A refinação de fibra curta, longa e suas misturas

"Refining of short fiber, long fiber and mixtures of them"

Ripasa, 15 de Março de 2007

Luciano R. Oliveira - Metso Paper Brasil
luciano.r.oliveira@metso.com

Contents of the presentation

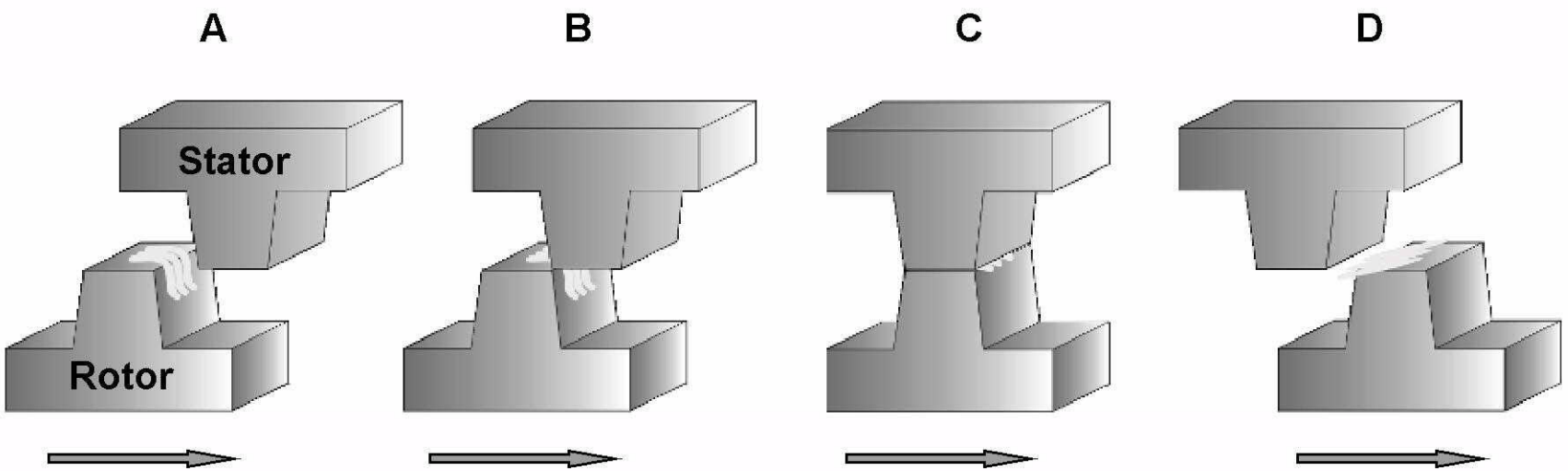
- **LC refining review**
- **The Optifiner**
- **Refining performance with separated and mixed pulps**

The Purpose of LC Refining

- **Refining is the most effective way to affect paper quality as well as the runnability of paper and printing machines**
  - **increased bonding ability**
  - **smoother paper surface**
  - **required porosity**

- **Refining is mechanical treatment of fibers between metallic bars in the presence of water**

Effect of Refining



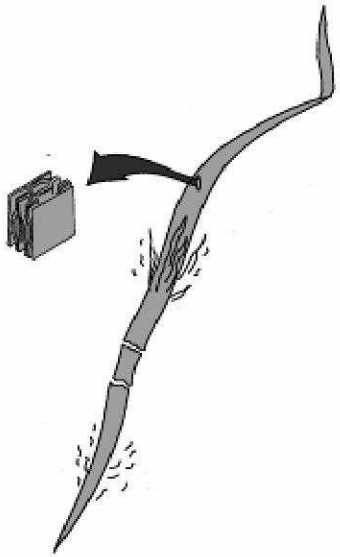
- A: Fiber flocs hang over the bar edges
- B: Flocks receive the first hit
- C: Flocs are pressed between rotor and stator bars
- D: Rotor bars have completely swept over stator bars

Effect of Refining

Delamination and swelling of fibers

Shortening of fibers

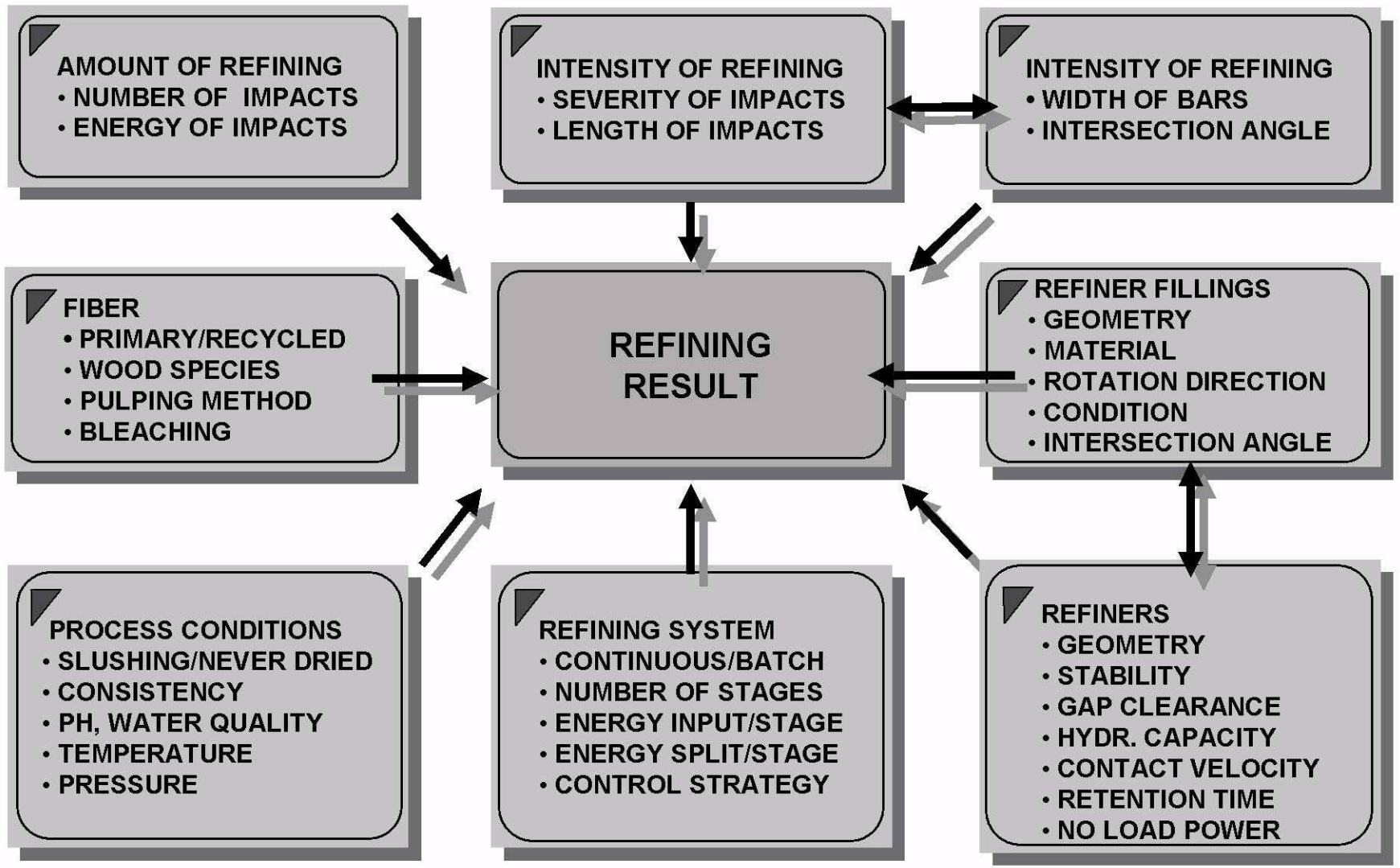
Creation of fines



Removal of primary fiber wall

External fibrillation

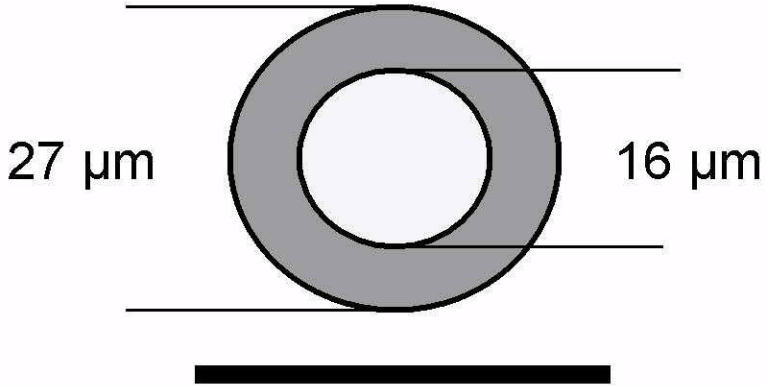
Factors affecting refining



Fiber Characteristics

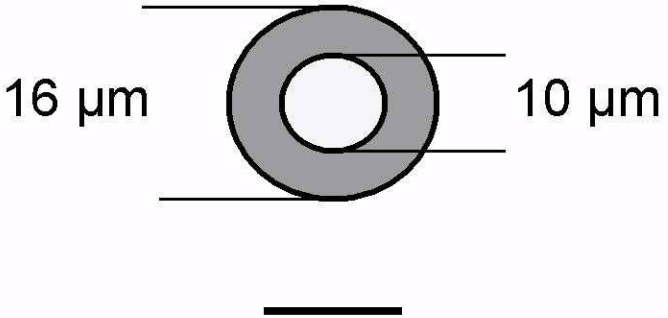
Pine

Pinus silvestris



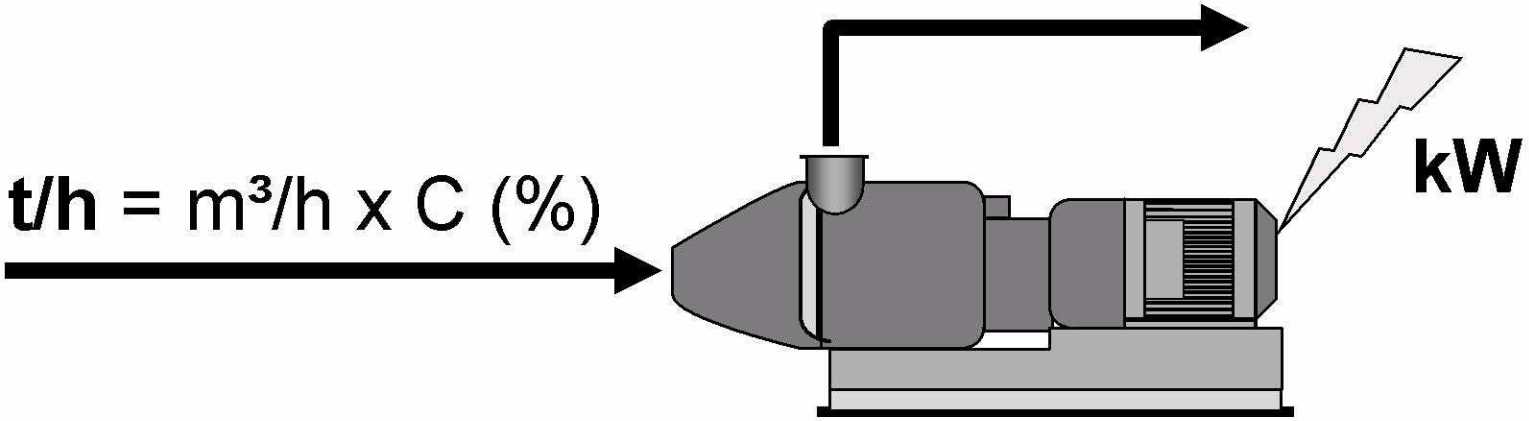
Fiber length	3.5 mm
Coarseness	0.16…0.23 mg/m
Fibers	2.5 million per gram

Eucalyptus



Fiber length	0.8 mm
Coarseness	0.08 mg/m
Fibers	15 million per gram

Amount of Refining



$$SRE\ (kWh/t) = \frac{Pe\ (kW) = Pt\ (kW) - Po\ (kW)}{m\ (t/h)}$$

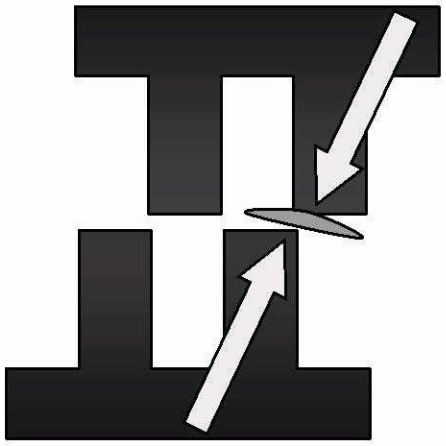
Amount of Refining
Typical Energy Inputs in One Pass

metso paper

• Softwood Sa	60…200 kWh/t
• Softwood Si	40…100 kWh/t
• Hardwood Sa	40…80 kWh/t
• Hardwood Si	25…40 kWh/t
• Recycled fiber	20…100 kWh/t
• Post refining of mechanical pulps	30…80 kWh/t
• Reject refining in chemical pulp mill	50…100 kWh/t
• Trim refining	20…50 kWh/t

