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Energy savings in TMP using High Efficiency Refining

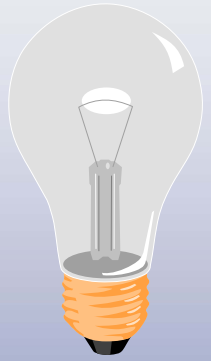
Presented by:
Marc Sabourin
Director, Process Development
Andritz

PAPER MILL POWER USE

MECHANICAL PULPING OPERATIONS ACCOUNT FOR THE MAJORITY OF POWER CONSUMPTION

PLANT	POWER	% of Total
Mechanical Pulp Mills	120 MW	67%
Paper Machines	32 MW	18%
Kraft Pulp Mill*	17 MW	9%
Pumping	3 MW	2%
Fibre Supply	2 MW	1%
Effluent Treatment	2 MW	1%
General Site	2 MW	1%
Generation	24 MW	13%

ELECTRICITY USE IN MECHANICAL PULPING



Mechanical Pulping relies more so on mechanical actions to separate and develop wood fibers, rather than using chemical means

Electricity is the main source of energy for generating the mechanical forces necessary to produce mechanical pulp.

ELECTRICITY USE IN MECHANICAL PULPING

High Consistency Refining (HCR) uses less than 10% of the power applied to separate and develop fibers for papermaking; approximately 90% of the energy is lost in the form of “low quality” steam.

High Efficiency refining is required to reduce the heat loss and better use power to develop wood fibers.

ELECTRICITY USE IN MECHANICAL PULPING

The energy dissipation in Low Consistency Refining (LCR) is much lower than HCR, and is primarily in the form of pumping losses.

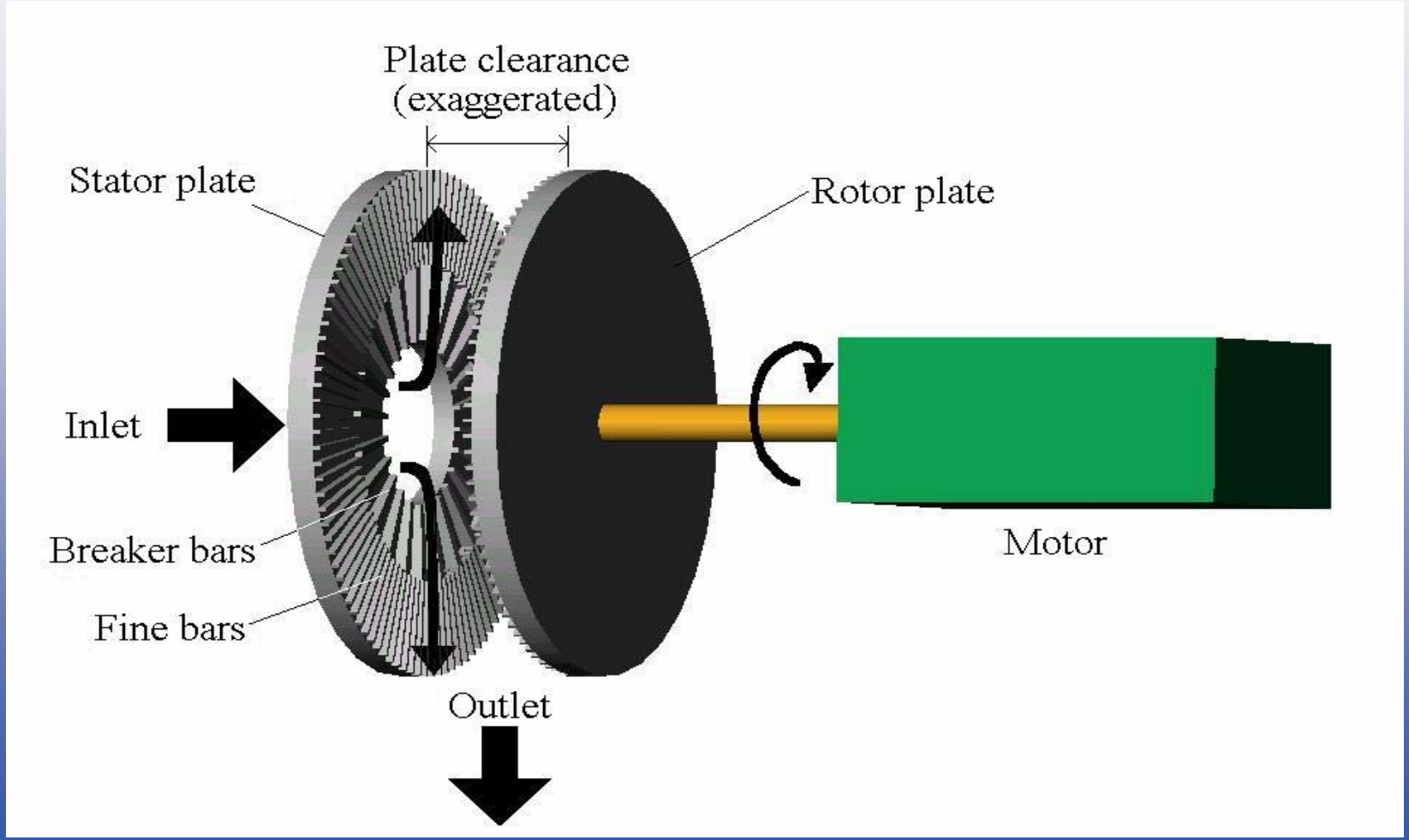
The energy consumption of the TMP process decreases when displacing HCR with LCR. More HCR displacement translates into higher energy savings.

ELECTRICITY USE IN MECHANICAL PULPING

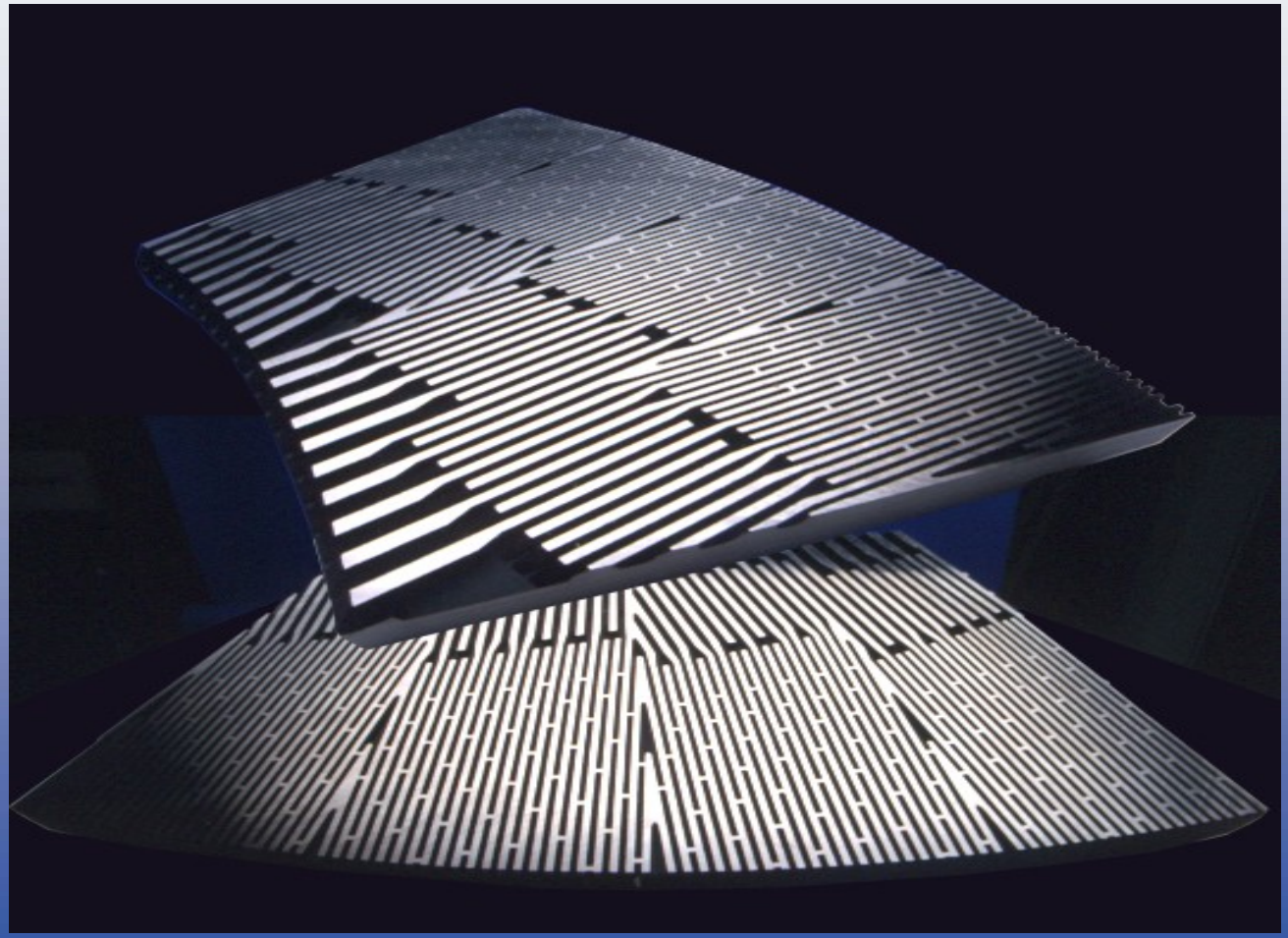
Why conduct HCR in thermomechanical pulping if power requirements are so high?

