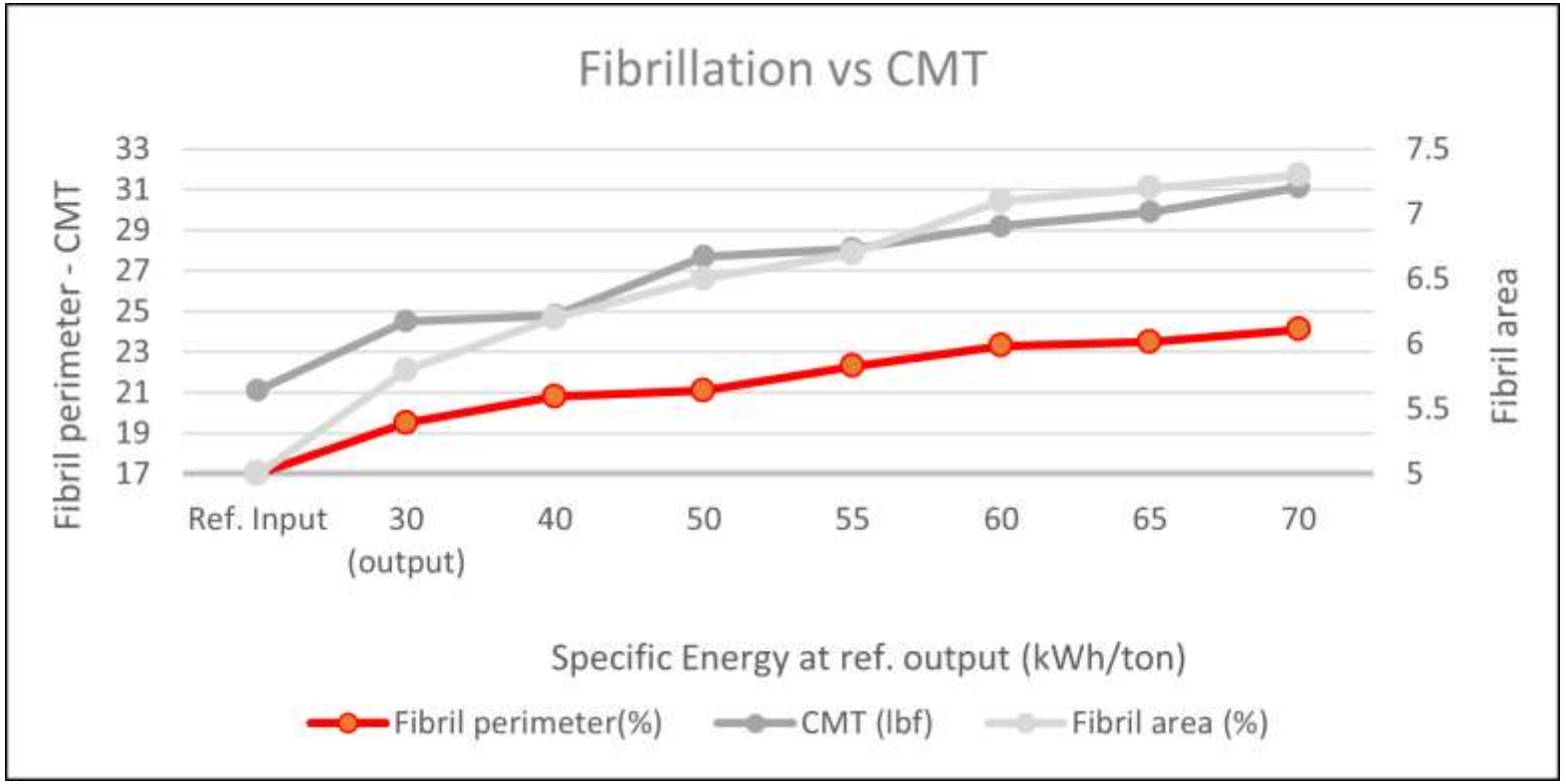



# Optimum refining load

## With new discs

**Specific energy on  fibrillation:**

The higher the specific refining energy (with segments at the beginning of their lifecycle) the greater the fibrillation and the CMT increases, this means they are directly proportional variables