Intensity of Refining
Specific Edge Load

$$SEL\ (J/m) = \frac{Pe\ (kW) = Pt\ (kW) - Po\ (kW)}{Ls\ (km/s) = Cl\ (km) \times n\ (r/s)}$$



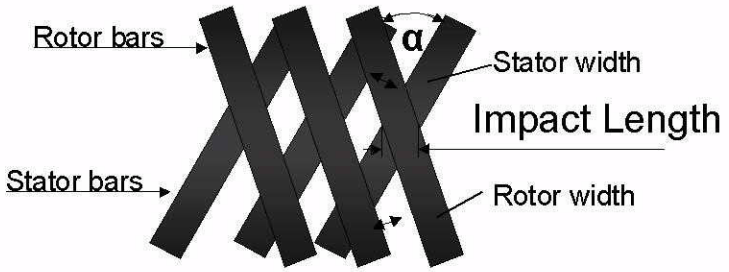
SEL is the energy applied to fibers from the rotor edge to the stator edge

Refining Intensity
Specific Edge Load - typical figures

- **Softwood, weak** **2.0…4.0 J/m**
- **Softwood, strong** **4.0…6.0 J/m**
- **Hardwood, weak** **0.4…0.8 J/m**
- **Hardwood, strong** **0.8…1.5 J/m**
- **Recycled fiber, weak** **0.4…2.0 J/m**
- **Recycled fiber, strong** **2.0…4.0 J/m**
- **Post refining of mechanical pulps** **0.7…1.5 J/m**
- **Reject refining in chemical pulp mill** **0.5…2.0 J/m**

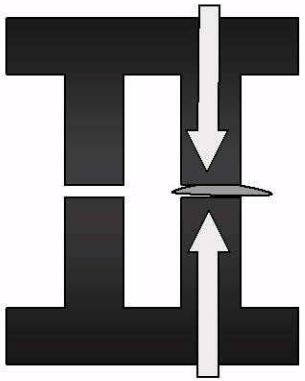
Intensity of Refining
Specific Edge Load

Intensity of Refining, Specific Surface Load



$$SSL\ (J/m^2) = \frac{SEL\ (J/m)}{IL\ (m)}$$

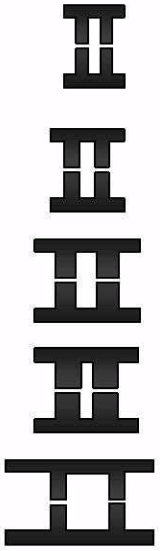
$$IL\ (mm) = \frac{Wrotor\ (mm) + Wstator\ (mm)}{2} \times \frac{1}{\cos \alpha/2}$$



SSL is the energy applied to fibers from the rotor surface to the stator surface

Refiner Fillings Geometry

Application	Type	Bar width, mm	Groove width, mm
Hardwood	SF,SM,SC	2.0…3.0	3.0…4.0
Mixed pulp	MX	3.5	4.5
Softwood	LF,LM,LC	4.0…5.5	5.0…7.0
Fibrillating	FS,FL	4.0…8.0	3.0…5.0
Cutting	TS,TM,TC	2.5…4.5	7.0…9.0



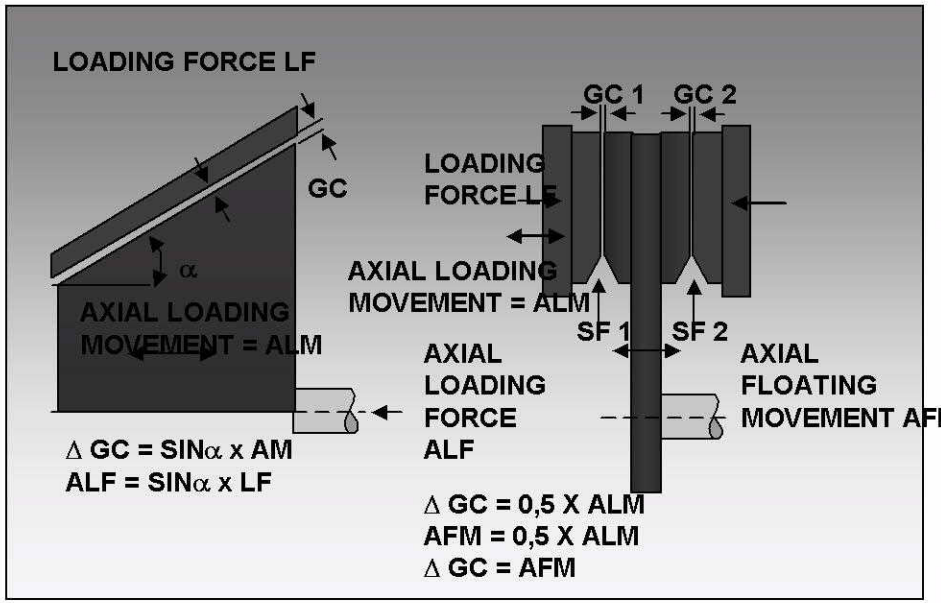
Optifiner RF
Refiner family

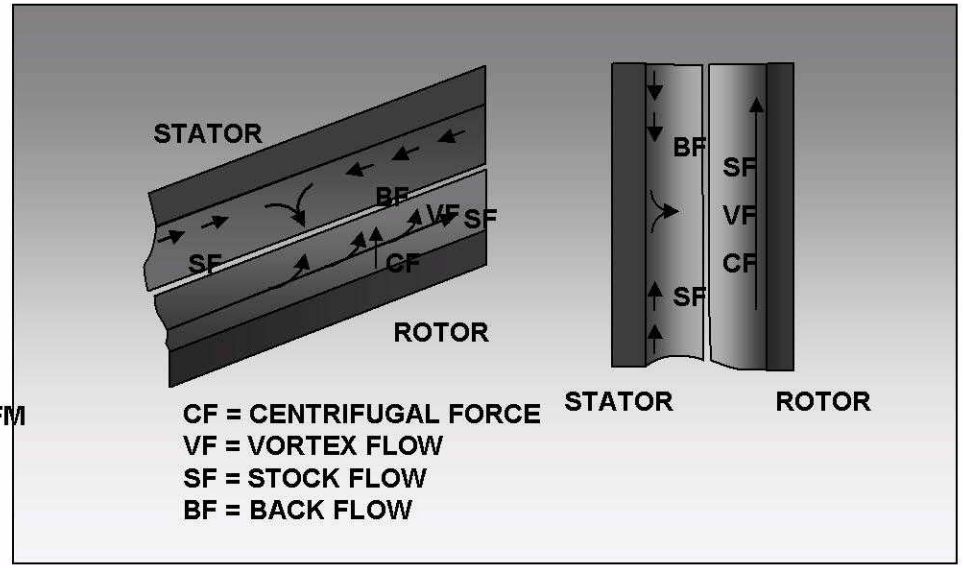
OptiFiner type	Capacity tpd	Motor power kW	Speed rpm
RF-0	5-50	90-110	900-1800
RF-1	5-150	160-315	720-1200
RF-2	25-250	315-500	600-900
RF-3	50-350	400-800	514-720
RF-4	100-500	800-1500	450-600
RF-5	300-800	1500-2600	330-514

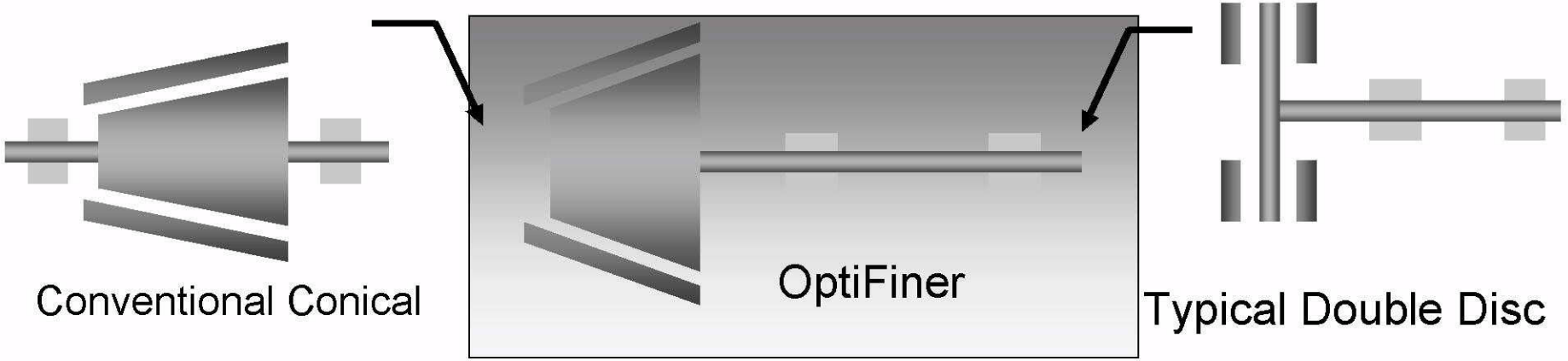
- Proven concept with over 2000 references!