HCR refining is required to refine wood chips and establish the initial pulp quality fingerprint. This is not possible with LCR alone.

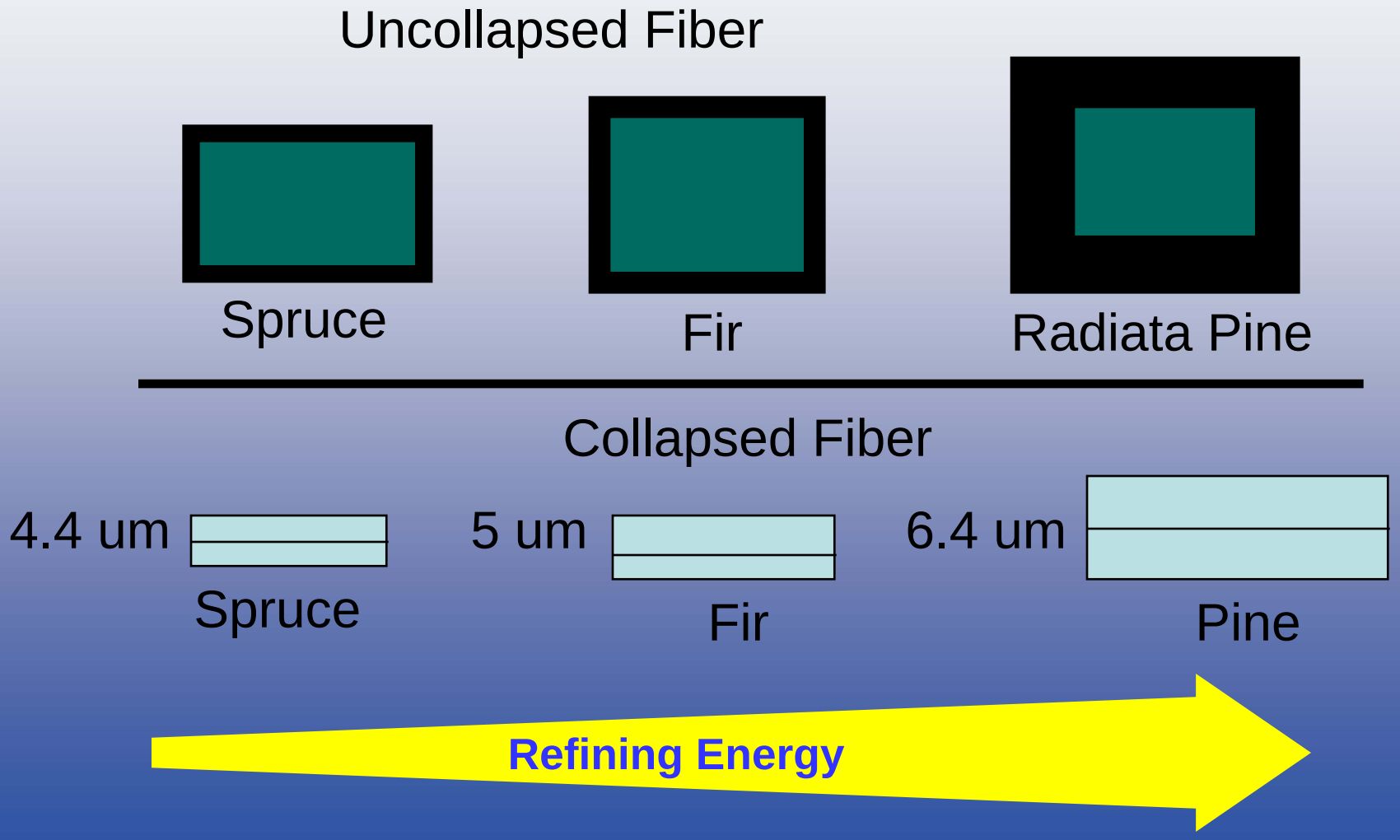
Thermomechanical Pulping (TMP)



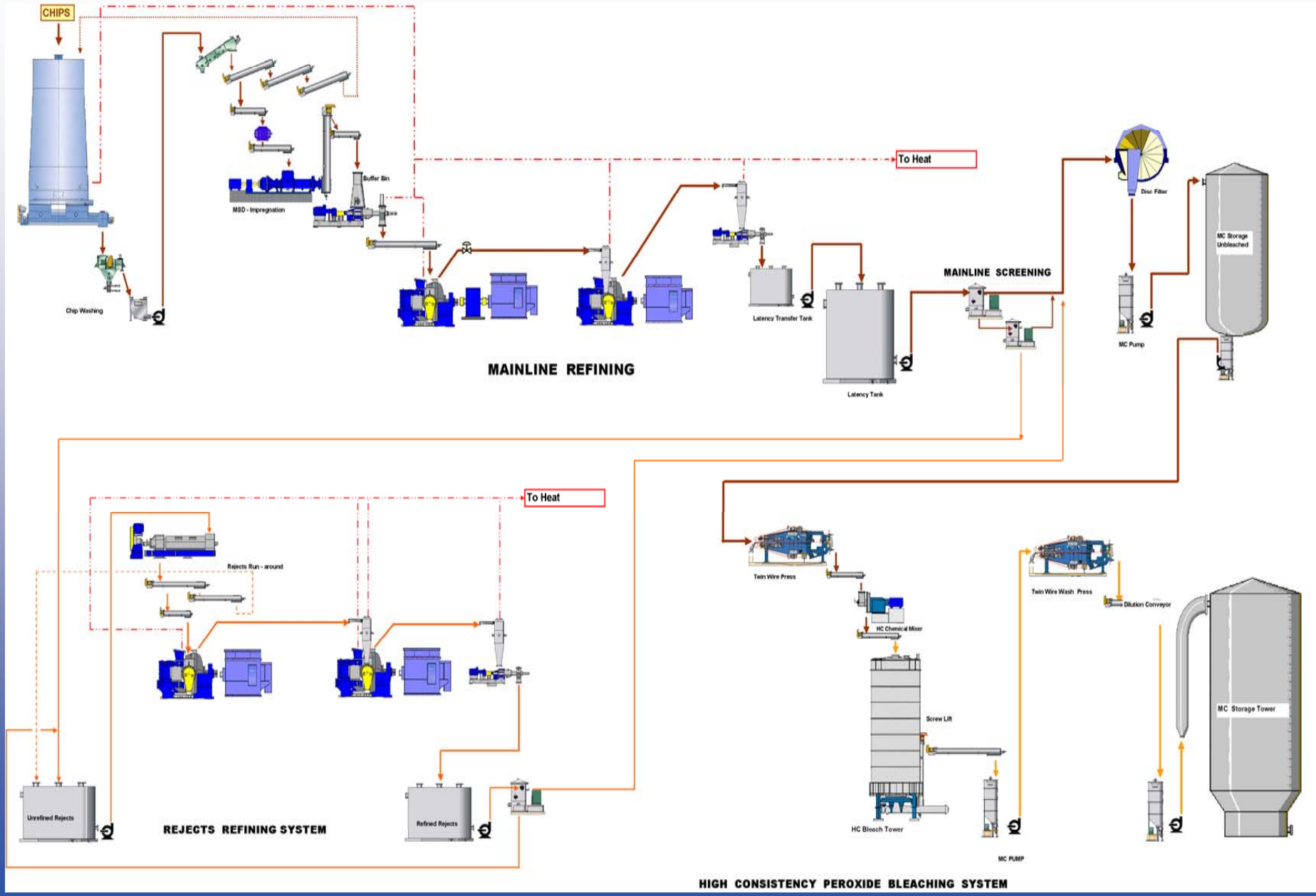
TMP
Refiner Plates



Raw Material & Refining Energy



TYPICAL TMP FLOWSHEET



History OF TMP

- **TMP found widespread growth since the early 1970's.**
- **Today, TMP is used in most newsprint and lightweight magazine paper mills throughout the world.**
- **High yield, adequate strength, and good optical properties help contribute to the dominance of TMP in these markets.**
- **A main drawback of TMP is high electrical energy consumption.**