# Optimum refining load

## At mid-life of discs

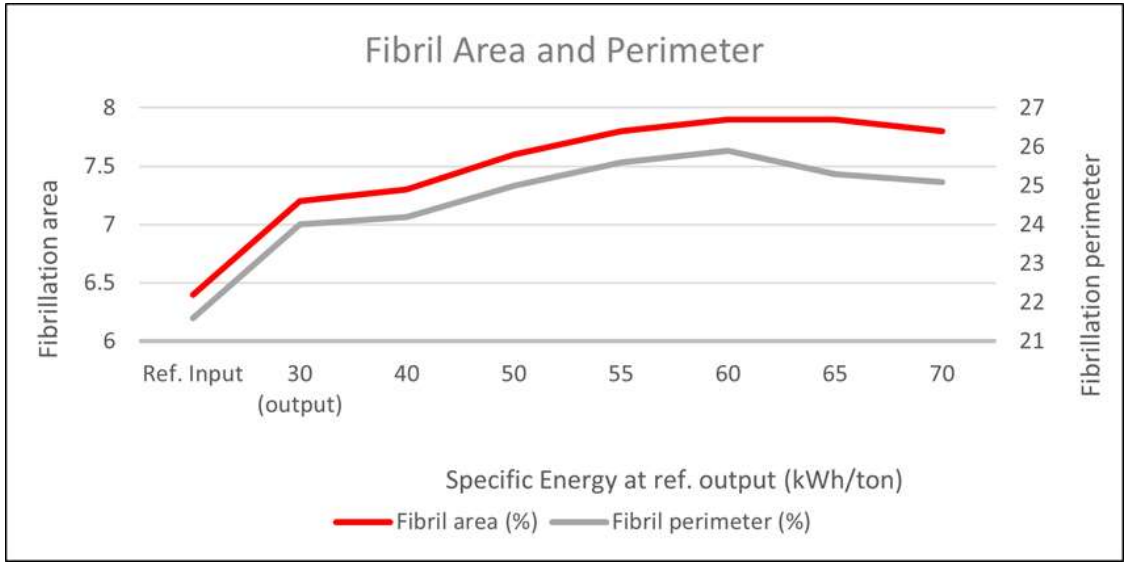
**Specific energy on  fibrillation:**

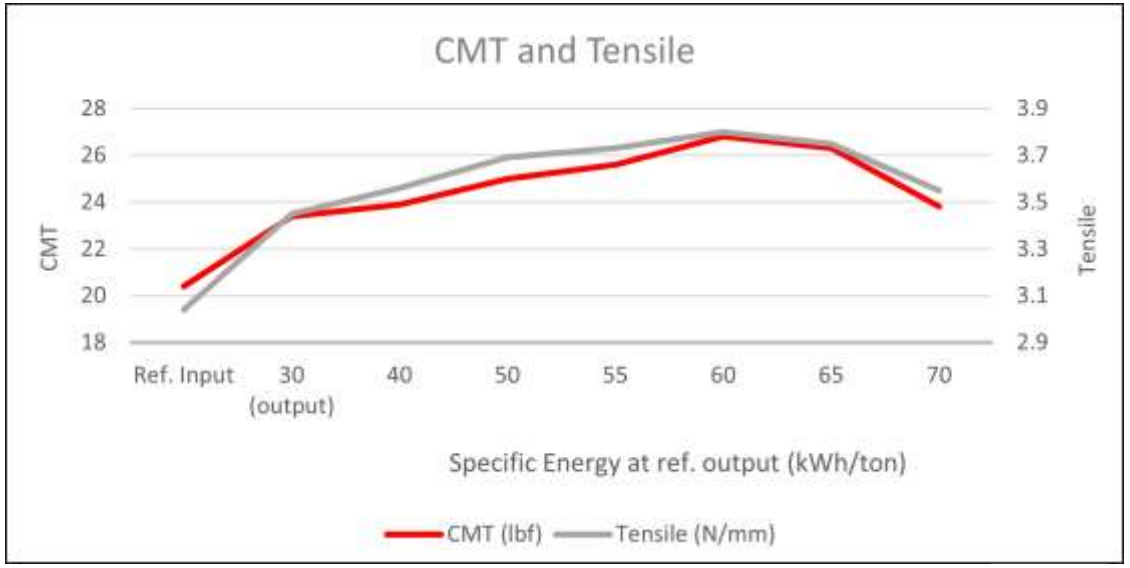
Fibrillation area and perimeter  are good until specific energy of  60 kwh/ton .

**Specific energy on product properties:**

CMT and Tensile also starts to decrease beyond 60 kwh/ton.

Hence this load was considered the maximum beyond which fibers would be damaged



# Fiber Morphology to improve process quality

## Strategies implemented

**Understand incoming raw material –** The incoming raw material was classified and pulper loading made in accordance to recipe of each manufactured grade to take advantage of fiber length

**Understand action of refining on fiber–** Fibrillation (Fibril Area and perimeter) was measured  after refining to understand the optimum Specific energy (kWh) that results in best fibrillation.

**Determine perfoming life of refiner discs –** Studies conducted over the life of the refiner elements to find the best effective refining performance life of the discs.

**Maximize product strength by optimizing the refiner load –** Find out the optimum specific energy required at half-life of the discs where the maximum end-product strength can be achieved


**ABB/L&W Fiber Tester Plus used for making morphology measurements**

# Summary of Fiber morphology studies

## Situation

- Mill works with a wide variation of incoming fibers,
- Raw material quality properly not understood
- Refining effect on fibres unknown.
- Too much fines and fiber damage
- Need to maximise fibre properties, reduce chemicals and to produce uniform quality

## Solution

- Fiber morpohology studies were made with ABB/L&W Fiber Tester
- Raw material studied and suitable blend chosen based on fiber properties for each grade.
- Optimum refining load balancing product strength and drainage achieved
- Best load point for maximum refiner disc life determined

## Benefit

- ✓ Improved and stable quality
- ✓ Optimal raw material consumption
- ✓ Less fibre loss and damage
- ✓ Lower energy consumption
- ✓ Optimized disc life
- ✓ Reduced consumption of strength agents
- ✓ Better CMT values on fluting grades

**FPC Papeles Chile optimized raw material usage and maximized strength properties (CMT)**

# Conclusions

- Recycled fibres need gentle treatment,  Develop, not damage.
- Establish Specific Energy (SE) not just for drainage (freeness), but also fiber characteristi
- Segregate raw material at the yard, design sma recipe to take advantage of fiber properties.
- Savings in energy, chemicals and extended dis life, faster grade changes, etc.  are valuable sid benefits.

**Additionally,  Advanced Process Control systems,  soft sensors and predictive modelling based on big data with control strategies  can empower paper manufacturers to enhance quality, reduce variability, and lower production costs**

# Thank you!