OptiFiner vs. double disc

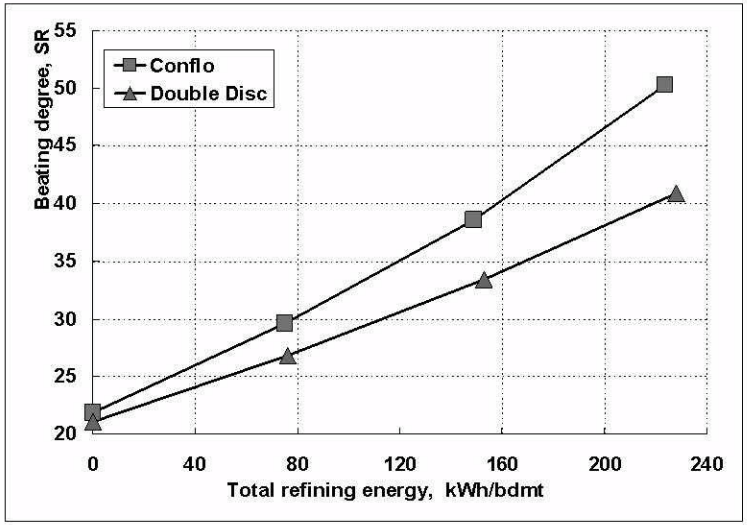
metso paper

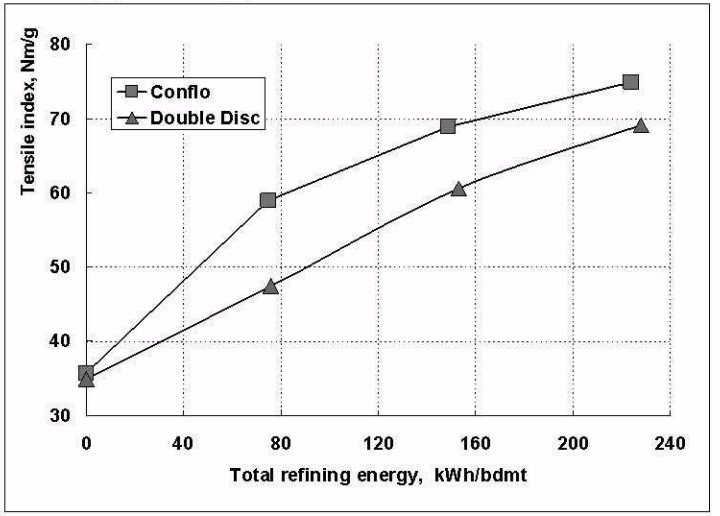


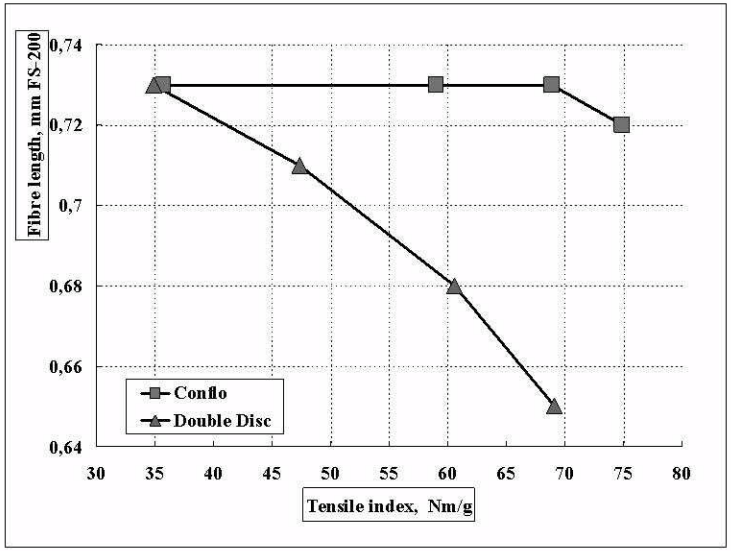


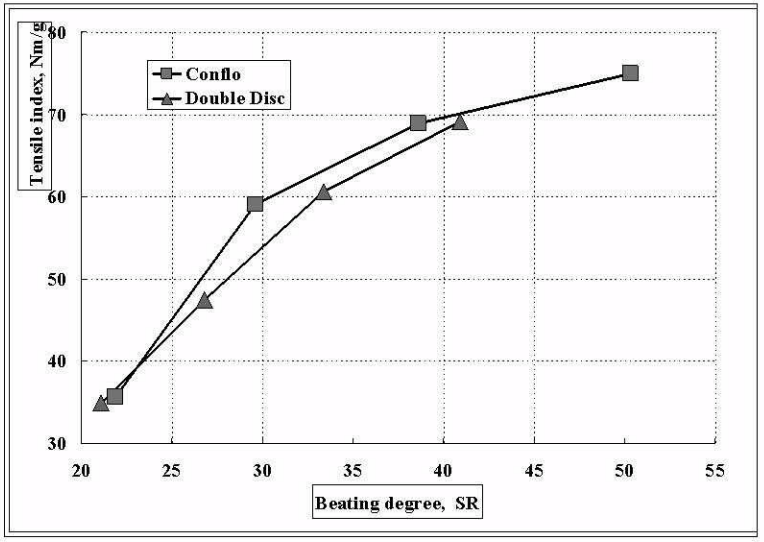


OptiFiner vs. double disc
Eucalyptus pulp









Refining Performances with Separated and Mixed Pulps

Metso Paper

Topics

- **Conical refiner at varying capacities**
  - Brazilian eucalyptus kraft
  - Canadian pine kraft
- **Mixed vs separate refining**
  - Scandinavian pine + Brazilian eucalyptus
  - Canadian pine + European mixed hardwood
- **Future refining system.**
  - Separate pre-refining
  - Mixed main refining
  - Trimming refining

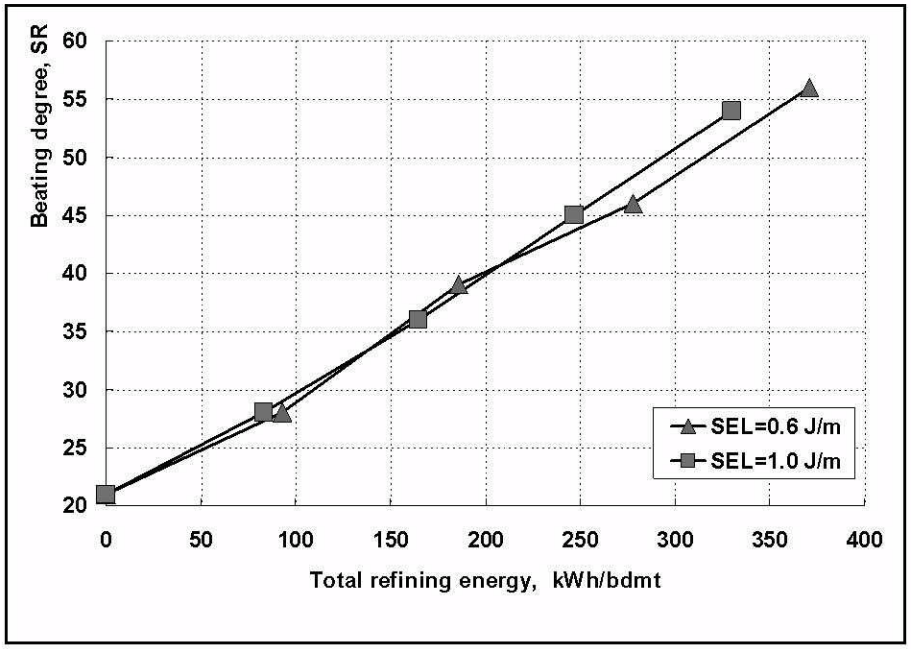
Conical refiner at varying capacities

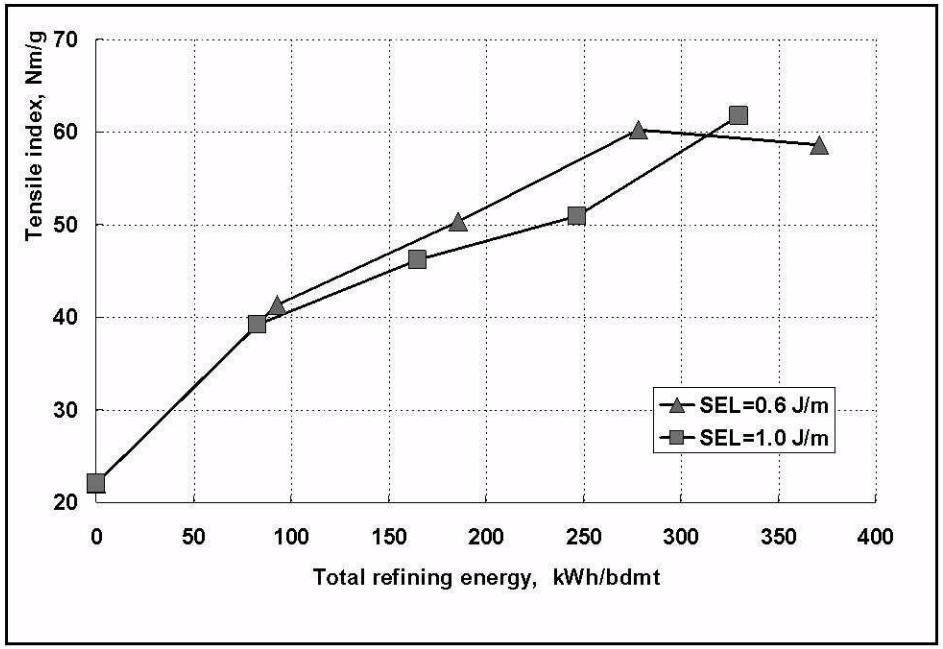
Refining of Brazilian dried ECF bleached eucalyptus sulphate pulp
Conflo JC-01, 1000 rpm = 24 m/s

Refining conditions

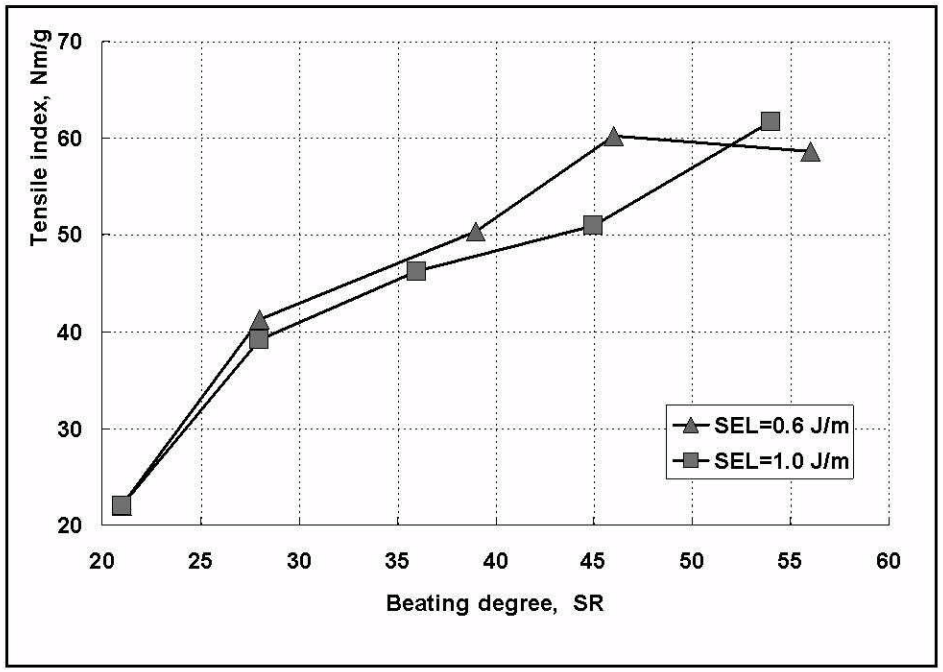
Net kWh/bdmt	4*60	4*60
Fillings	SM	SM
SEL, J/m	0.6	1.0
SSL, J/m^2	235	390
Consistency, %	4.5	4.4
Flow, lpm	545	910
Efficiency, %	63.5	74.7

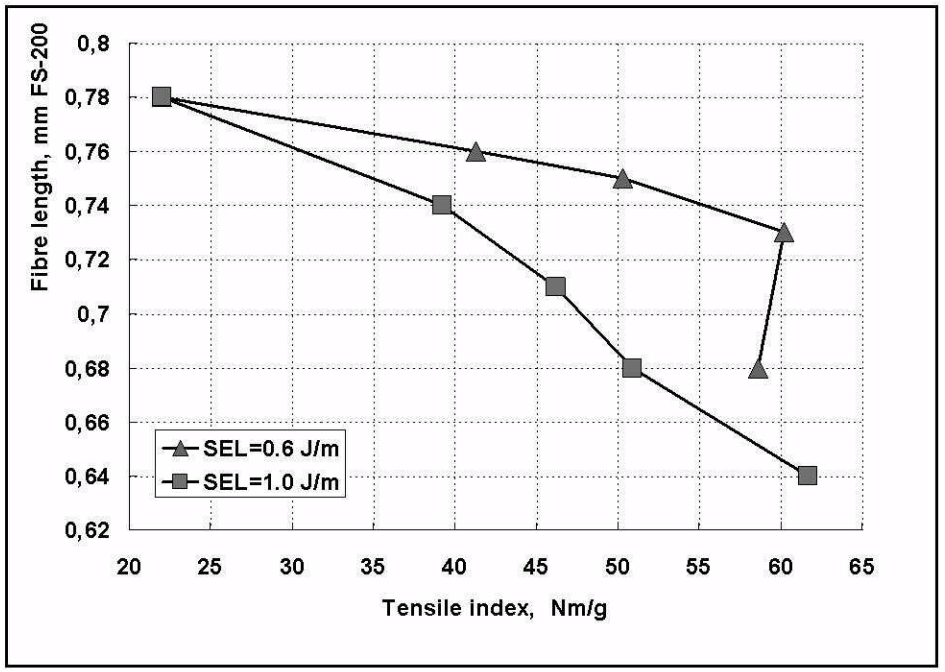
Conical refiner at varying capacities





Conical refiner at varying capacities





Conical refiner at varying capacities

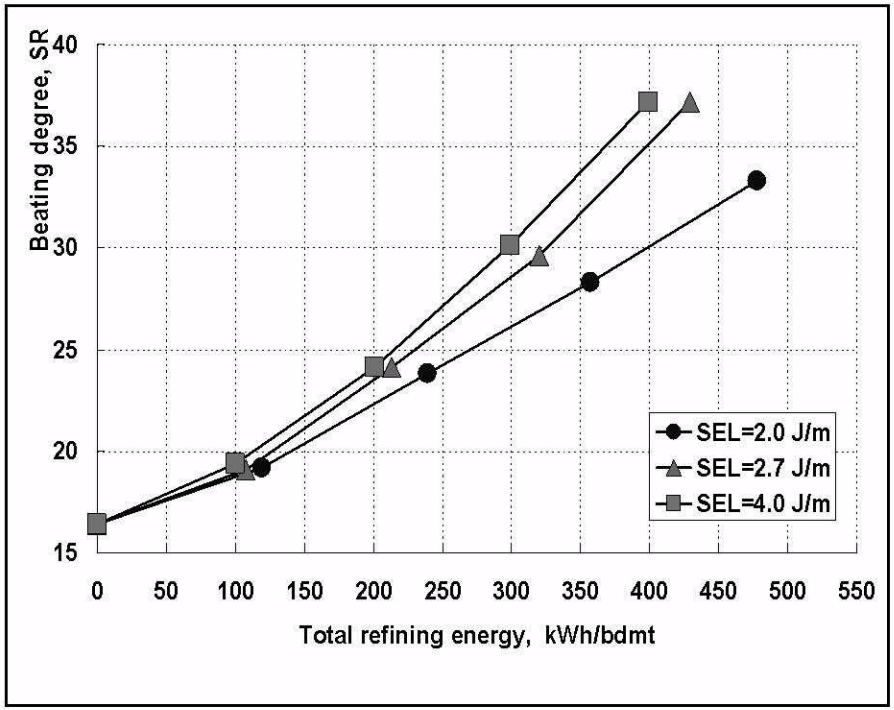
Refining of Canadian dried ECF bleached softwood sulphate pulp