History OF TMP

- **Low power rates during the first thirty years of TMP influenced the design of TMP systems.**
  - **Most TMP systems were designed to supply the steam drying requirements at the papermachine(s).**
  - **Refiner operating pressures were selected to meet heat recovery requirements for clean steam.**
  - **The value of steam relative to electricity will continue to decrease as power rates escalate**

USE OF MECHANICAL PULPS

Potential Use of TMP and CTMP in Different End Products

PRODUCT	SOFTWOOD TMP	SOFTWOOD CTMP	HARDWOOD CTMP
NEWSPRINT	95-100	80-100	70-80
SC PAPER	65-80	70-90	35-50
LWC	50-65	35-75	40-50
FINE PAPER	NS	50-80	50-60
PAPER BOARD			
SOLID BOARD	20-40	20-40	20-40
FOLDING BOXBOARD	20-25	25-35	15-20
LIQUID PACKAGING	NS	20-25	15-20
TISSUE	NS	20-40	20-40
FLUFF	NS	80-100	NS

ENERGY REDUCTION OPPORTUNITIES IN TMP

- ENERGY IN MECHANICAL PULPING
  - ENERGY REDUCTION STRATEGIES
    - CHIP PRE-TREATMENT
    - CONTROL
    - REFINER PLATES
    - **HIGH EFFICIENCY REFINING**
      - **High Consistency**
      - **Low Consistency**

EFFECT OF ROTATIONAL SPEED PULP STRENGTH & ENERGY

		1500 rpm	1800 rpm	2300 rpm
Ref. Intensity		Low	Low	High
Freeness	mL	150	150	150
Shives %	%	0.83	0.80	0.76
Tensile Index	Nm/g	34.8	35.2	31.7
Tear Index	mNm^2/g	9.4	9.4	8.3
Scatt. Coeff	m^2/kg	52.7	53.5	54.8
Spec. Energy	kWh/ADMT	1935	1882	1690

Conventional TMP pulps produced at a pressure of 50 psi

ENERGY REDUCTION IN THERMOMECHANICAL PULPING

- Historical work and general understanding established that energy consumption could be reduced at the expense of pulp strength.

- How can we prevent strength loss at high refining intensity?

ENERGY REDUCTION TECHNOLOGIES

- High Intensity TMP Process Optimized = RTS
- High speed refining technology that provides sufficient heating to withstand high intensity refining, thus achieving both energy savings and preservation of pulp strength.

HISTORY OF RTS

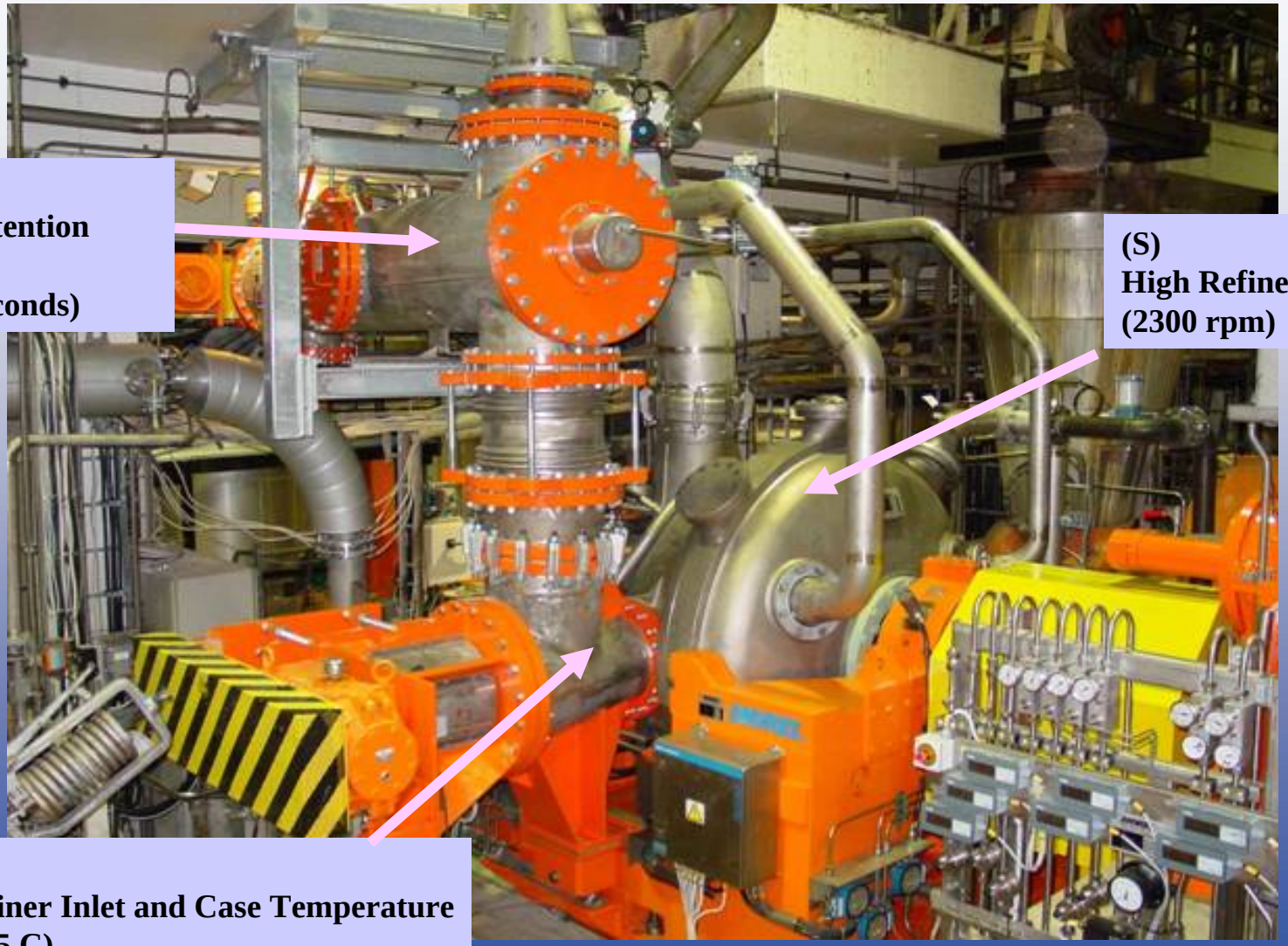
- RTS was first introduced in 1996 at Perlen Paper in Switzerland.
- Inspiration for RTS came from pilot plant studies that uncovered a window of operation where both strength and optical properties are preserved at high refining intensity.
- Annual RTS capacity has steadily increased to over 2 million tons per year since 1996.

RTS

- What is RTS ?

- A thermomechanical pulping process that operates at:
  - lower retention time (R),
  - higher temperature (T),
  - and higher refiner speed (S)

