Beyond the Basics: Cutting-Edge Stock Preparation for Molded Fiber

Thermoformed Molded Fiber Symposium

University of Maine

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Valmet

Agenda

- Introduction
- Pulping
- Equipment protection
- Refining
  - Refiner types
  - Refining mechanism and impact on fibers
  - Factors affecting refining
  - Specific energy
  - Refining intensity
  - Refining efficiency
- Deflaking

Valmet Today: Progress built on 220 years of industrial history

From cloth making to high-tech processes

1797 Jokioisten Verkatehdas
1841 Götaverken
1856 Tampella
1858 Beloit
1860 KMW
1868 Sunds Defibrator

1942
Rauma-Raahe

1951
Valmet

1968–1996
Several M&As:
1986 KMW
1987 Wärtsilä paper finishing machinery
1992 Tampella Papertech

1999
Metso created through merger of Valmet and Rauma

Acquisitions
2000
Beloit Technology
2006
Kvaerner Pulping
Kvaerner Power
2009
Tamfelt

End of 2013
Demerger to Valmet and Metso

2015
Metso Process Automation Systems to Valmet

2019
Valmet acquires GL&V and J&L Fiber Services Inc

2020
Valmet acquires PMP Group

2021
Valmet acquires EWK Umwelttechnik and ECP Group

2022
Neles merged into Valmet

Valmet acquires Coldwater Seals

2023
Valmet acquires Novatech Automation's Process Solutions business and Körber's Business Area Tissue

Valmet Today: Unique offering combining process technology, services, and automation

Board and paper technologies

- Board, paper, and tissue production lines, tissue converting
- Rebuilds
- Machine sections
- Stock preparation systems
- Recycled fiber systems

Services

- Spare and process parts
- Workshop and roll services
- Fabrics
- Maintenance development and outsourcing
- Field services
- Process upgrades
- Industrial Internet solutions

Pulp technologies

- Complete pulp mills
- Pulp mill processes
  - Wood handling, Cooking and fiber line, Pulp drying and baling, Chemical recovery

Energy technologies

- Heat and power generation
- Air emission control
- Biofuels production

Flow Control and Automation Systems

- Valves
- Valve automation
- Valve controls
- Distributed Control Systems (DCS)
- Quality Management Systems (QMS)
- Analyzers and measurements
- Industrial applications
- Services and Industrial Internet solutions

Overview of stock preparation offering

Solutions and equipment to process raw materials for all paper grades and pulp lines

Raw material handling

Old Corrugated Containers (OCC)

Sorted office paper (SOP)

Virgin fiber bales

- Recycled fiber plants
- OCC plant
- Deinking (DIP) plant
- Reject & sludge handling
- Stock preparation
- Bale pulping
- Refining
- Approach flow system
- Broke collection and handling
- White Water systems

Paper & Board

Board and paper lines

Tissue lines

Pulp

- Mechanical pulp lines
- Pulp drying machines

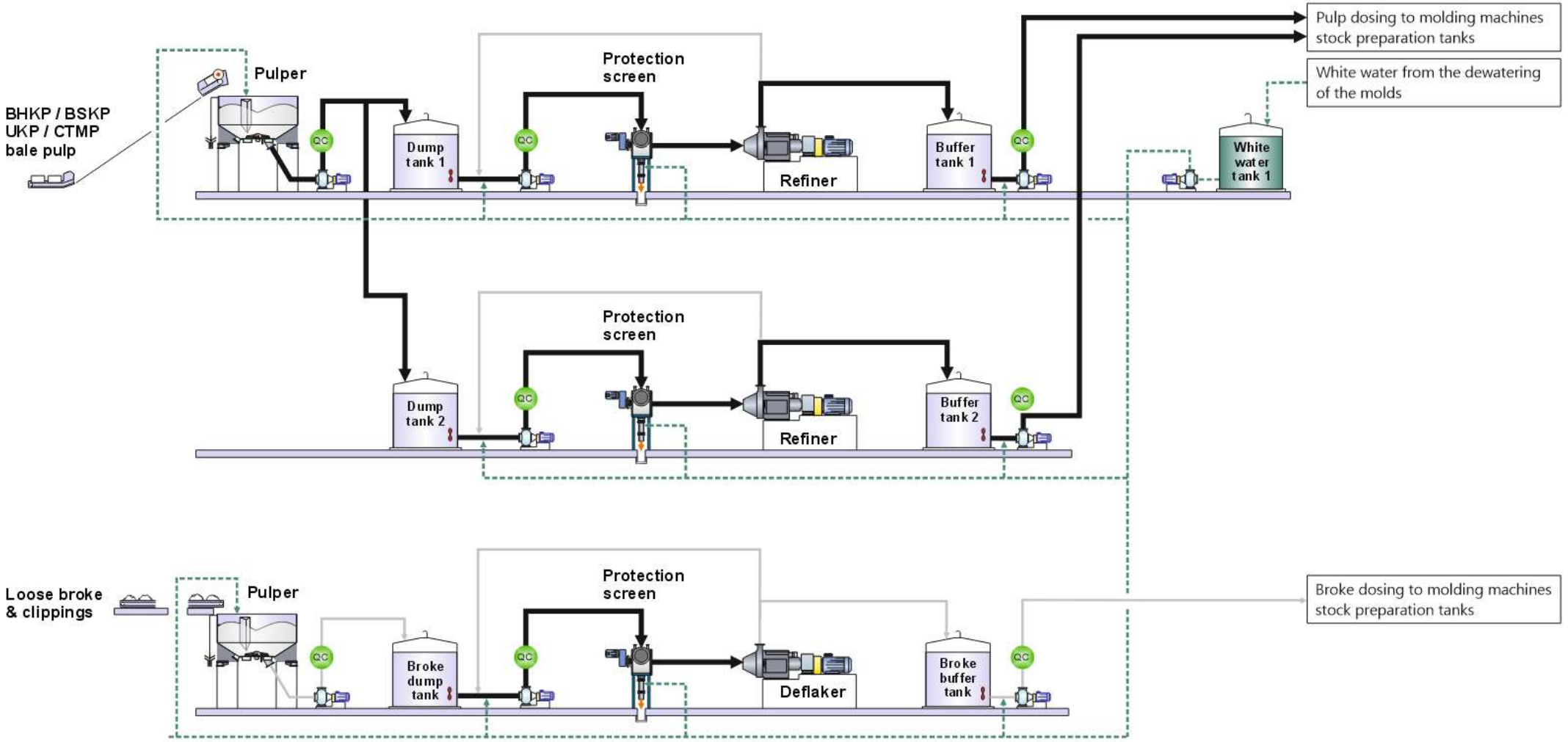
Stock preparation for molded fiber

Mold your fibers for optimal results

Well designed stock preparation system ensures smooth operation and preferred end-product qualities