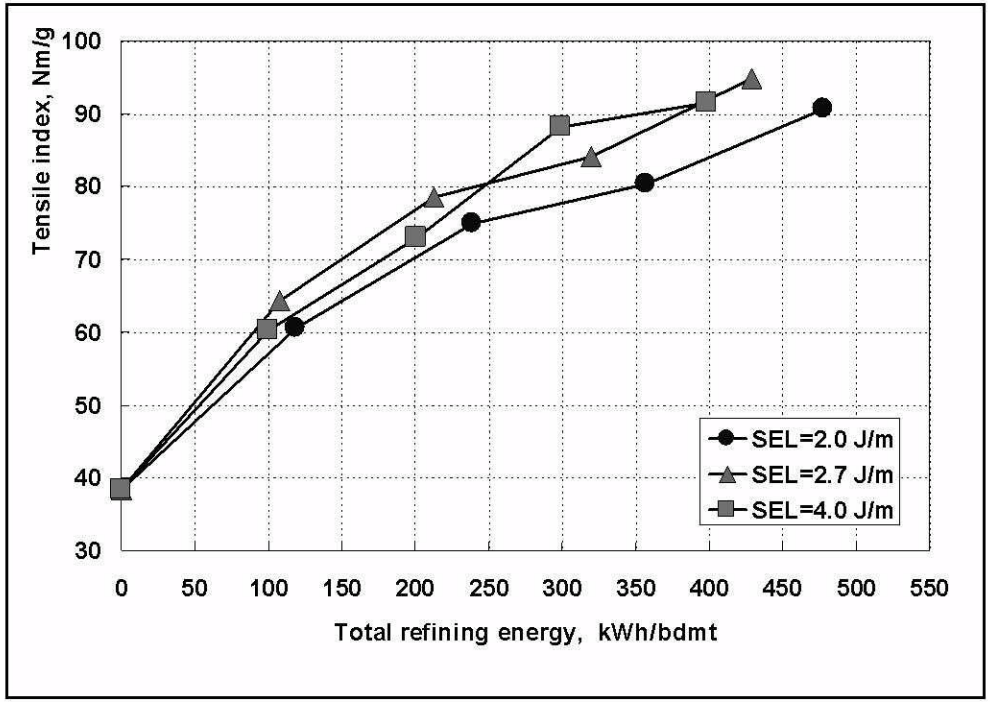
- Conflo JC-01, 1000 rpm = 24 m/s

Refining conditions

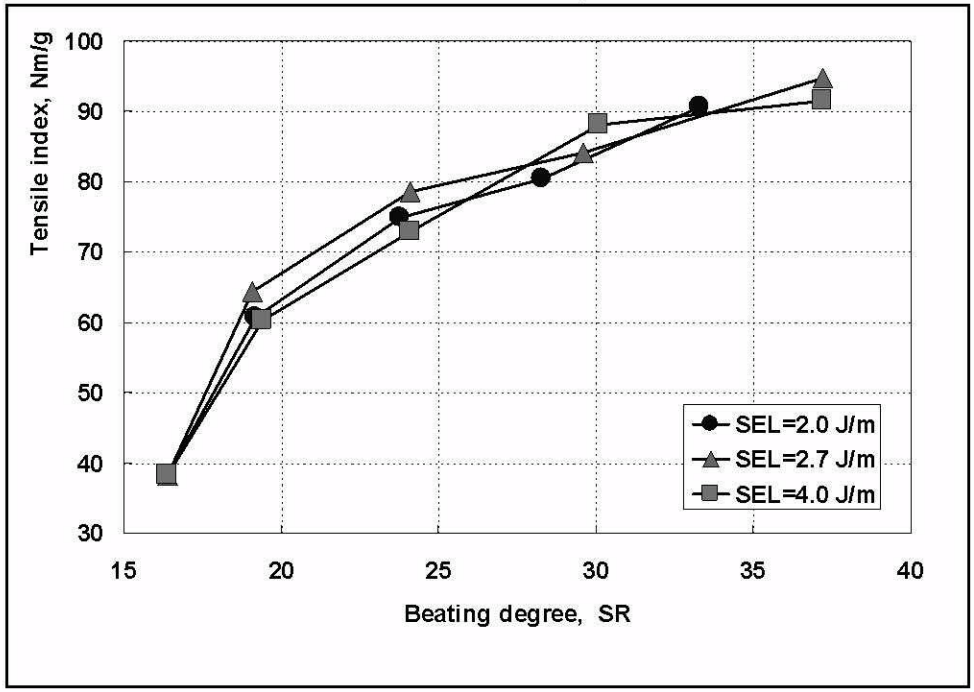
Net kWh/bdmt	4*75	4*75	4*75
Fillings	LM	LM	LM
SEL, J/m	2.0	2.7	4.0
SSL, J/m^2	423	570	845
Consistency, %	3.8	3.9	3.9
Flow, lpm	502	667	945
Efficiency, %	63.5	70.1	77.5