RTS Technology

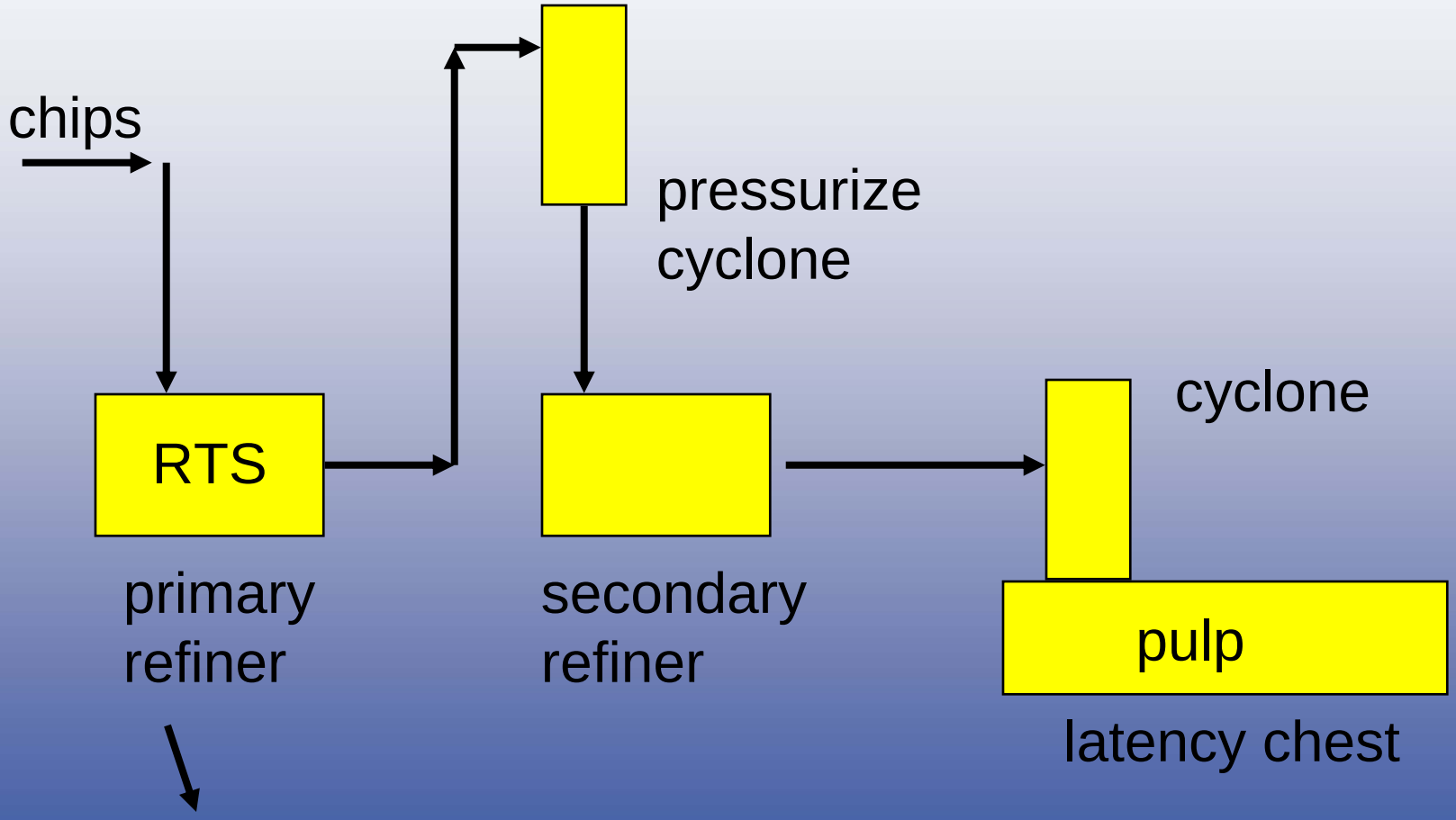


(R)
Low Retention Time
(< 10 seconds)

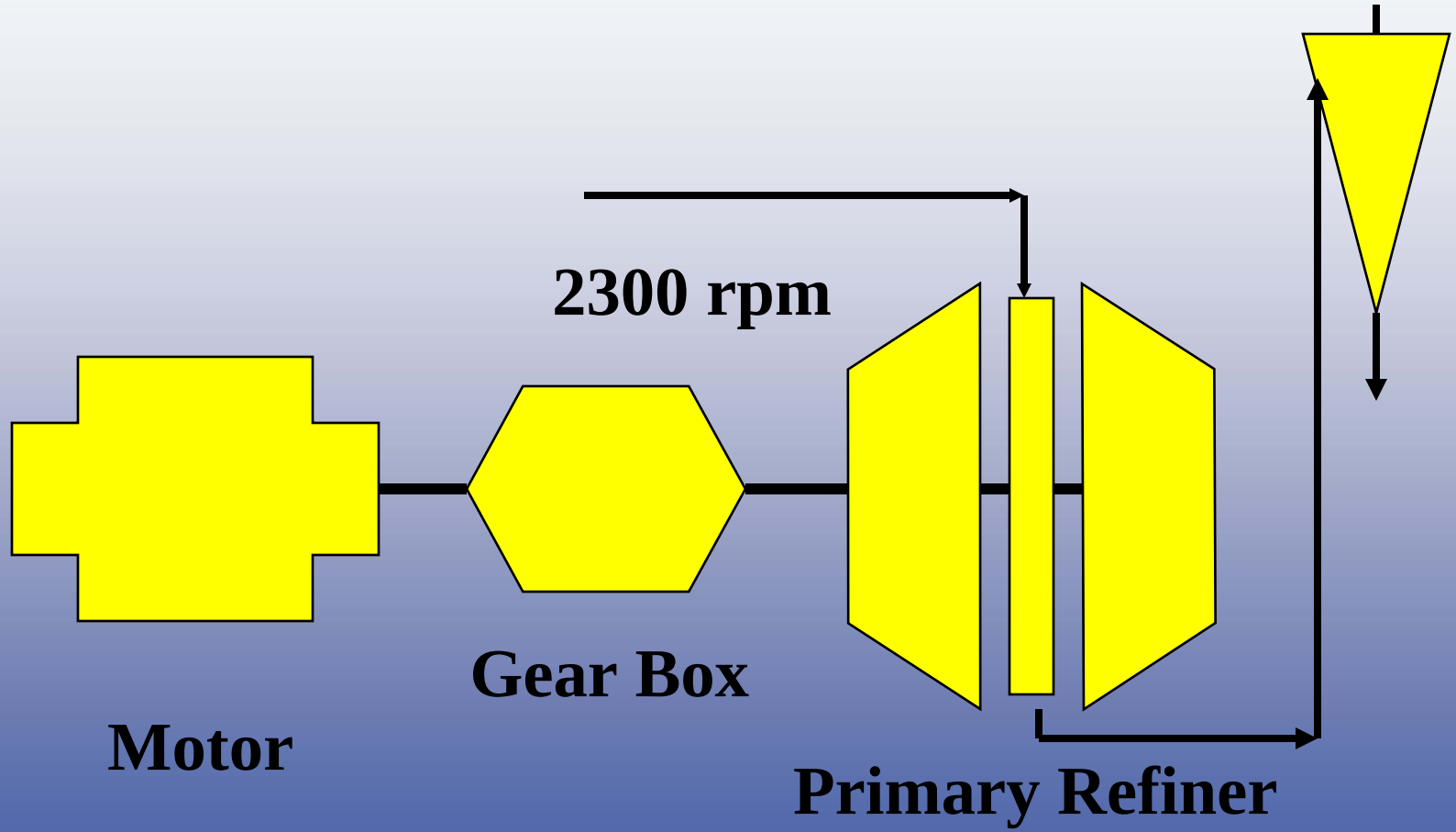
(S)
High Refiner Disc Speed
(2300 rpm)

(T)
High Refiner Inlet and Case Temperature
(160 – 185 C)