Stock preparation concept for multiple forming machines

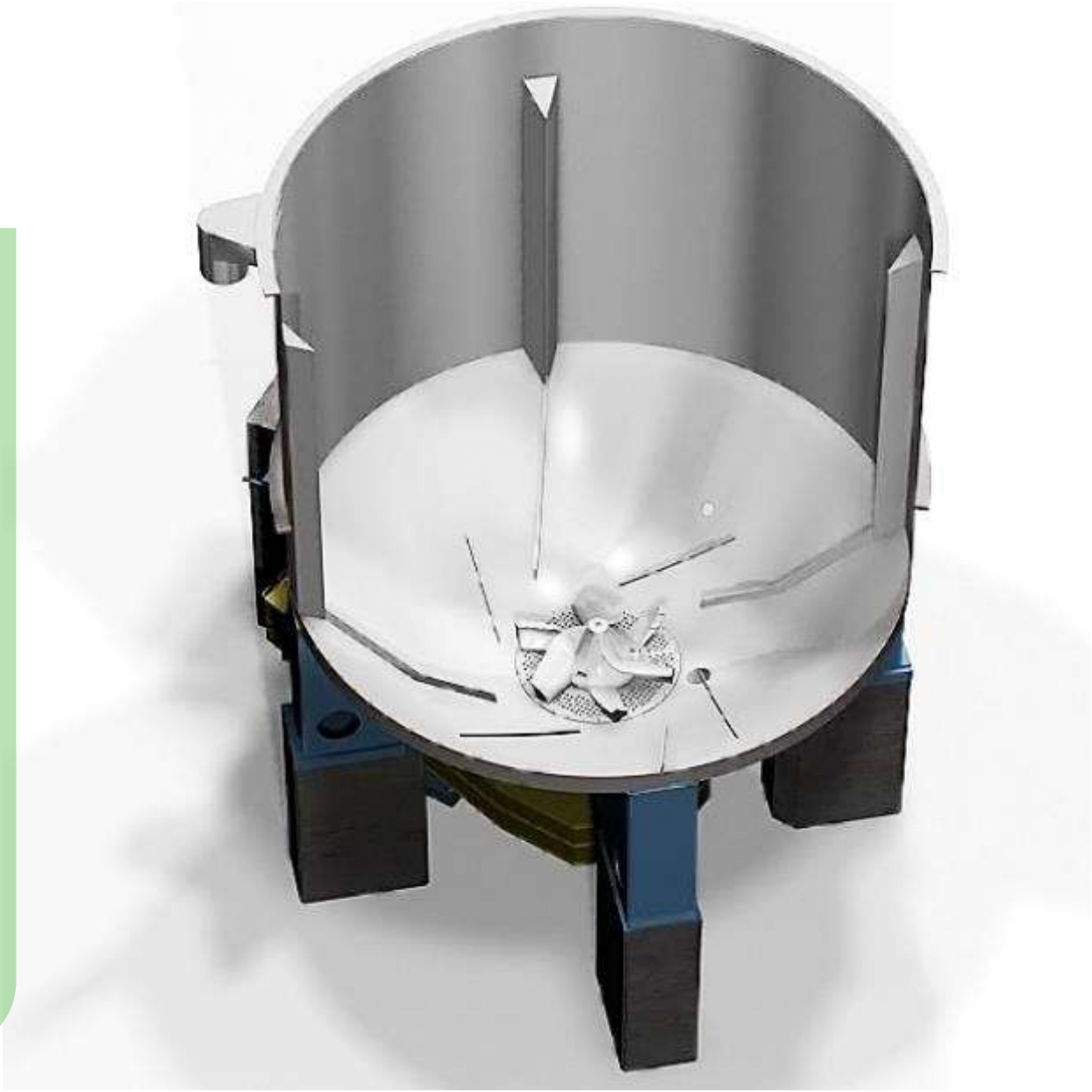
Several different fiber types from one pulper



Pulping

Bale Pulper

- One bale pulper - batch operation
- Several different fiber types can be served from one pulper
- Number of fiber lines depending on need for separation of fibers and individually treat the fiber types
- Broke collection from several machines can be brought to common broke pulper
  - Plant layout and need for separation of broke types define the number of broke lines