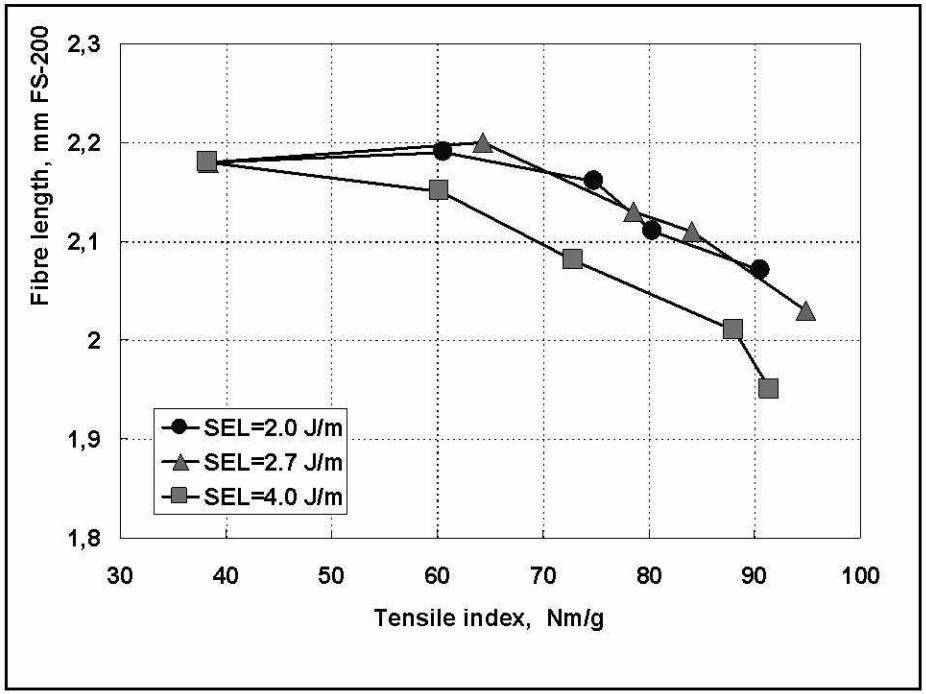
Conical refiner at varying capacities





Conical refiner at varying capacities

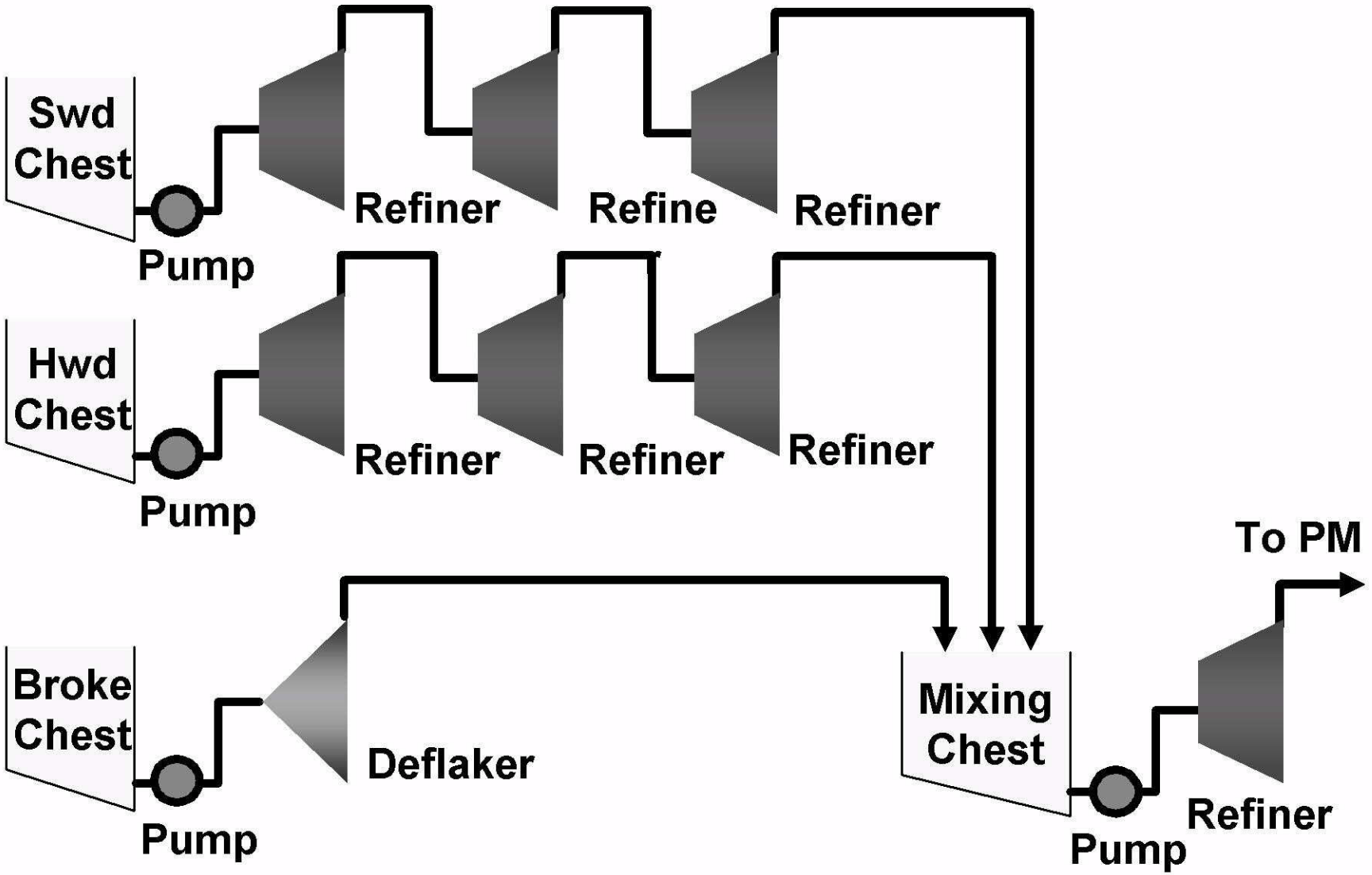




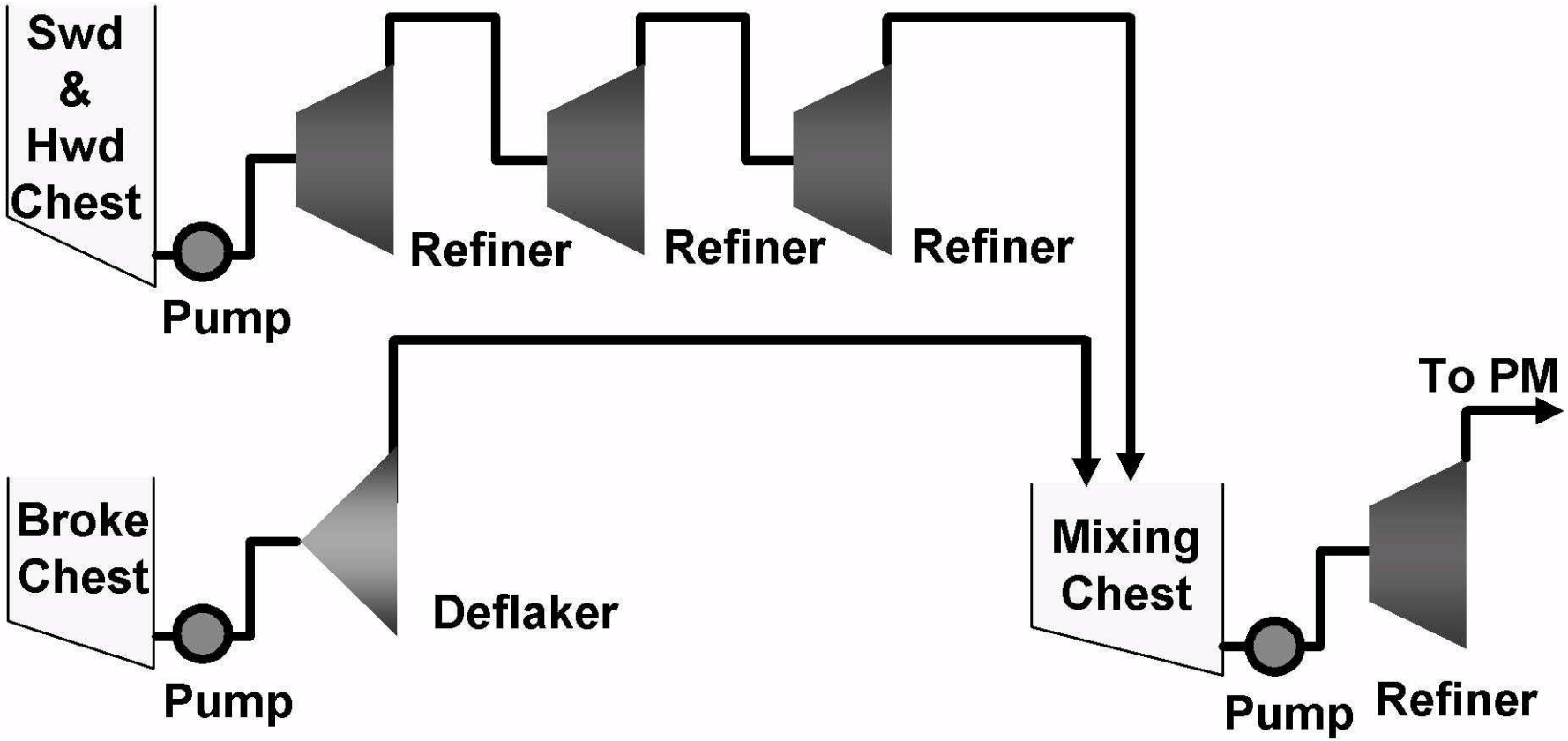
Separate or Mixed Refining?

- **Both systems are widely used**
- **Old small paper machines most typically have a mixed system**
- **New large paper machines most typically have a separate system**

Separate or Mixed Refining?



Separate or Mixed Refining?



Fibers

Pulp	Fiber L. mm	Coars. mg/m	SR degr.	Tensile Nm/g
Pine1 Sa	2.09	0.205	15	26.3
Pine2 Sa	2.18	0.166	16	38.3
Euca Sa	0.78	0.076	21	22.0
Hwd Sa	0.82	0.117	19	19.3

Fibers refined separately and in mixtures

Pine 1 - Eucalyptus series

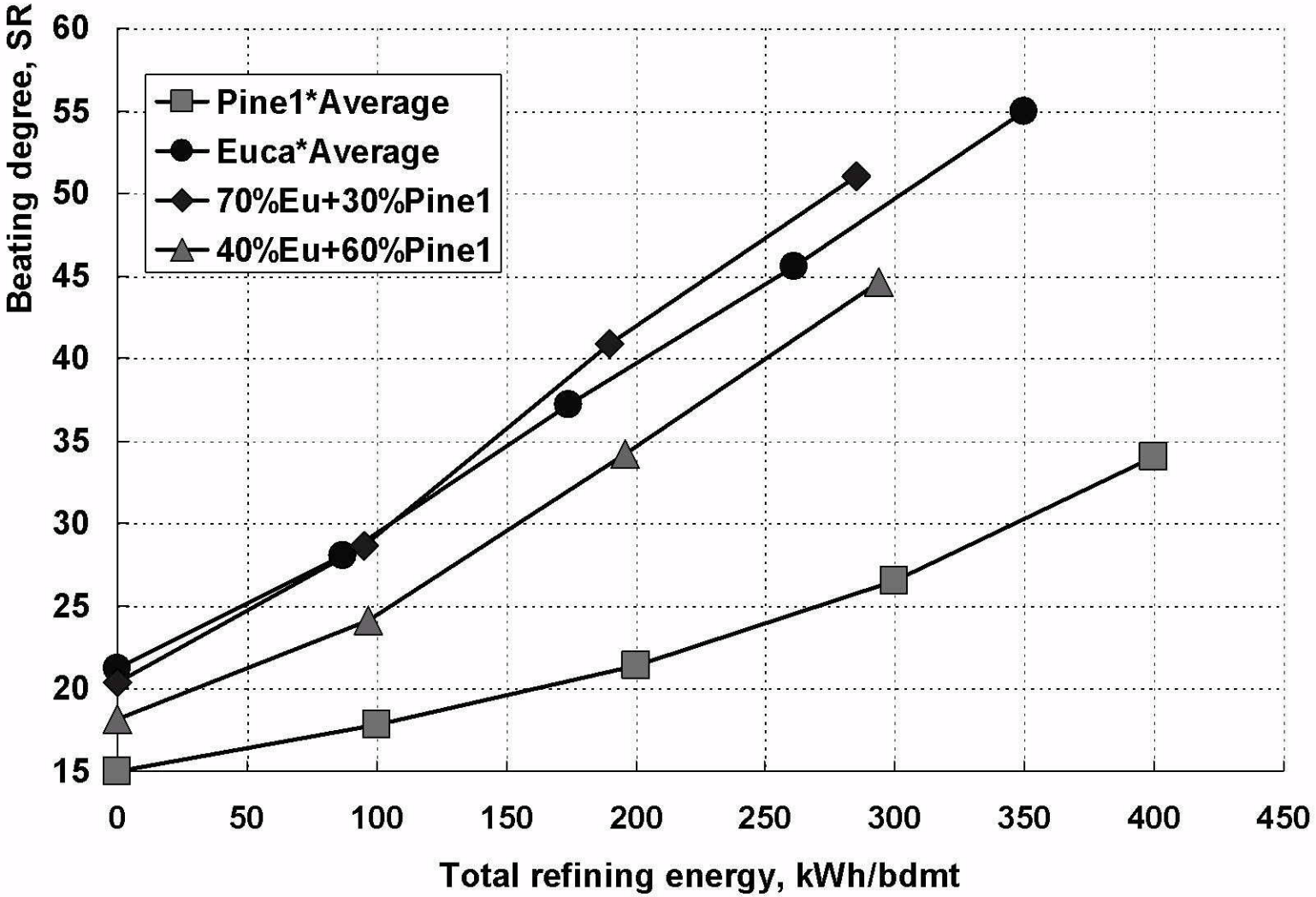
Separate and Mixed Refining of Dried ECF Bleached Scandinavian Pine and Brazilian Eucalyptus Pulps

- Conflo JC-01, 1000 rpm = 24 m/s

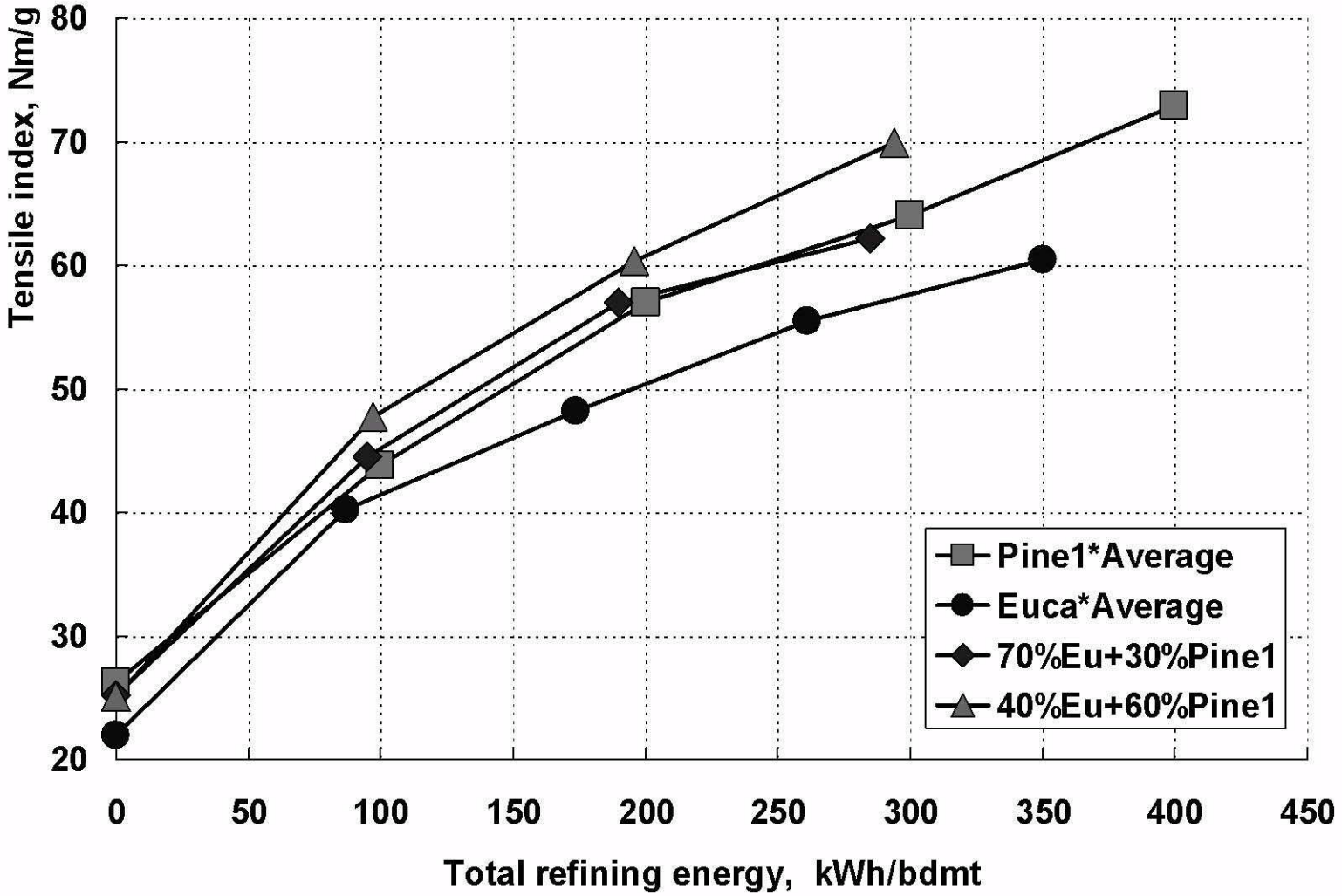
Refining Conditions

• Pulp	100% Pine1	100% Euca	30% Pine1 70% Euca	60% Pine1 40% Euca
• Net kWh/bdmt	4*75	4*60	3*70	3*70
• Fillings	LM	SM	LF	LF
• SEL, J/m	~3.5	~0.8	2.1	2.1
• SSL, J/m^2	740	315	500	500
• Cons., %	4.0	4.5	4.5	4.5
• Flow, lpm	842	667	650	650
• Effic., %	72.2	70.1	70.6	70.6