RTS TECHNOLOGY



RTS Technology



Fibre separation at high temperature and high retention time

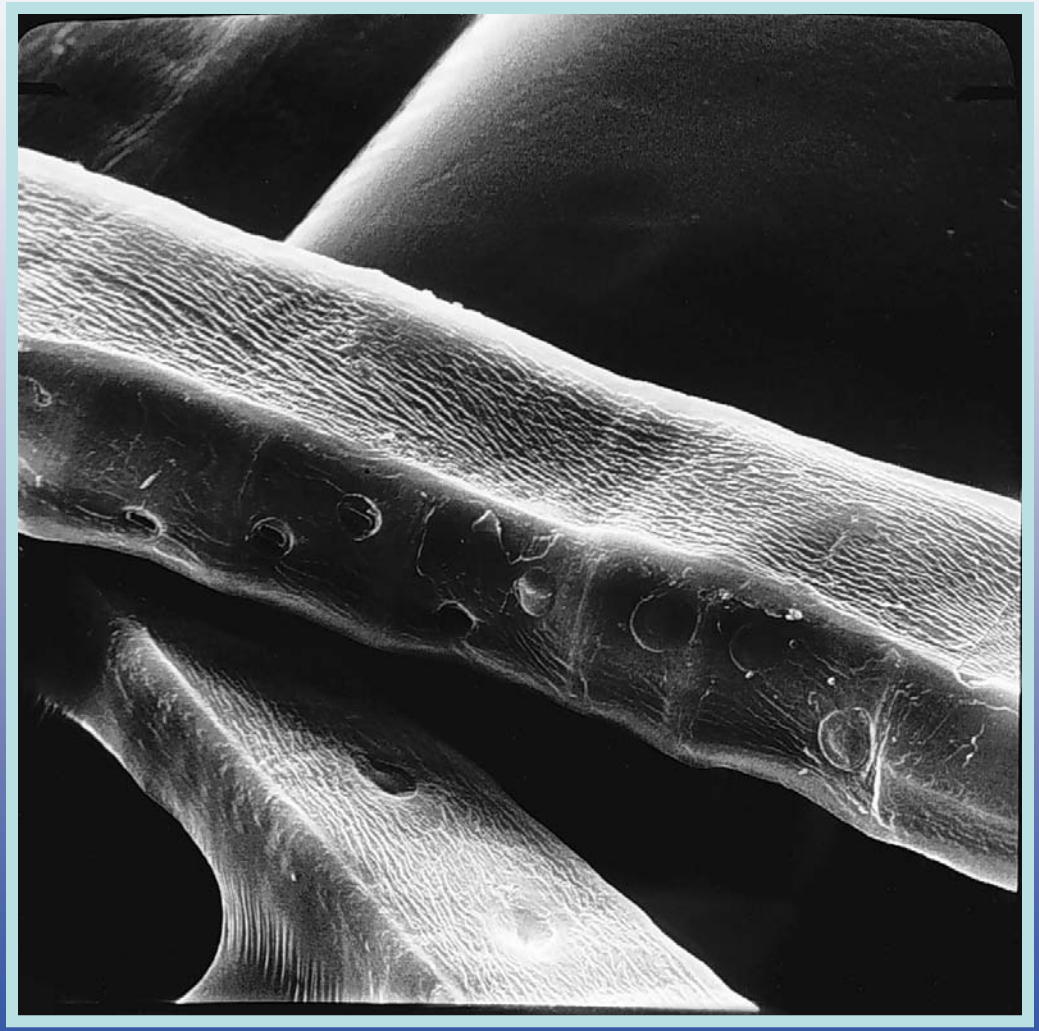


Fig.20

Fibre separation at high temperature and low retention time

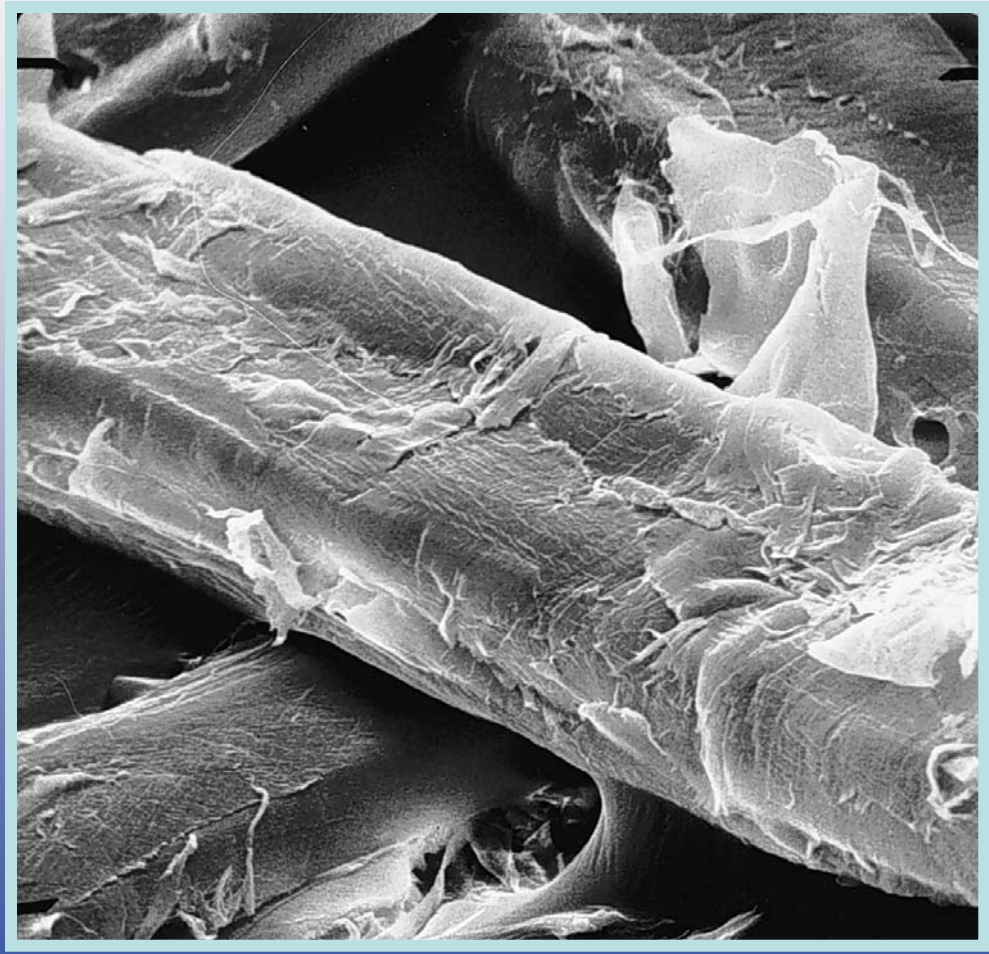


Fig.21

RTS

- Reduced electricity requirement is attributed to two mechanisms during RTS refining:
  - During high intensity refining a higher proportion of bar impacts results in adhesive failure rather than deformations
  - At higher temperatures, lower stress levels are required for viscoelastic failure

RTS ON SPRUCE AT 100 ml FREENESS

PROCESS	TMP	RTS
ENERGY kWh/ODMT	2250	1850
BULK cc/g	2.31	2.28
TEAR INDEX mN.m^2/g	8.5	8.2
TENSILE INDEX Nm/g	39	40
LIGHT SCATTERING m2/kg	50	50
BRIGHTNESS	60	60

Published results from Norskeskog Folum mill in Norway

RTS ON PINE AT 90 ml FREENESS

PROCESS	TMP	RTS
ENERGY kWh/ODMT	2890	2455
BULK cc/g	2.85	2.78
TEAR INDEX $mN.m^2/g$	9.2	8.9
TENSILE INDEX Nm/g	32.8	33.3
BURST INDEX $kPa.m^2/g$	1.9	1.9

Published results from Bowater Calhoun mill in USA

EFFECT OF RTS TECHNOLOGY

- The energy savings decreases production costs and reduces greenhouse gases (GHG's) to the atmosphere.

- For a typical TMP mill with 1000 tonne per day capacity, saving 20% on motor power equates to over $5 million USD annual savings. This value will increase with the rising cost of electricity.

RTS Operating Capacity

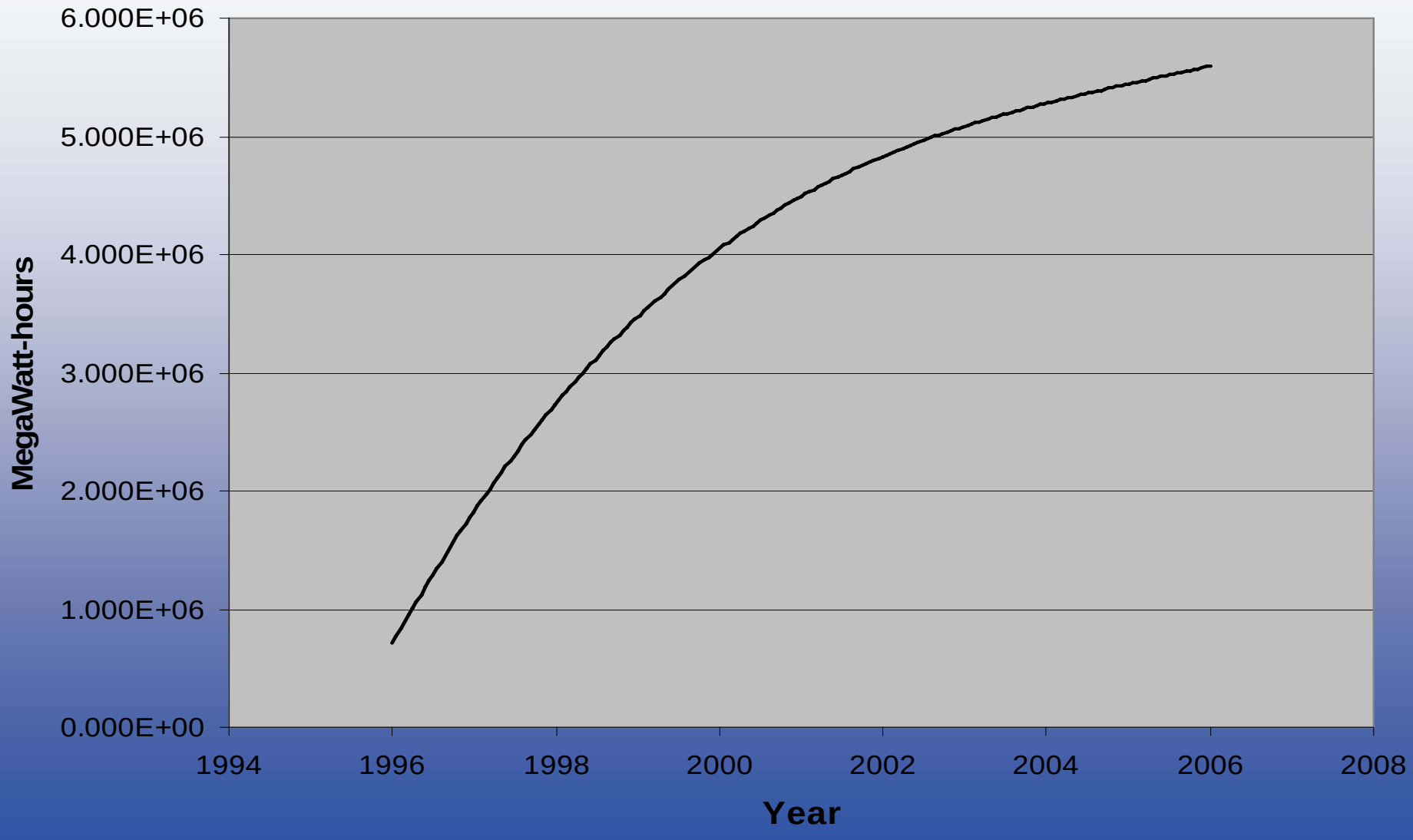
- RTS is used in the production of a number of products, including newsprint, specialty papers, LWC and SCA papers, and board, using a variety of wood species.