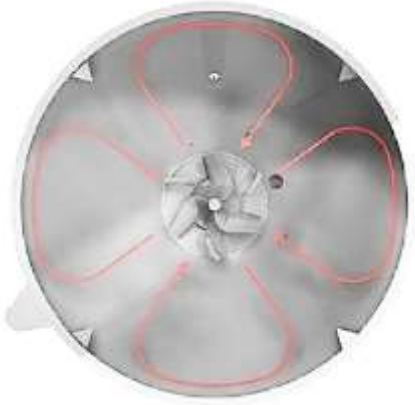


Bale Pulper

Operation principle

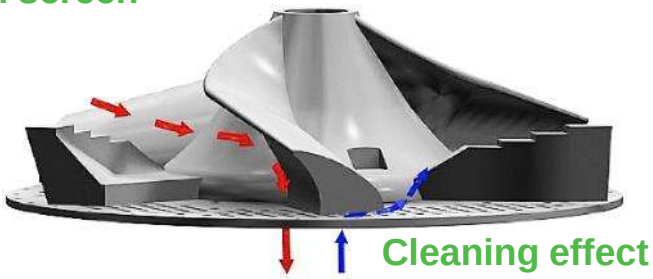
Mechanical forces

Hydraulic forces



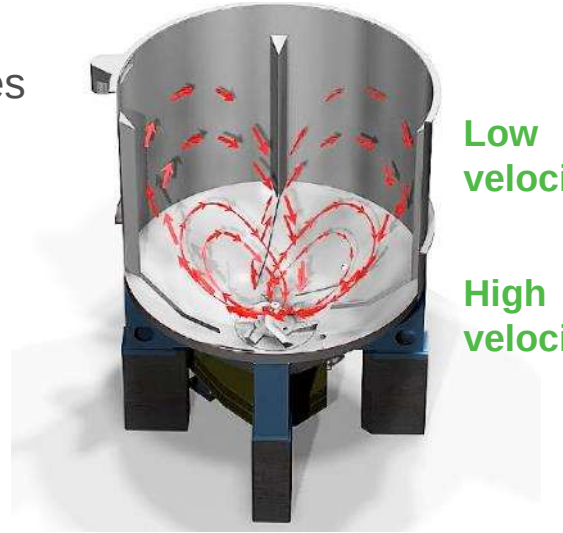
High capacity through screen plate

Discharge



Cleaning effect

Hydraulic forces



Low velocity

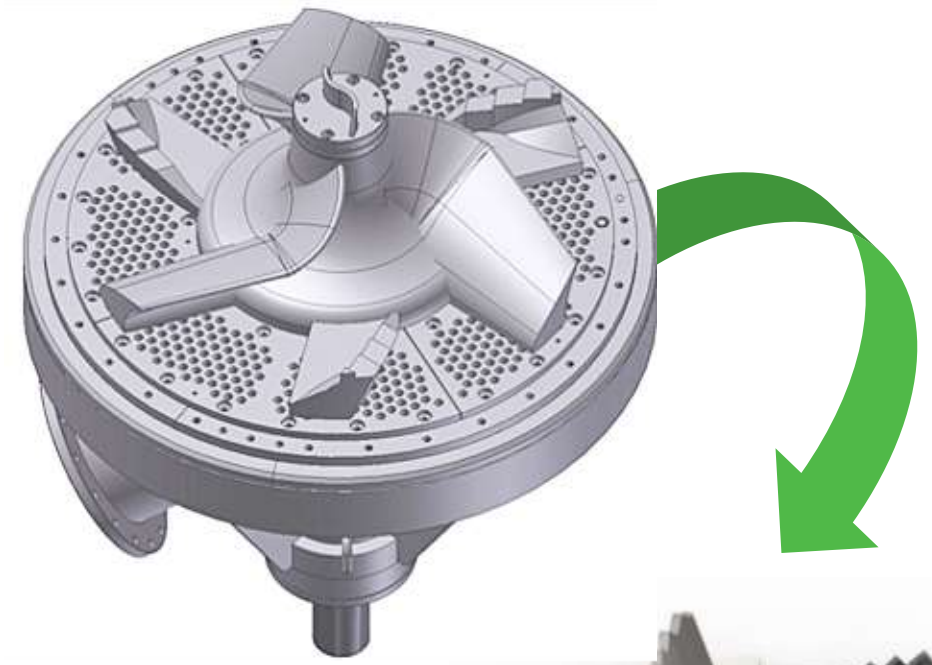
High velocity

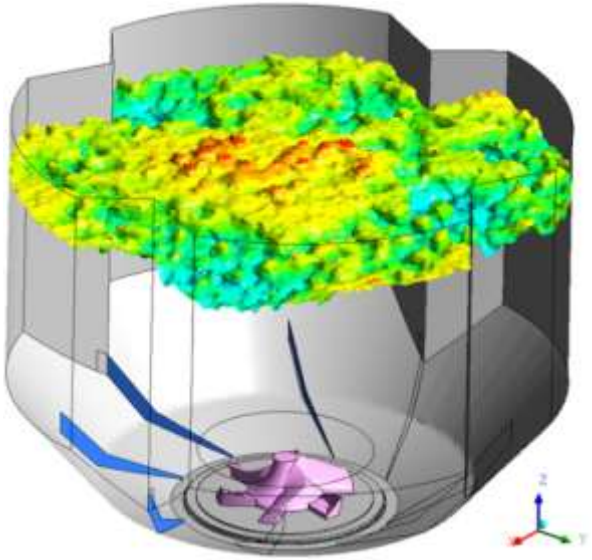
Bale Pulper

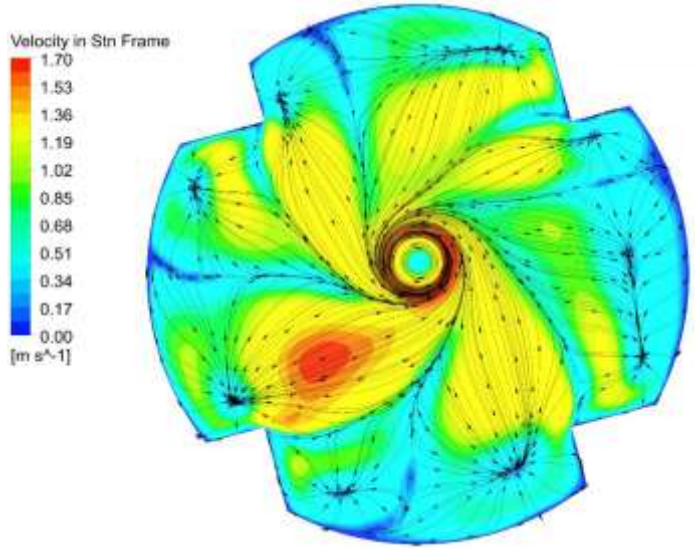
Factors affecting slushing

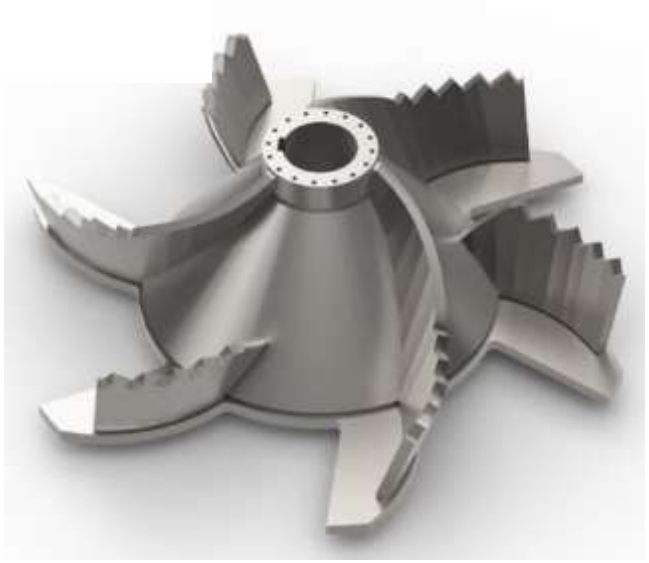
Improving pulper performance

- Vat design
- Rotor design and material
- Process – hydraulics, consistency, controls





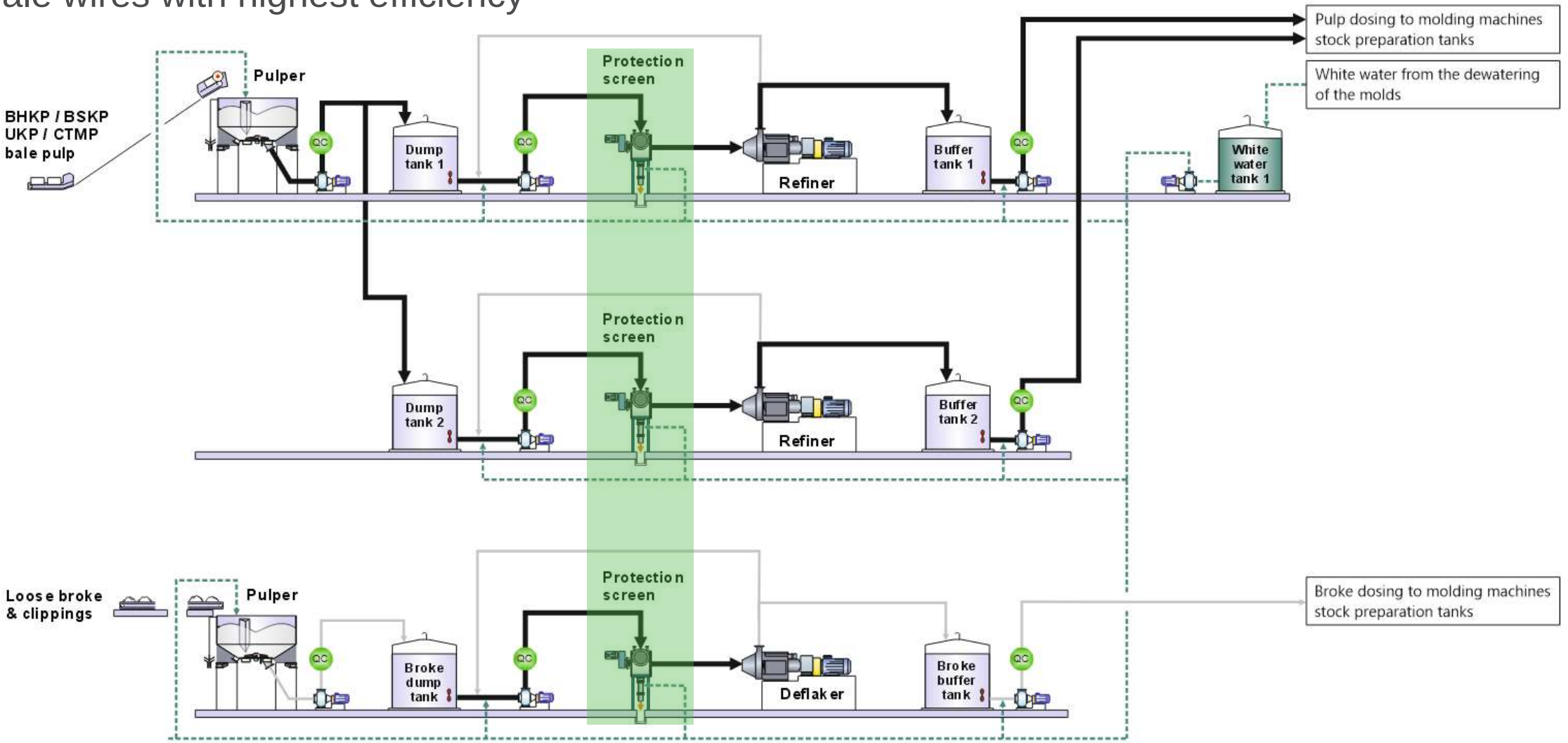




Equipment protection

Refiner and Deflaker protection alternatives

Valmet Protection Screen DX offers barrier protection down to 2 mm wide slots to remove remaining bale wires with highest efficiency