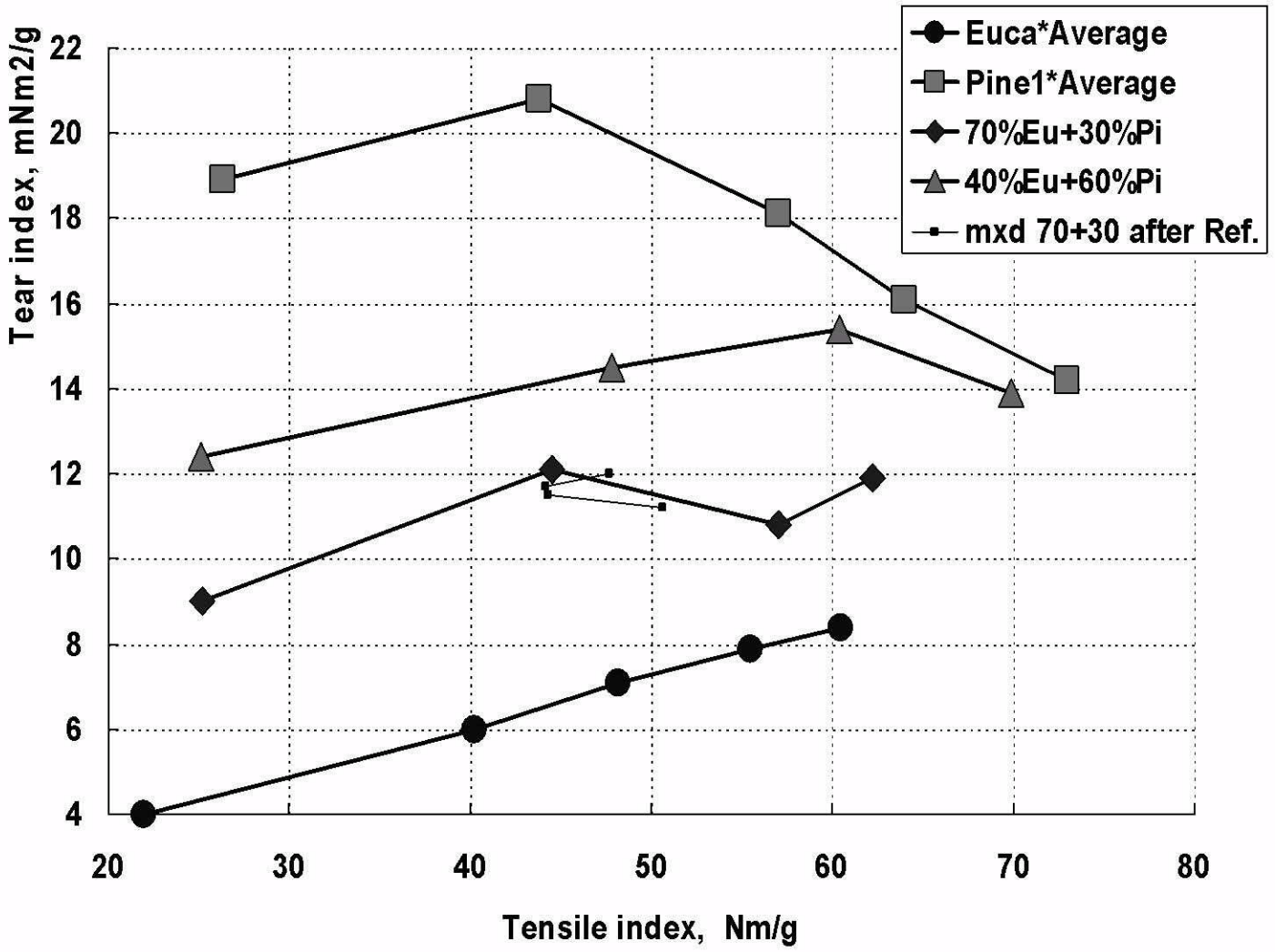
Pine 1 - Eucalyptus series



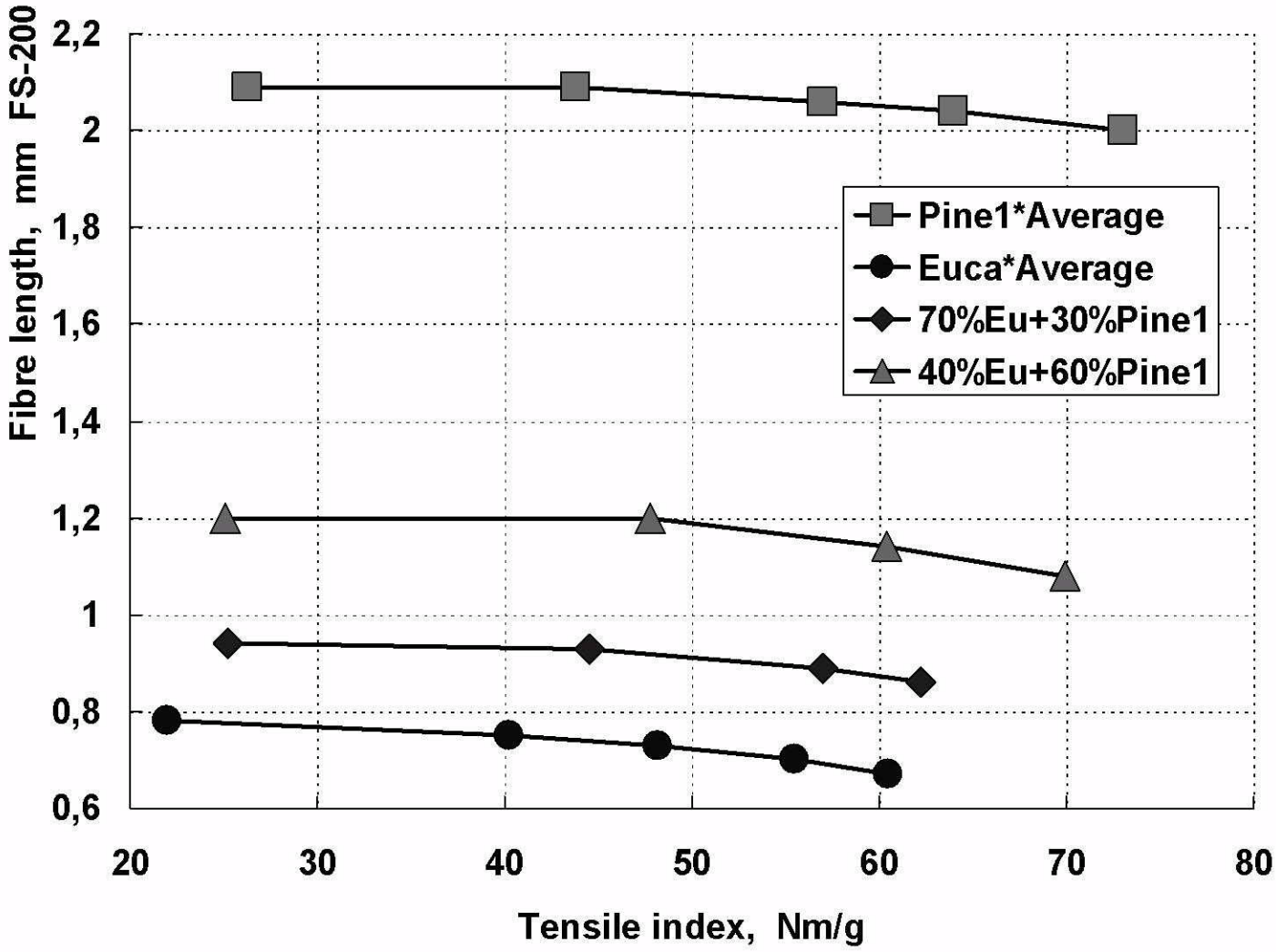
Pine 1 - Eucalyptus series



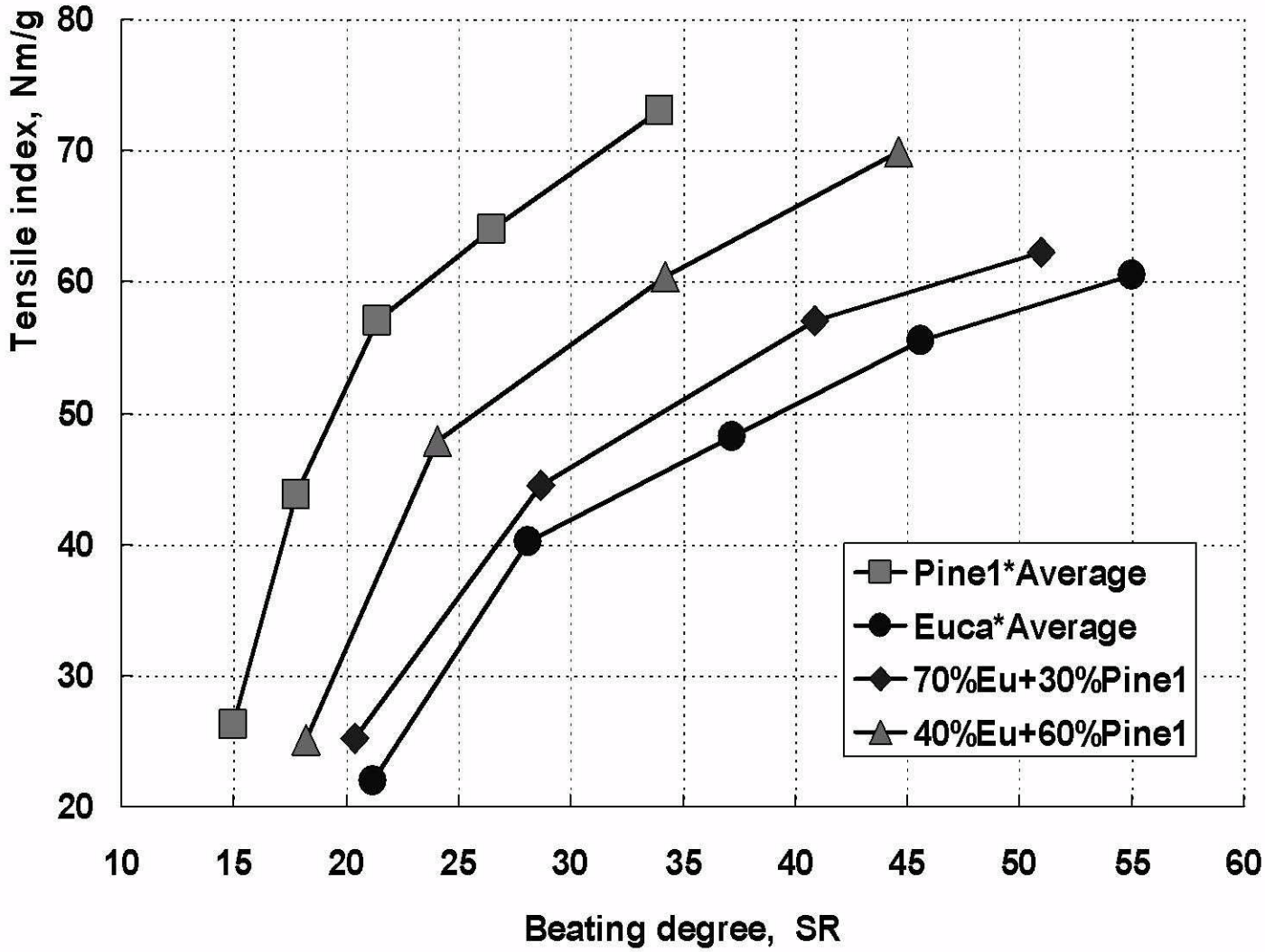
Pine 1 - Eucalyptus series



Pine 1 - Eucalyptus series



Pine 1 - Eucalyptus series



Pine 2 - Mixed hardwood series

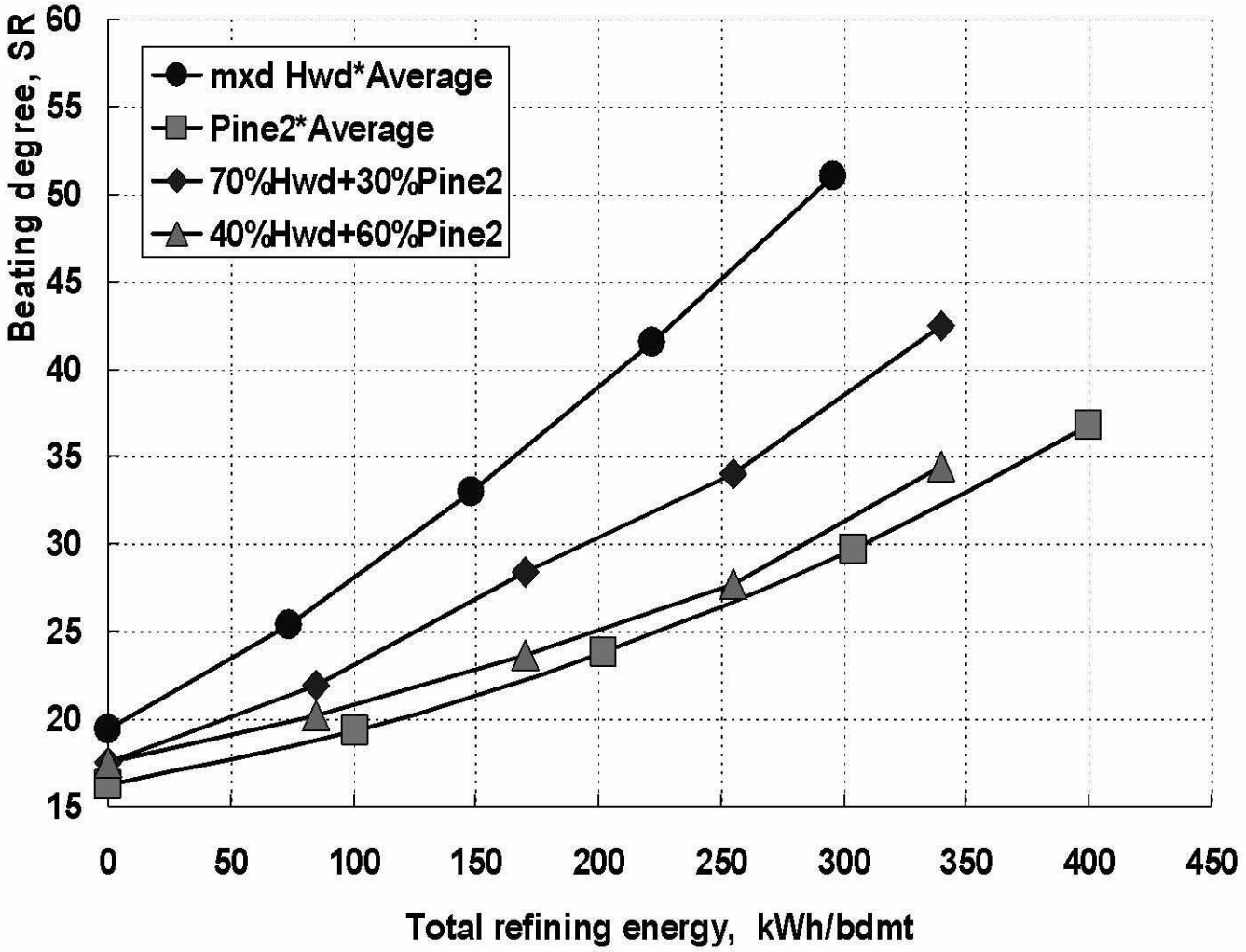
Separate and Mixed Refining of dried ECF bleached Canadian Pine and European mixed Hardwood Pulps.