- To date, operating RTS in place of conventional TMP refining has saved in excess of 5 billion kilowatt-hours.

RTS Capacity as of 2005

	Year	BDMT/Y	Furnish	Product
Papierfabrik Perlen	1996	125 000	spruce	LWC, Specialty
CMPC Maule	1996	105 000	pine	Board- middle ply
UPM Shongau	1997	105 000	spruce	News
NSI Walsum	1997	190 000	spruce	LWC
NSI Follum	1999	95 000	spruce	News, Specialty
Bowater Calhoun	1999	320 000	pine	News, Specialty
UPM Stracel	2000	85 000	spruce	News, Specialty
Holmen Paper Workington	2001	105 000	spruce	Board- middle ply
Holmen Paper Hallstavik	2002	225 000	spruce	News, SC
CMPC Maule	2003	125 000	pine	Board- middle ply
Solikamsk	2003	135 000	spruce/fir	News, Specialty
Chenming JiangXi	2005	195 000	pine	LWC
NSI Walsum	2005	65 000	spruce	LWC
NSI Golbey	2005	145 000	spruce	News, Specialty

Cumulative Energy Savings in MW-hours



Global Impact

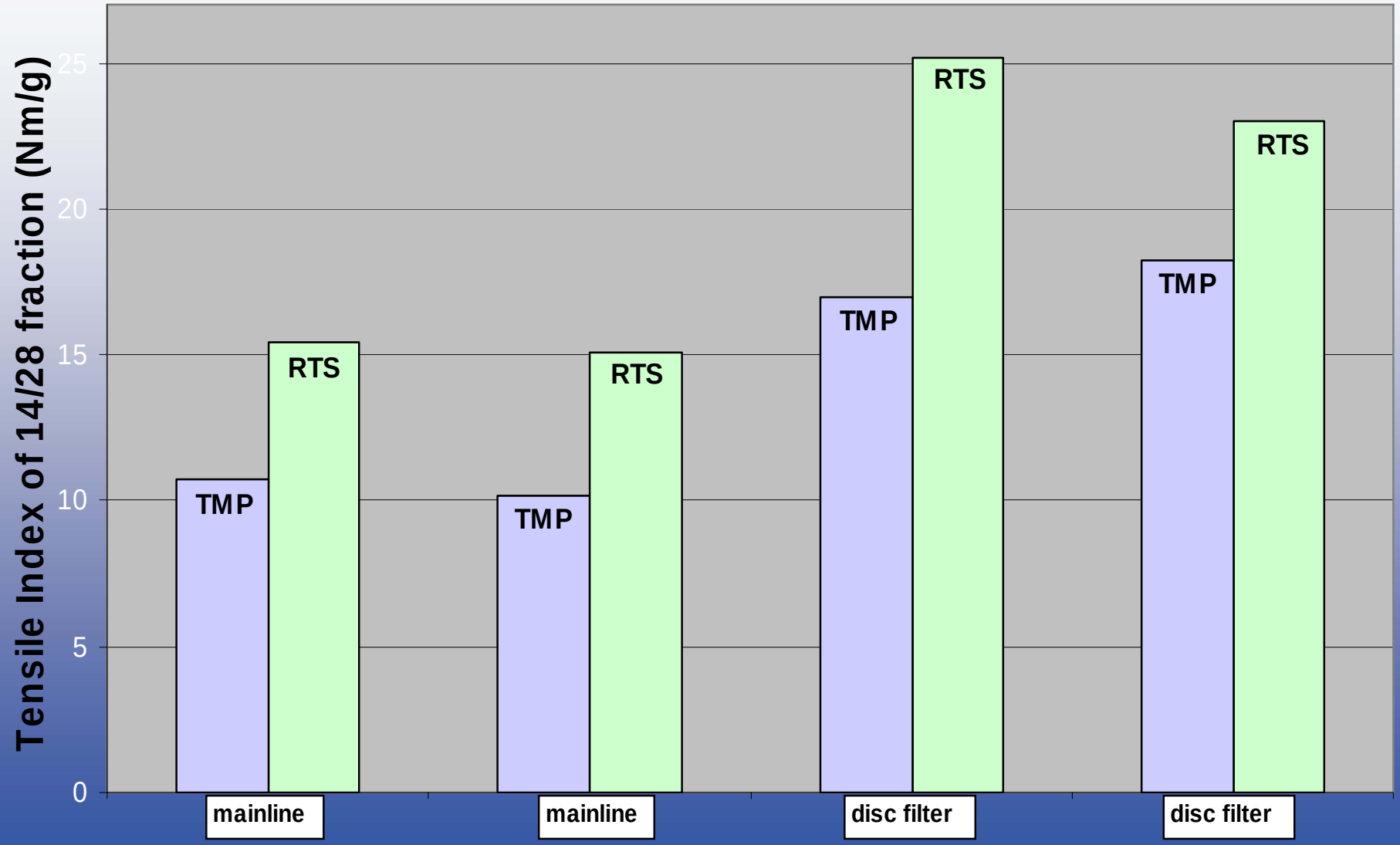
- As a hypothetical example:
  - Assuming that 20 million tonnes of worldwide annual TMP capacity is produced with 400 kWh/ton less energy, a savings of 8 million Megawatt-hours per year is achieved.
  - Assuming ½ of this electricity is derived from fossil fuels, using coal as an example; this would translate into a reduction in CO_2 emissions of approx 4 million tonnes.