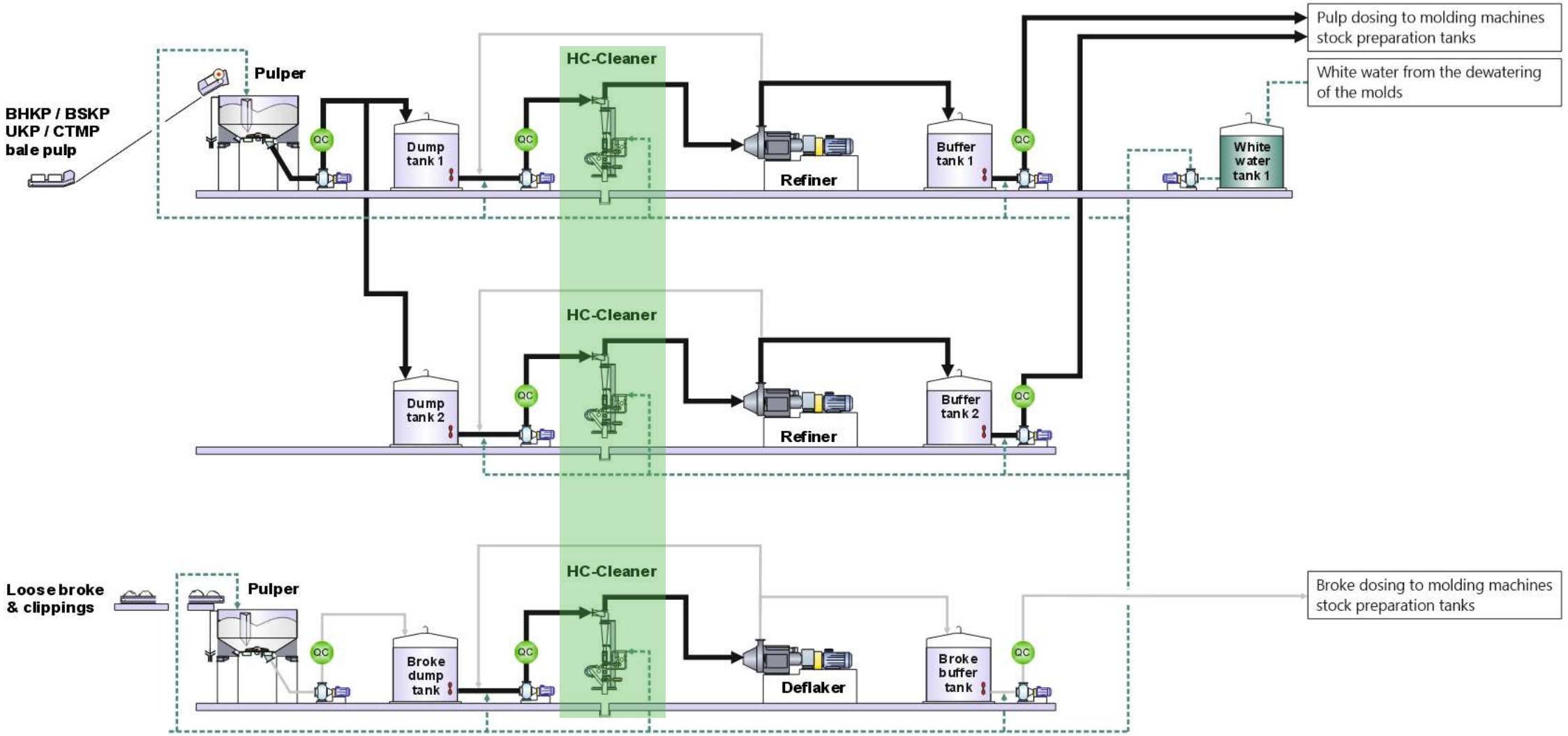
Protection Screen

- Used to remove large contaminants, safeguarding downstream equipment
- Barrier protection down to 2 mm wide slots
- Screen cylinder creates a barrier, filtering out contaminants larger than its screen cylinder apertures
- Can operate with consistencies up to 5.5%
- Low maintenance costs
- Low energy consumption
- Cost effective barrier screen that minimizes downtime

Valmet Protection Screen DX

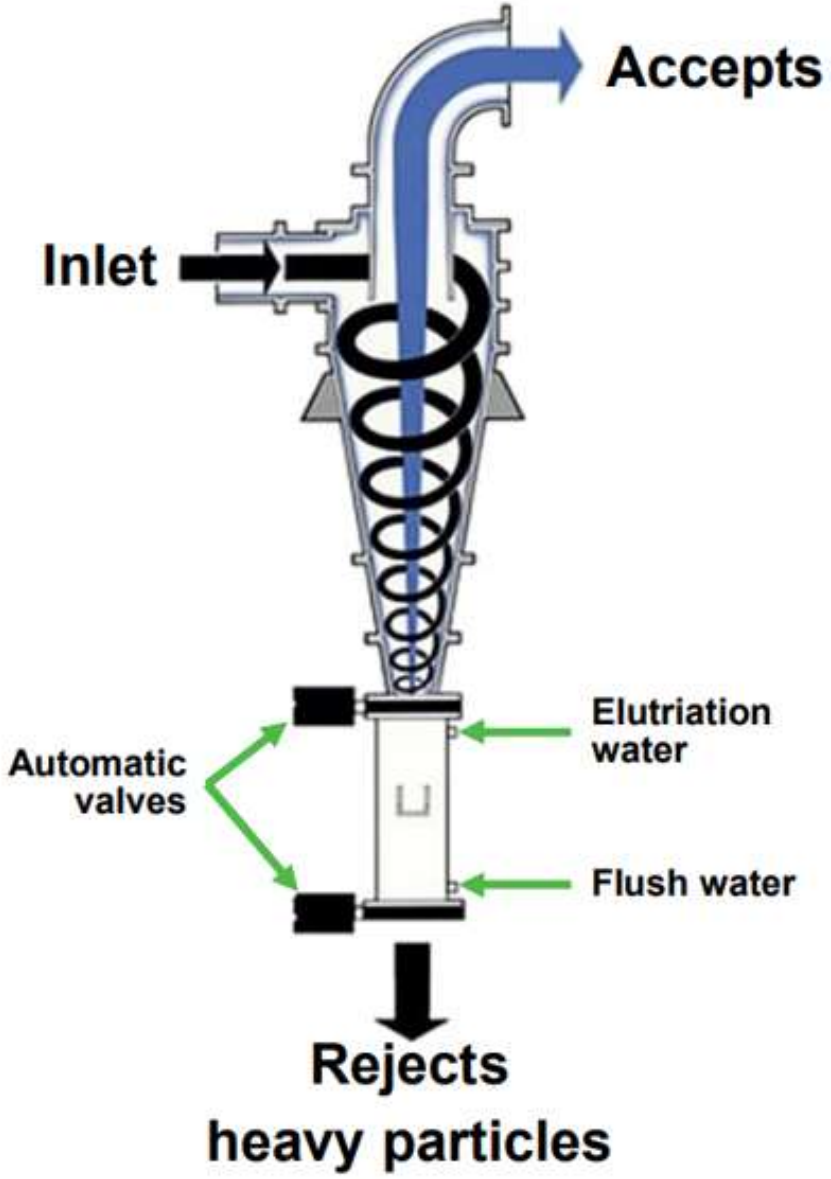
Refiner and Deflaker protection alternatives

Valmet high consistency cleaners – lower cost alternative offering good protection



High Consistency Cleaner

- Used to remove large heavy-weight contaminants (metal, rocks, etc.) to protect downstream equipment (refiners, deflakers, etc.)
- Lower cost alternative to protection screen, also offers good protection, but it is a probabilistic separation so there’s no 100% separation guarantee
- At low production rates, accepts consistency drops and may be too low for refining or deflaking