- Conflo JC-01, 1000 rpm = 24 m/s

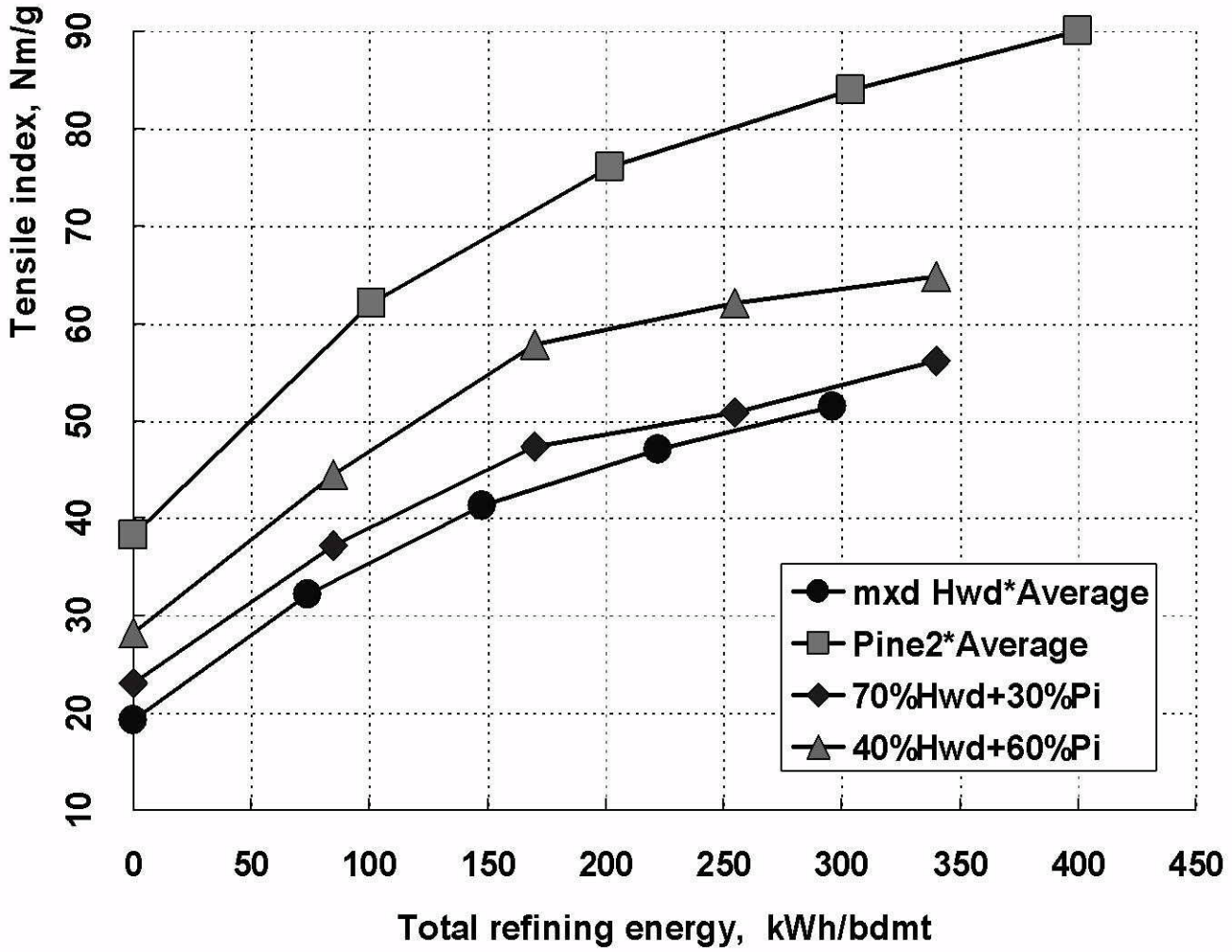
Refining Conditions

Pulp	100% Pine	100% Hwd	30% Pine 70% Hwd	60% Pine 40% Hwd
Net kWh/bdmt	4*75	4*50	4*60	4*60
Fillings	LM	SM	LF	LF
SEL, J/m	~3.5	~0.8	2.1	2.1
SSL, J/m2	740	315	500	500
Cons., %	3.9	4.4	4.5	4.5
Flow, lpm	865	875	740	740
Effic., %	72.2	70.1	70.6	70.6