Long Fiber Quality

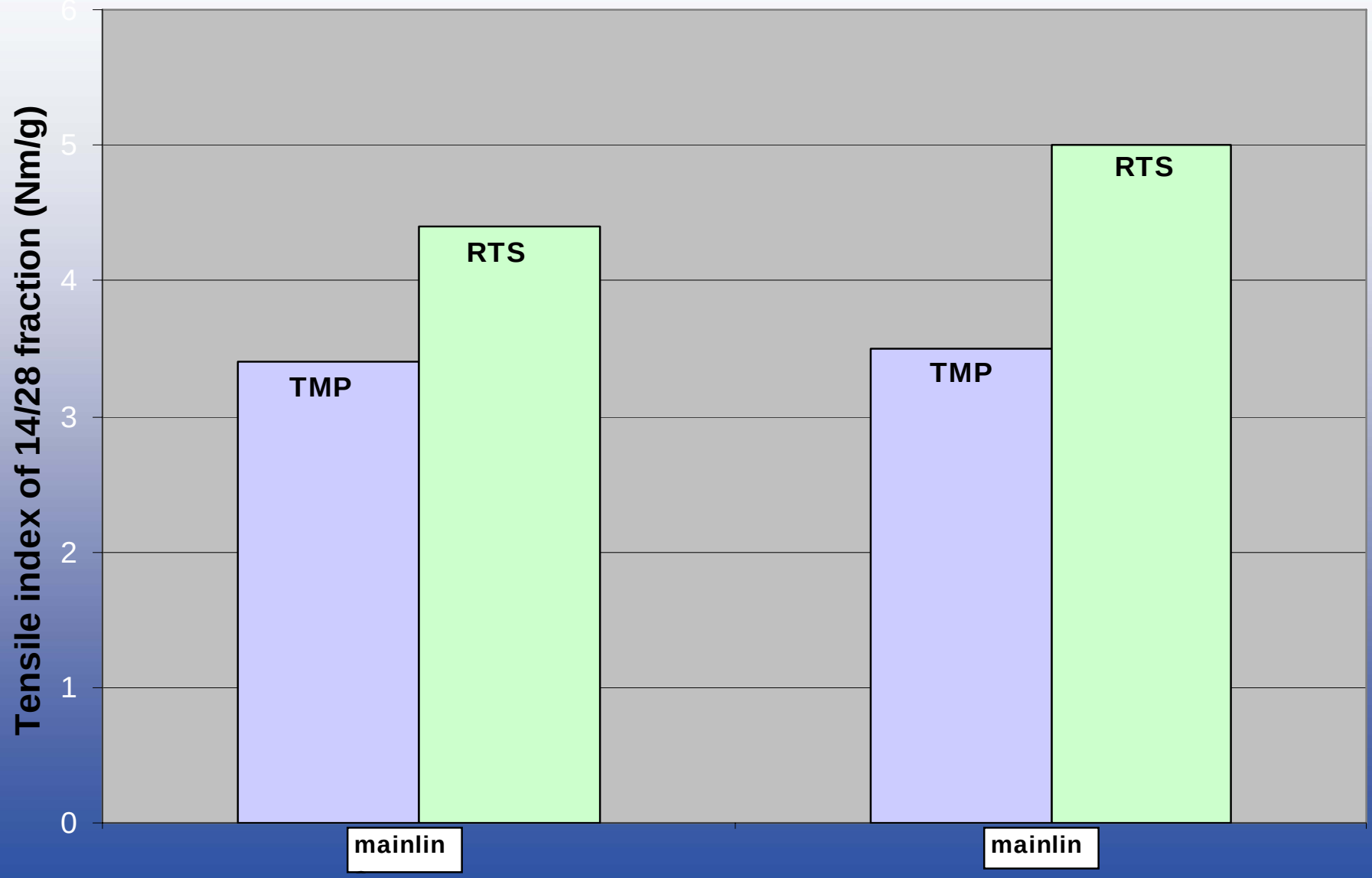
• Two pulps that are apparently similar on the basis of whole pulp properties (freeness, tensile index, etc) can differ significantly in long fiber quality.

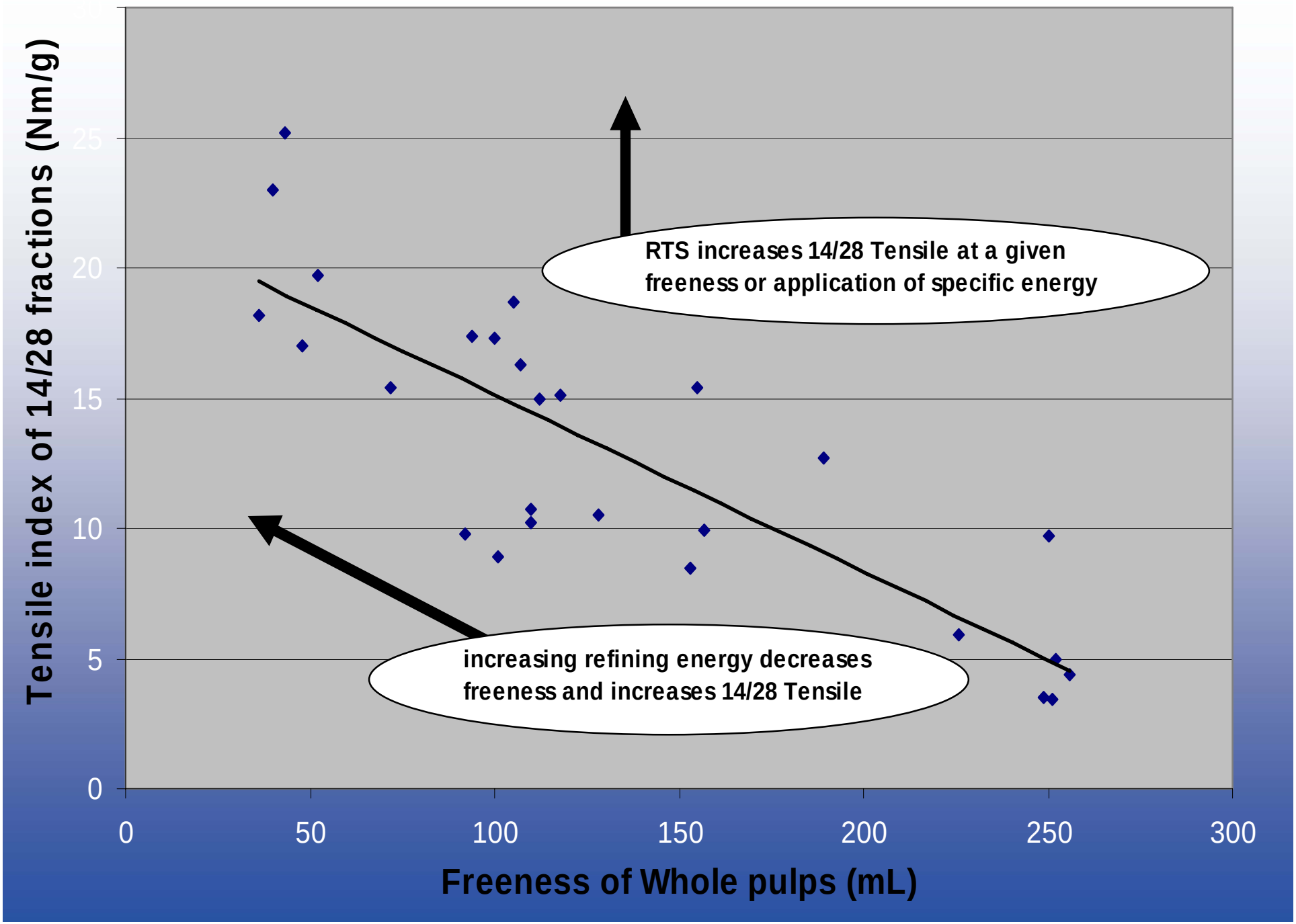
•The following figures illustrate long fiber bonding (Tensile index of 14/28 fraction) from a spruce and a pine mill operating TMP and RTS lines in parallel

Spruce


Tensile Index of 14/28 fraction (Nm/g)
25
20
15
10
5
0
TMP
RTS
TMP
RTS
TMP
RTS
TMP
RTS
mainline
mainline
disc filter
disc filter