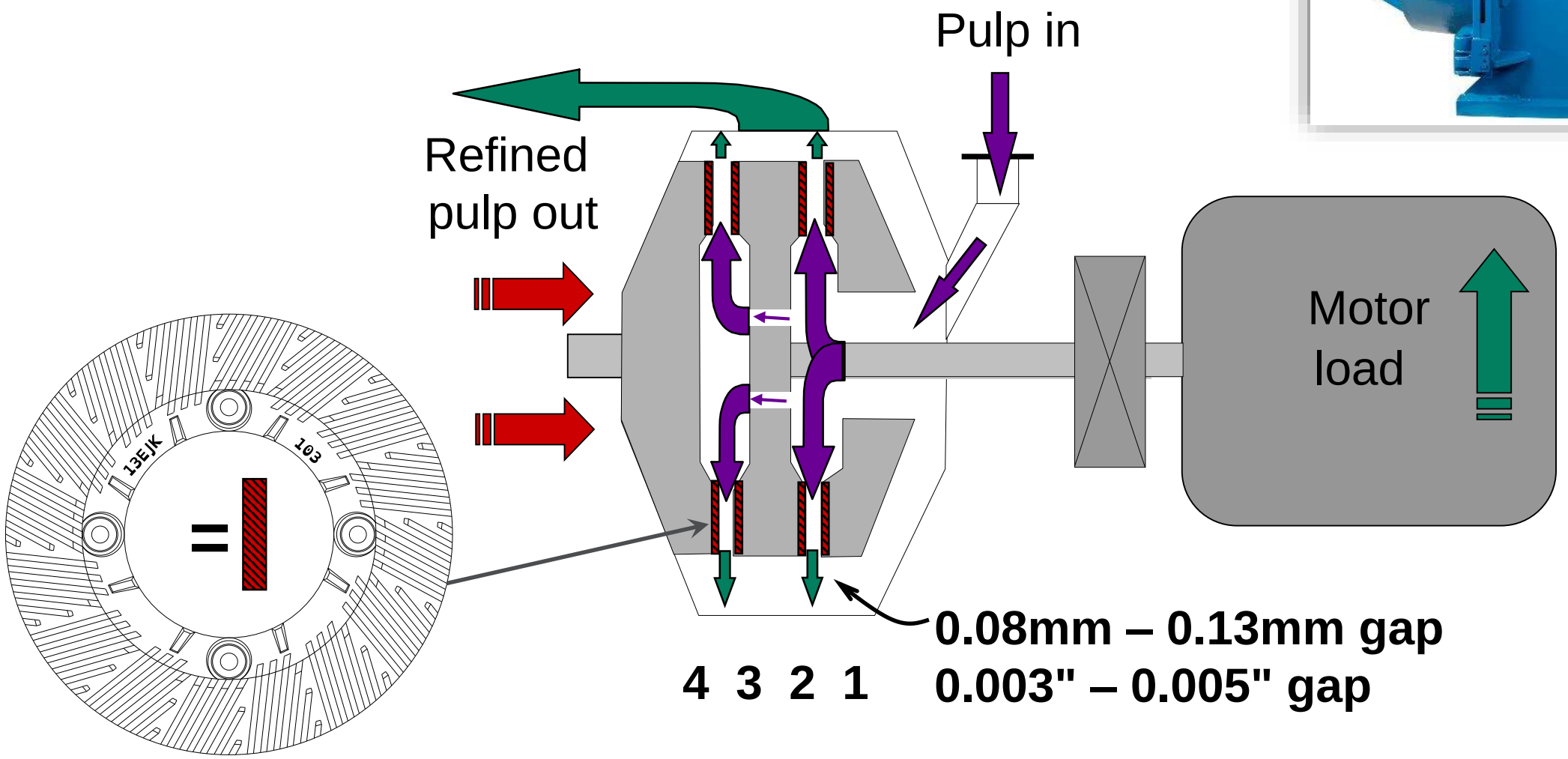
Refining

Refiners

Ensure the preferred qualities and strength in the final molded fiber products

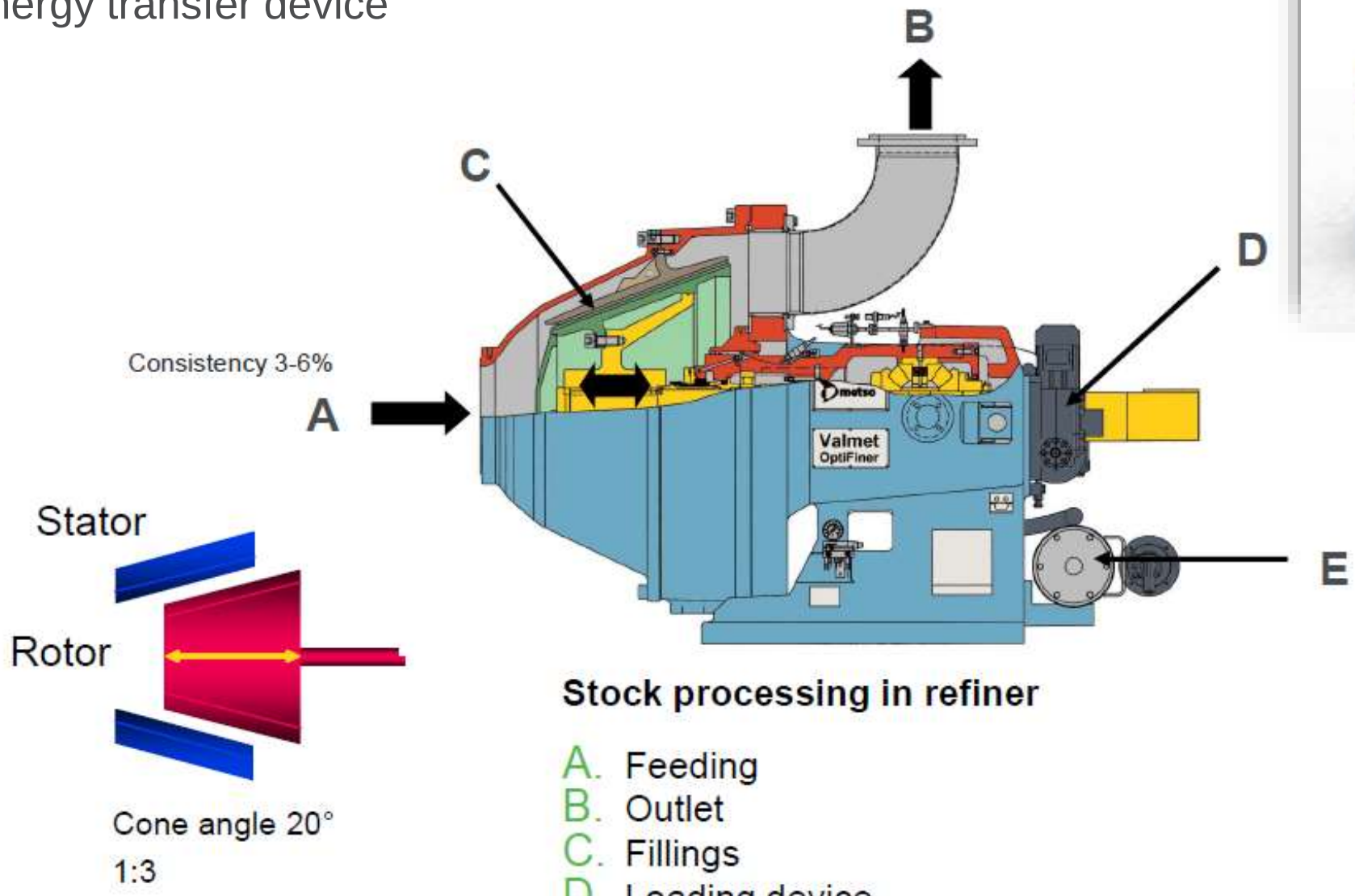
Double disk refiner operation

An energy transfer device



Conical refiner operation

An energy transfer device

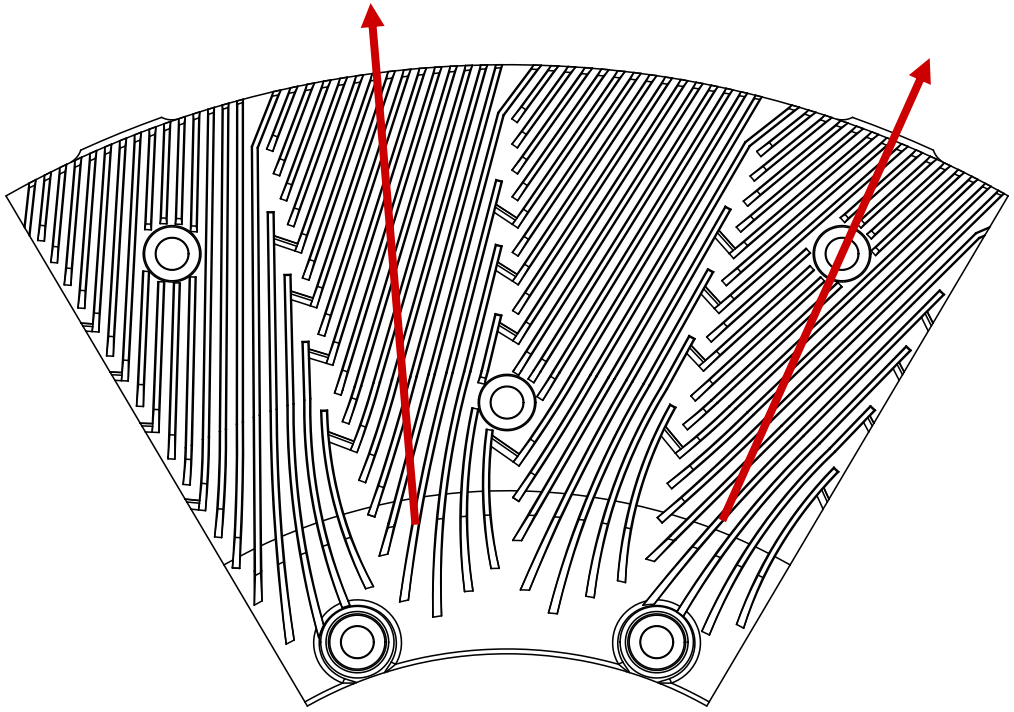


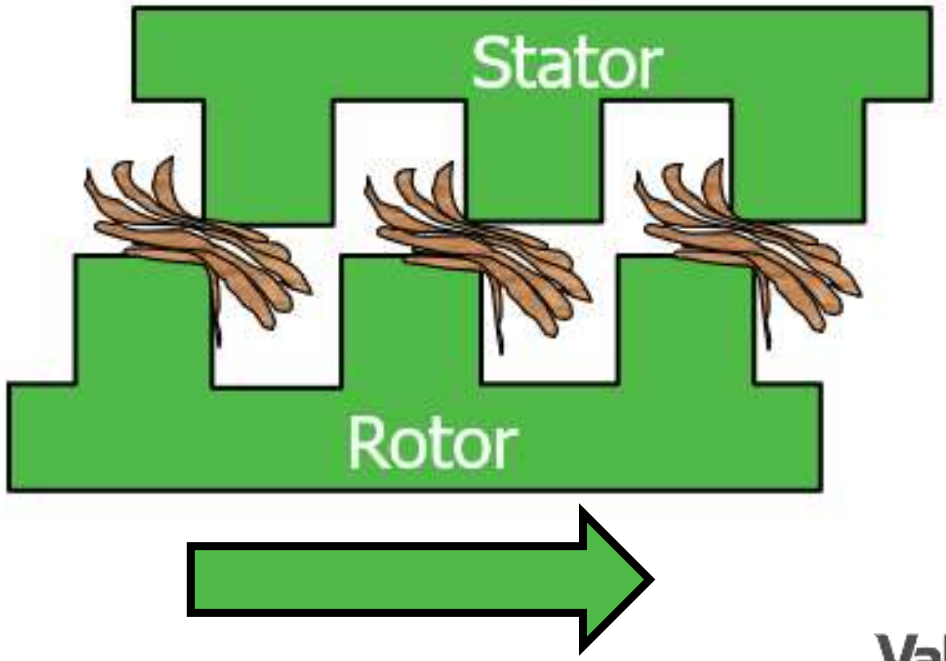
Stock processing in refiner

A. Feeding
B. Outlet
C. Fillings
D. Loading device
E. Lubrication unit

How refining works

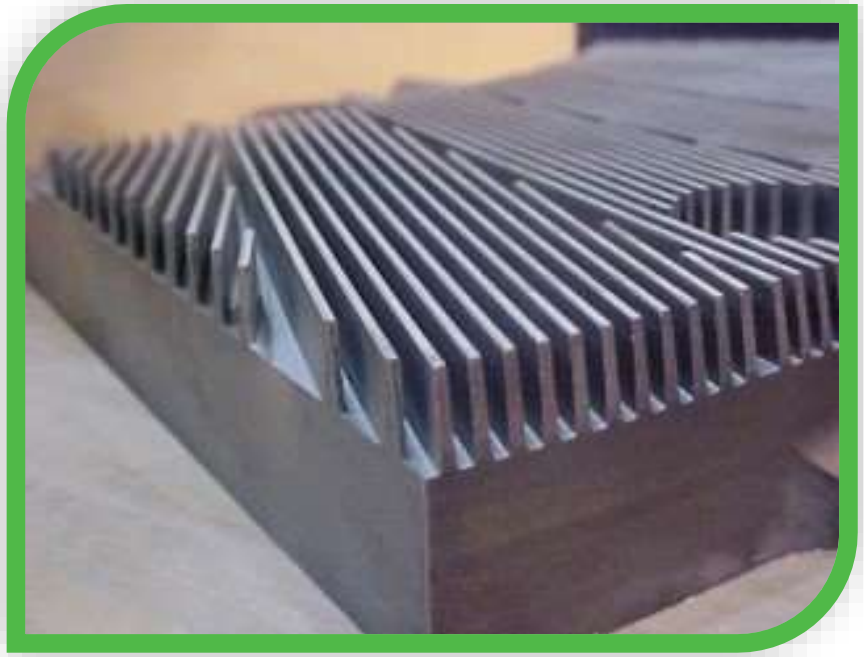
- Fiber flocs staple and collect along bar edges
- Fibers are compressed and unraveled as rotor and stator bars pass each other
- Successive compression and relaxation changes the fiber properties





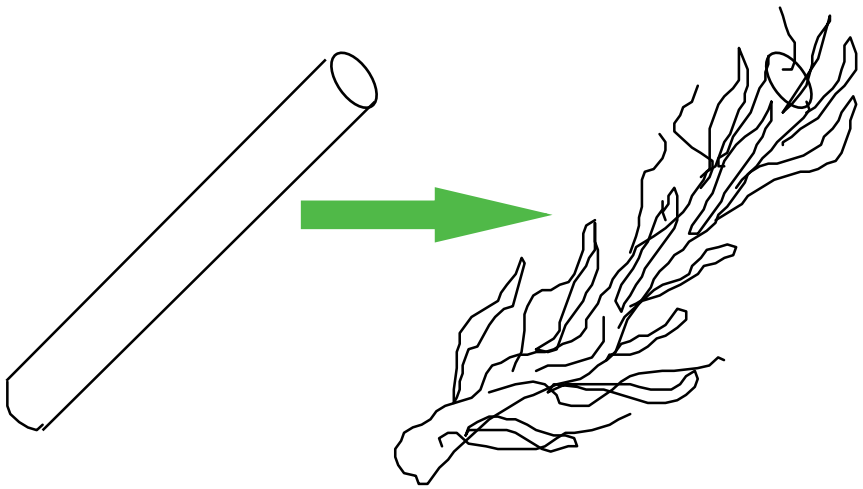