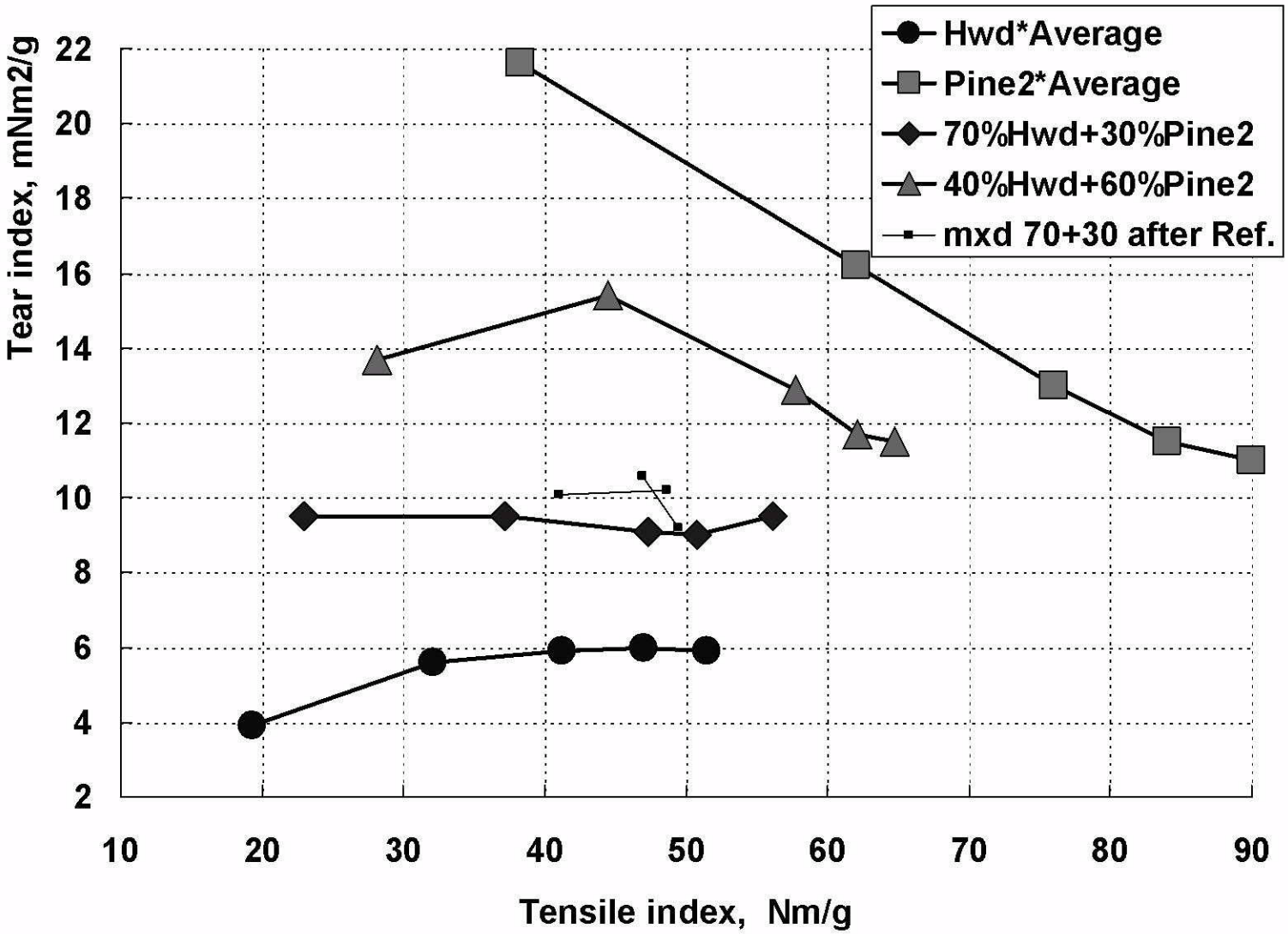
Pine 2 - Mixed hardwood series



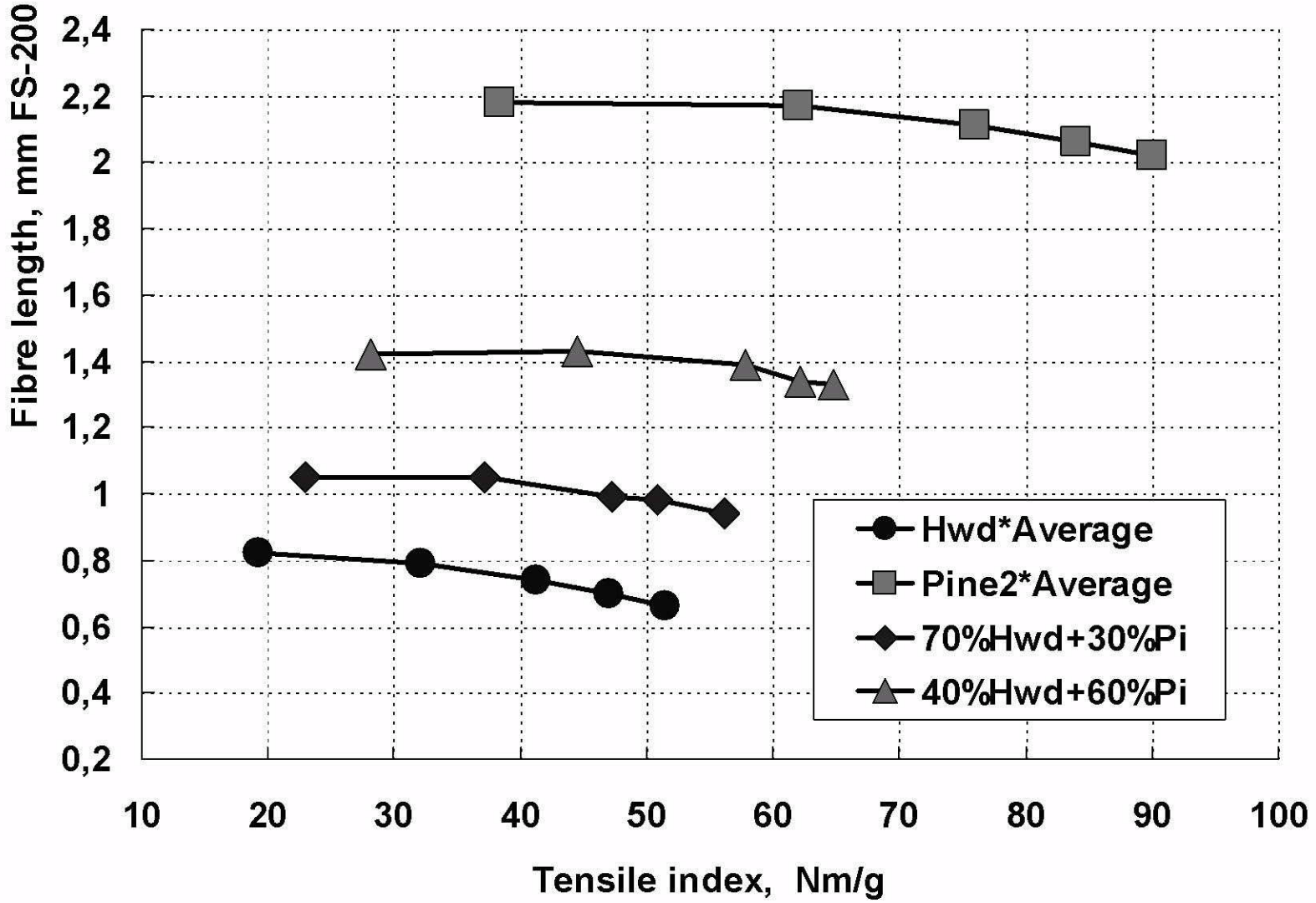
Pine 2 - Mixed hardwood series



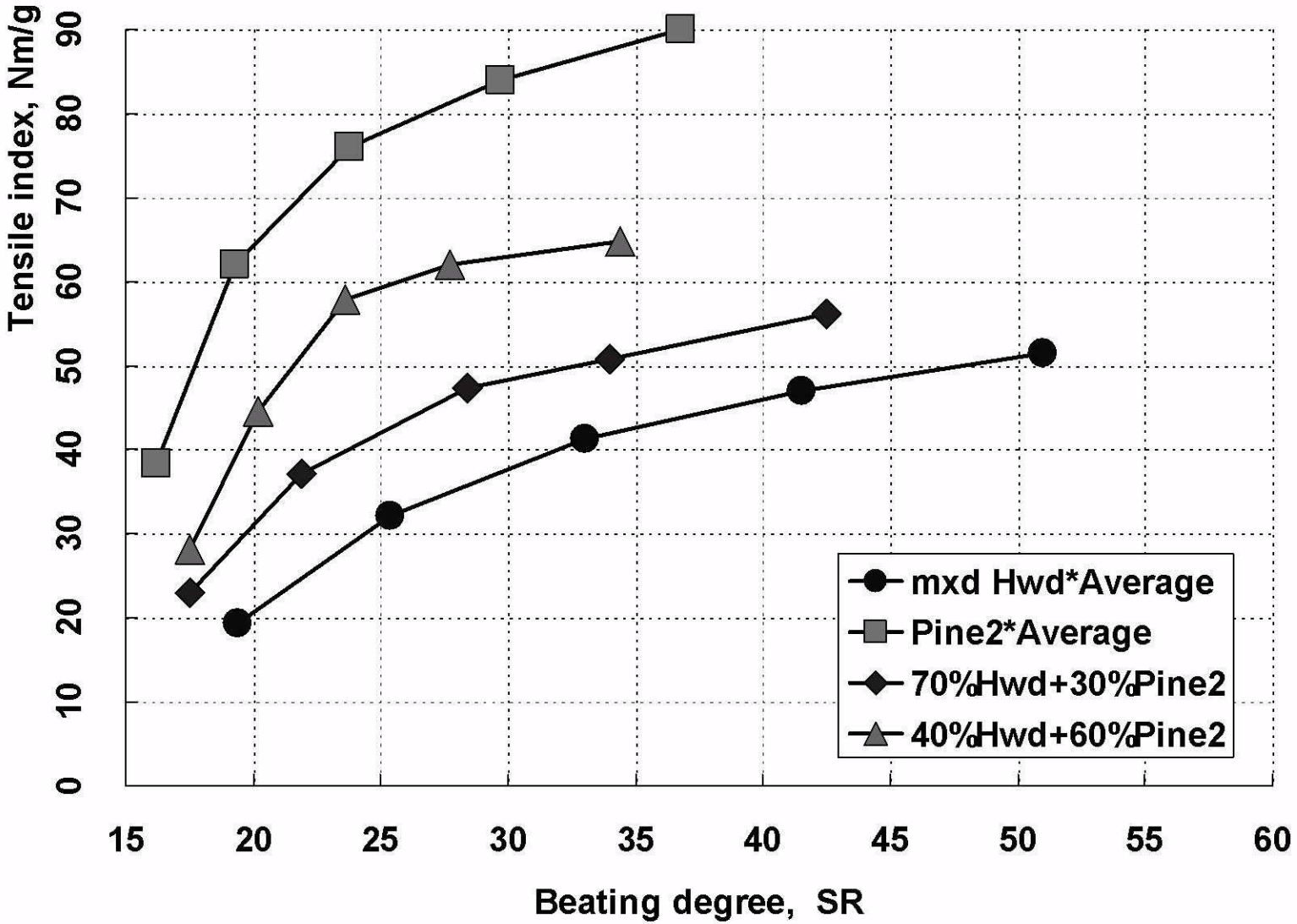
Pine 2 - Mixed hardwood series



Pine 2 - Mixed hardwood series



Pine 2 - Mixed hardwood series



Refining Strategy Evaluation Alternatives

- Total energy requirement for a given Schopper-Riegler
- Total energy requirement for a given tensile strength
- Obtained tear-tensile combination

Refining strategy evaluation
Alternative 1

Actual total energy requirement

- Softwood to 25 SR in separate refining
  - Pine1 = 270 kWh/bdmt
  - Pine2 = 225 kWh/bdmt
- Hardwood to 35 SR in separate refining
  - Eucalyptus = 155 kWh/bdmt
  - Mxd Hardwood = 165 kWh/bdmt
- 30%Swd+70%Hwd mixture to 32 SR in mixed refining
  - Pine1+Eucalyptus = 122 kWh/bdmt
  - Pine2+Mxd Hardwood = 225 kWh/bdmt

Calculated total energy requirement in mixed refining for 30%Swd+70%Hwd mixture to 32 SR

- Pine1+Eucalyptus = 189.5 kWh/bdmt (+55.3%)
- Pine2+Mxd Hardwood = 183.0 kWh/bdmt (-18.7%)

Refining strategy evaluation
Alternative 2

Actual total energy requirement

- Softwood to 70 Nm/g in separate refining
  - Pine1 = 365 kWh/bdmt
  - Pine2 = 155 kWh/bdmt
- Hardwood to 50 Nm/g in separate refining
  - Eucalyptus = 195 kWh/bdmt
  - Mxd Hardwood = 275 kWh/bdmt
- 30%Swd+70%Hwd mixture to 56 Nm/g in mixed refining
  - Pine1+Eucalyptus = 185 kWh/bdmt
  - Pine2+Mxd Hardwood = 330 kWh/bdmt

Calculated total energy requirement in mixed refining for 30%Swd+70%Hwd mixture to 56 Nm/g

- Pine1+Eucalyptus = 246.0 kWh/bdmt (+33.0%)
- Pine2+Mxd Hardwood = 239.0 kWh/bdmt (-27.6%)

Refining strategy evaluation
Alternative 3

Obtained tear-tensile combination can be evaluated by evaluating separately refined fibers to fibers after mixed refining.

- **for Pine1+Eucalyptus both refining strategies show quite equal figures**

- **for Pine2+Mxd Hardwood separate refining seems to be slightly better than mixed refining**

Suitability of Mixed Refining

Softwood Grade	Hardwood Grade	
	Euca	Mxd Hwd
Pine1	++	+-
Pine2	na	- -

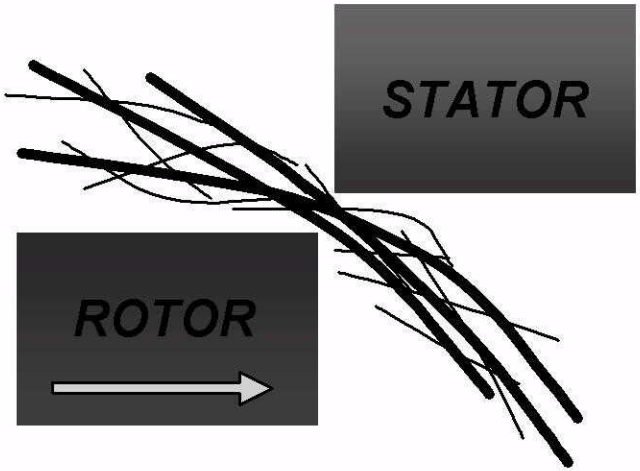
Fibers in mixed refining

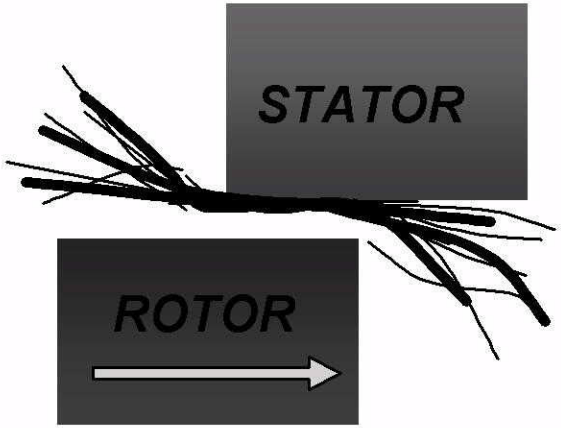
Physical dimensions and bonding ability of fibres are such that fibres form strong flocs, which do not break.

- effective fibre protection.
- effective refining through fibre-to-fibre contact.

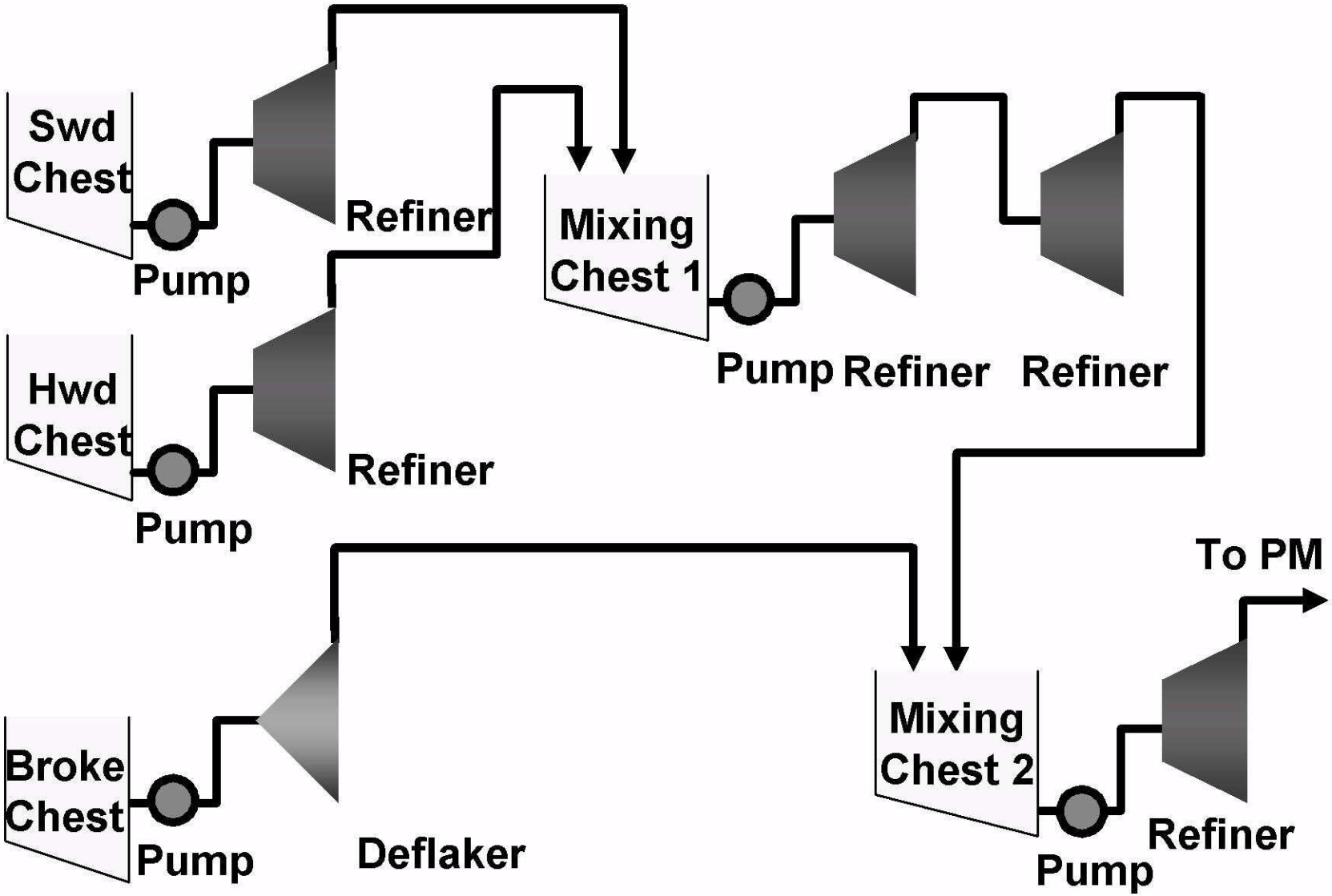
Refining conditions are correct.

- optimized refining intensity is lower than for softwood but higher than for hardwood.
- bars and grooves are wide enough for long and coarse softwood fibres.





Proposed refining system



Conclusion

- **Conflo® refiners are suitable for quite wide capacity range**
- **Conflo® refiners have several advantages over Double Disc refiners, such as:**
  - Lower energy consumption
  - Strength at lower drainage resistance
  - Less fibre cutting
- **Mixed refining is advantageous for some fibre mixtures**
- **Separate refining is advantageous for some fibre mixtures**
- **Most suitable seems to be combined refining system**
  - Optimized energy consumption
  - Maximized fibre development
  - Freedom in fibre selection


metso
paper