Southern Pine

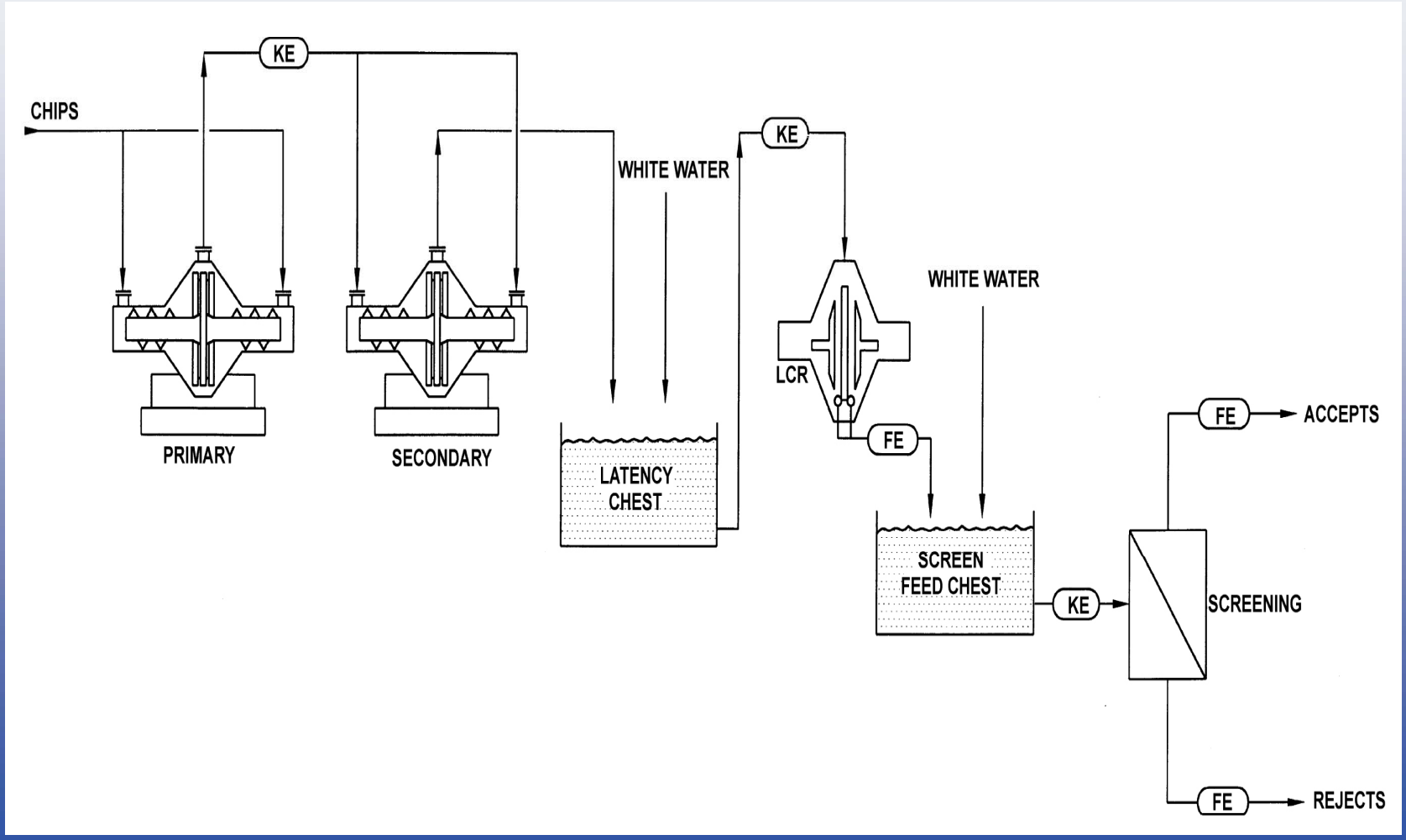



Tensile index of 14/28 fractions (Nm/g)
0
5
10
15
20
25
0
50
100
150
200
250
300
Freeness of Whole pulps (mL)
RTS increases 14/28 Tensile at a given freeness or application of specific energy
increasing refining energy decreases freeness and increases 14/28 Tensile

LOW CONSISTENCY REFINING

- Low consistency refining is a technology that has been around for many years.
- New breed of LCR refiners have been developed for TMP strength development.
- A number of mills have installed them in TMP lines as a third refining stage.
- Energy reductions of 50 - 150 kWh/BDMT have been claimed per LCR installed.

LCR REFINING AS THIRD STAGE

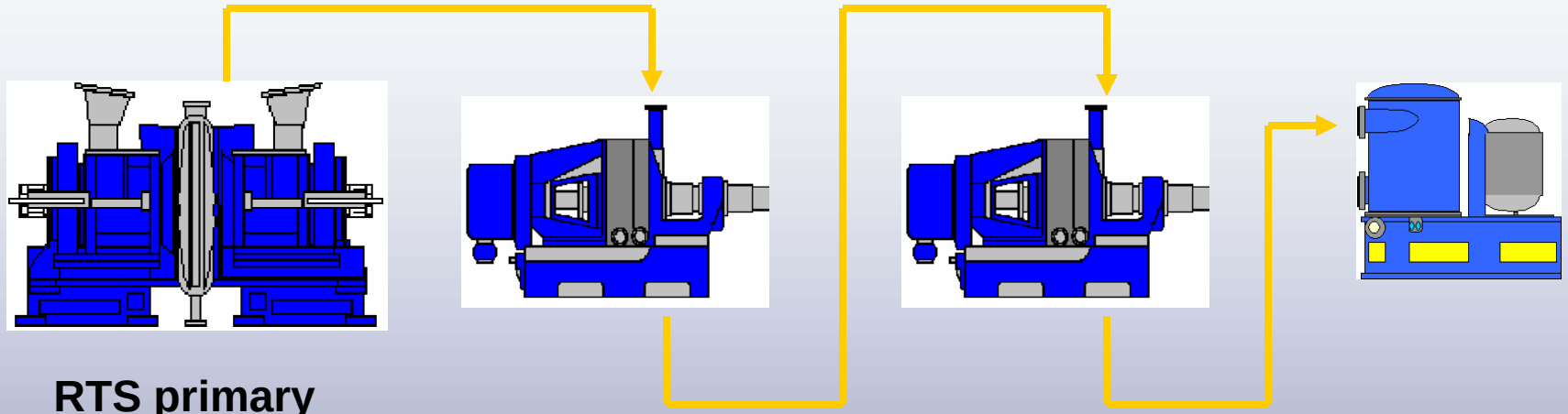


EFFECT OF LCR THIRD STAGE REFINING

		No LCR	With LCR
REF. ENERGY	kWh/ODMT	2000	1850
FREENESS	mL	116	110
TEAR INDEX	mNm^2/g	8.7	8.2
TENSILE INDEX	Nm/g	40.8	41.3
BURST INDEX	$kPa.m^2/g$	1.8	1.9
SHIVES	%	0.11	0.05

Published results from Bowater Calhoun mill in USA

Series LCR



RTS primary

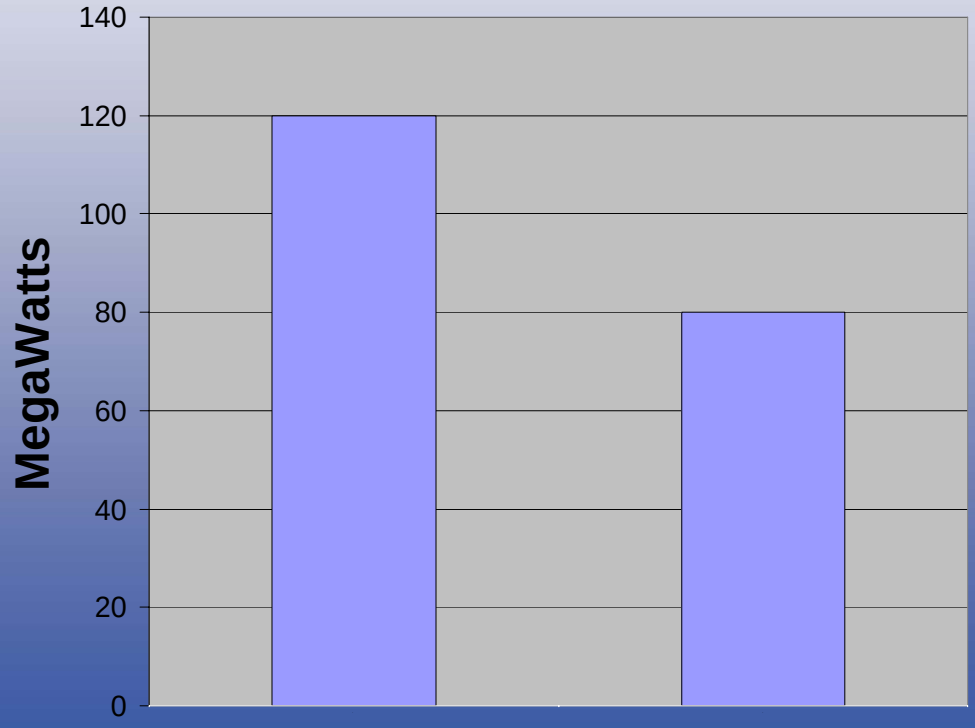
Low consistency refiners in series allow higher displacement of High Consistency Refining (HCR) energy, increasing the potential to reduce power cost per ton.

CONCLUSIONS

- RTS is a high efficiency HCR technology that reduces the energy consumption of the TMP process.
- High-Temperature LCR is a high efficiency technology rapidly gaining interest due to its lower installed cost and favorable Return on Investment (ROI).

CONCLUSIONS

- The potential exists to drop TMP demand at integrated paper mills from 120 MW down to 80 MW or less using more energy efficient technologies.



CONCLUSIONS

- North America and Europe
- N. American and European producers are rebuilding their TMP plants to operate at reduced energy consumption
- The focus will be on reducing production costs at the best possible Return on Investment (ROI).

CONCLUSIONS

- Asia and South America
- In Asia and South America producers are installing the latest in High Efficiency mechanical pulping equipment, process controls and refiner plate technology.
- Low energy technologies are necessary in these markets due to limitations on power supply and environmental issues.

Thank you for your attention

PRESENTED BY
Marc Sabourin
Director, Process Development
Andritz
marc.sabourin@andritz.com