Refining effects and objectives

- Effects
  - Defibration
  - Internal fibrillation
  - External fibrillation
  - Cutting



- Objectives
  - STFI, ring crush
  - Tensile, burst/mullen
  - Plybond
  - Formation
  - Freeness
  - Smoothness
  - Porosity
  - Bulk
  - Shive reduction
  - Fiber length
  - Fines
  - Etc.

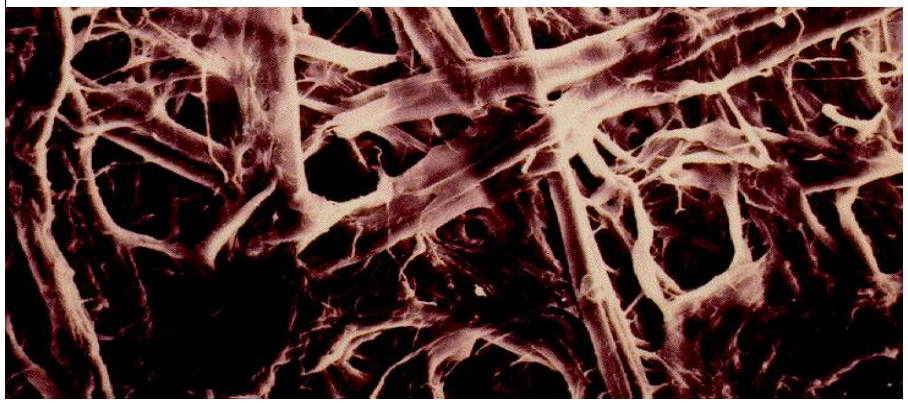
Effects of refining: external fibrillation – “brushing”



Increased surface area also gives more surface-to-surface contact (↑ strength)

Unrefined fibers with low surface area

Refined fibers with lots of surface area



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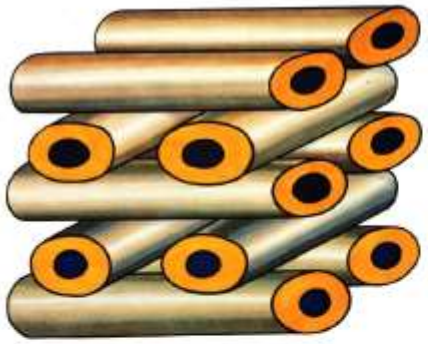
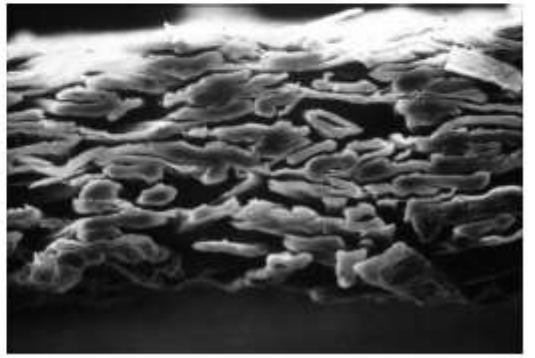
Effects of refining: internal fibrillation, fiber collapse, and densification

Unrefined



Stiff, rigid fibers

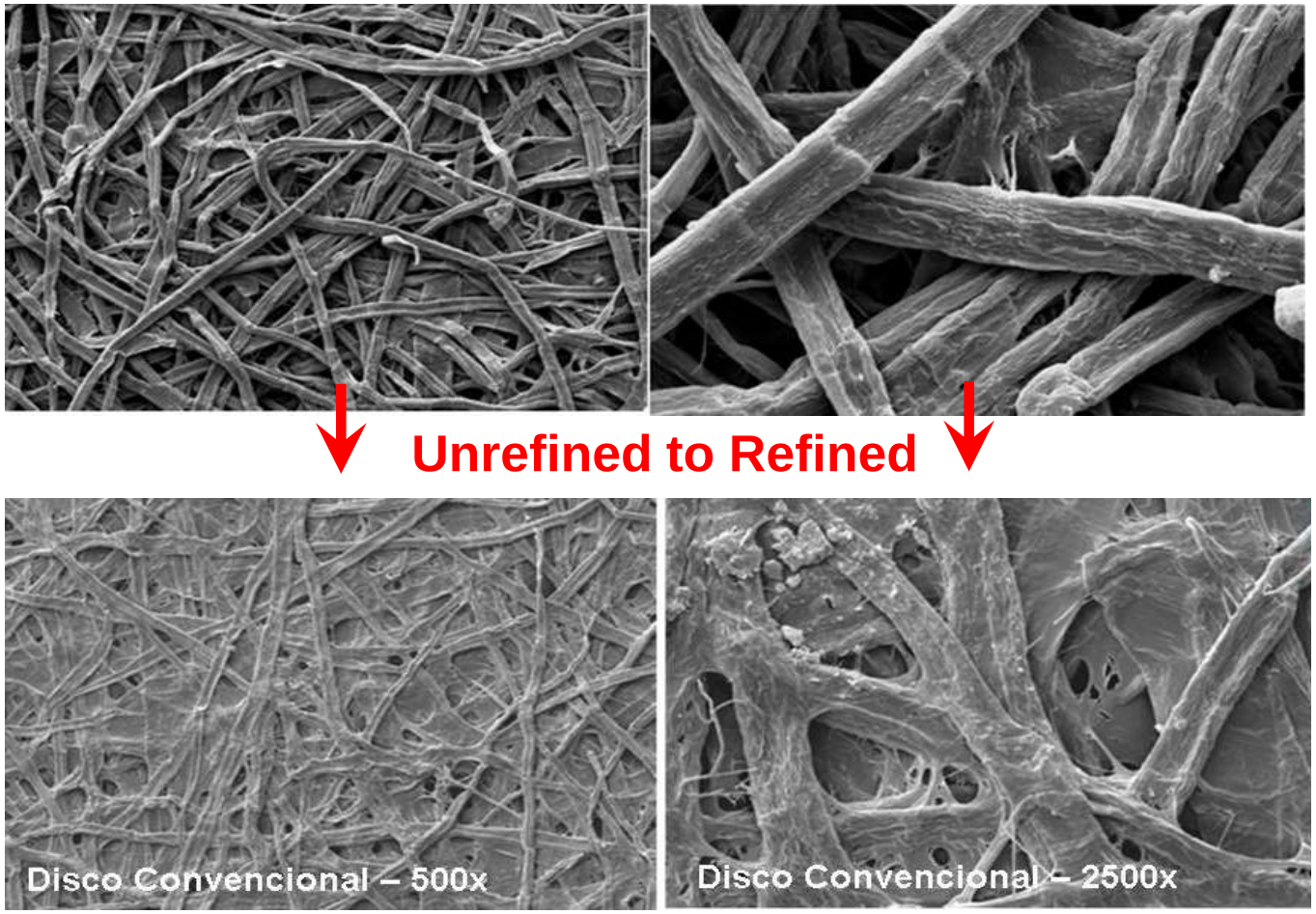
Refined



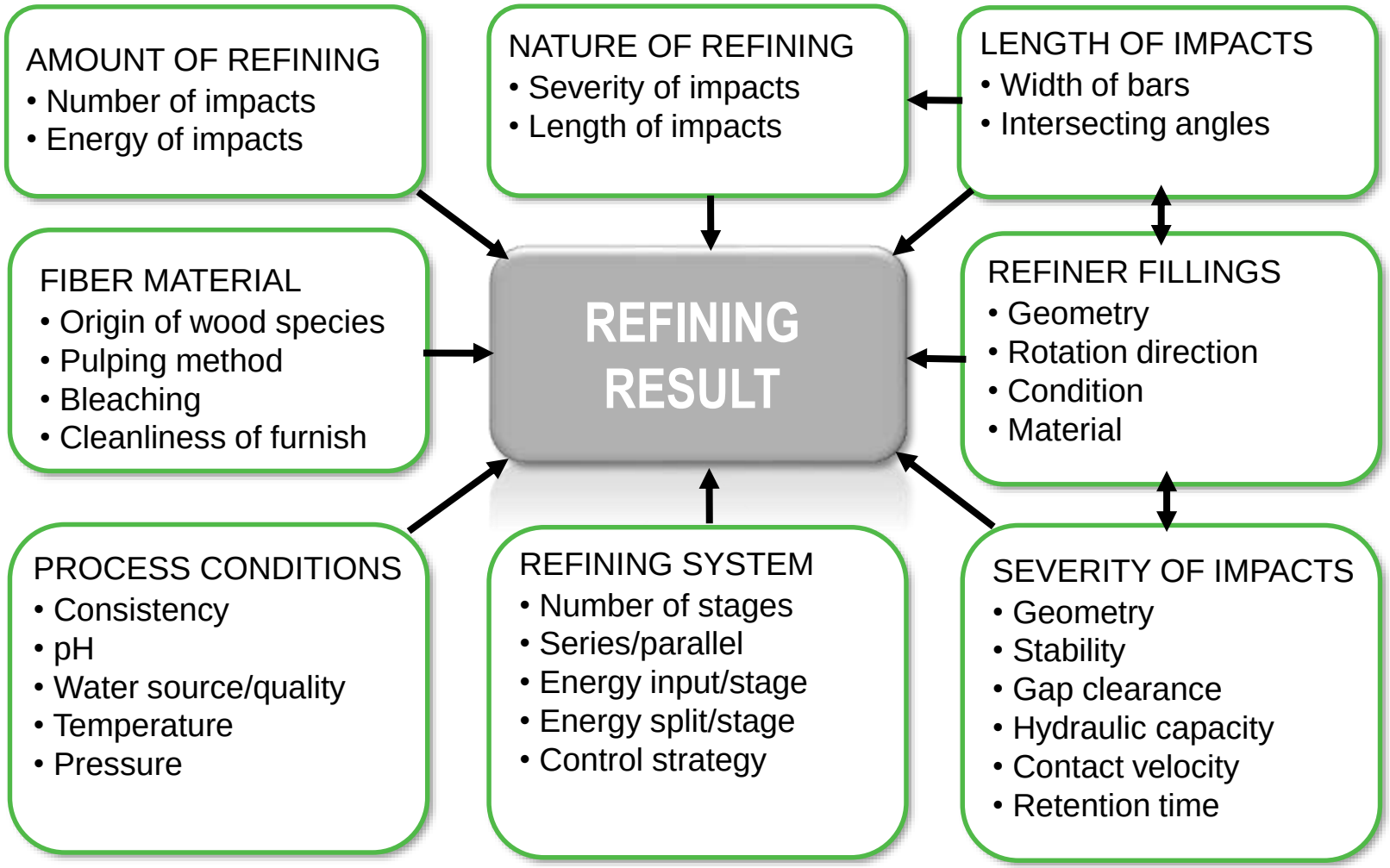
Flexible fibers

Flexible fibers have more surface-to-surface contact, increasing strength

External and internal fibrillation

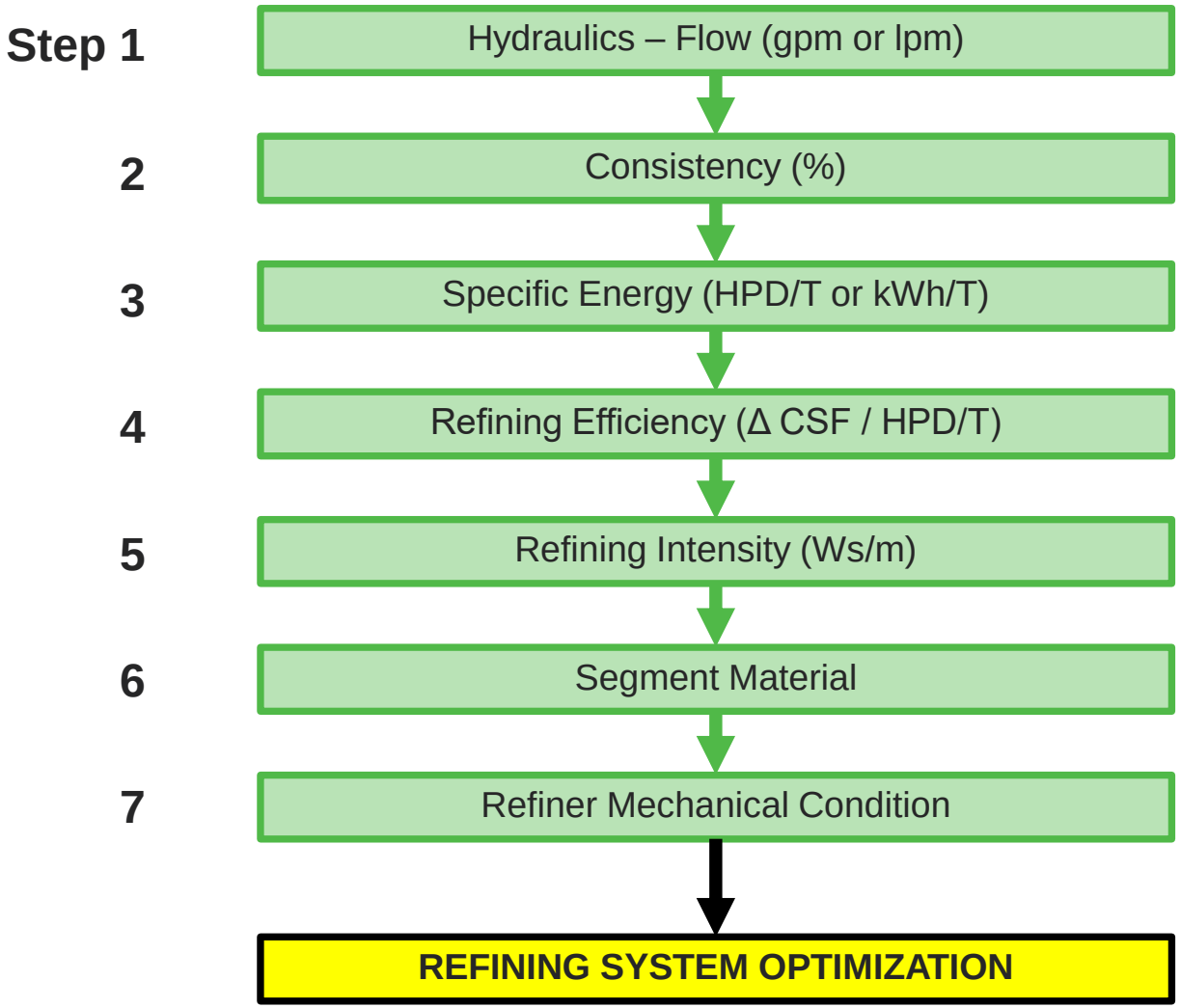


Factors affecting refining



Valmet's LC Refining Optimization Process

Refining 7 Step "Sub-System" Analysis



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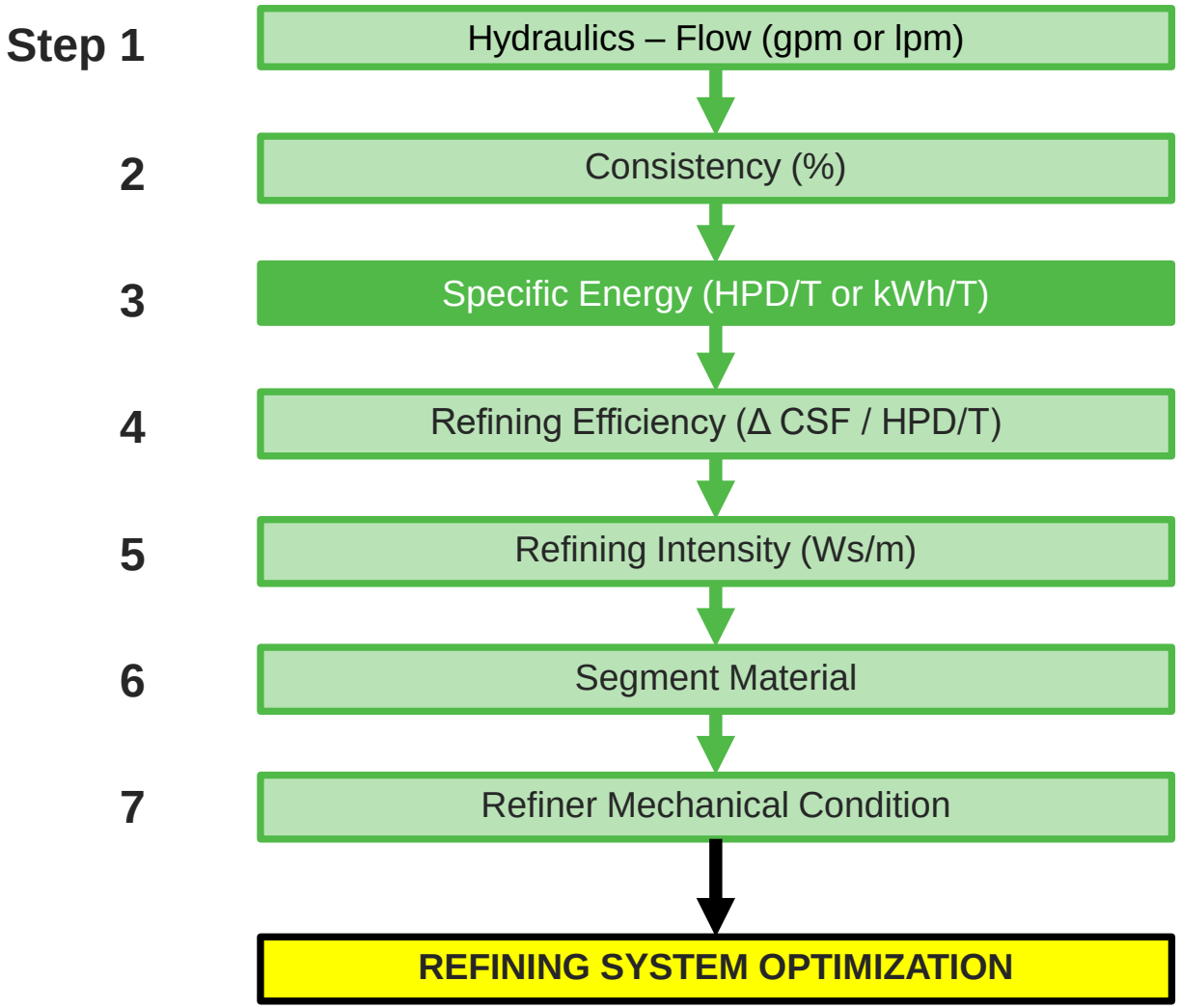
Refining 7 Step “Sub-System” Analysis



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Specific energy

Definition: The amount of energy transferred from the refiner's motor to the fiber

- Equation: $SE = HPD/T = \frac{\text{Motor Load (HP) - No Load (HP)}}{\text{TPD}}$
- Equation: $SE = kWh/T = \frac{\text{Motor Load (kW) - No Load (kW)}}{\text{TPHr}}$

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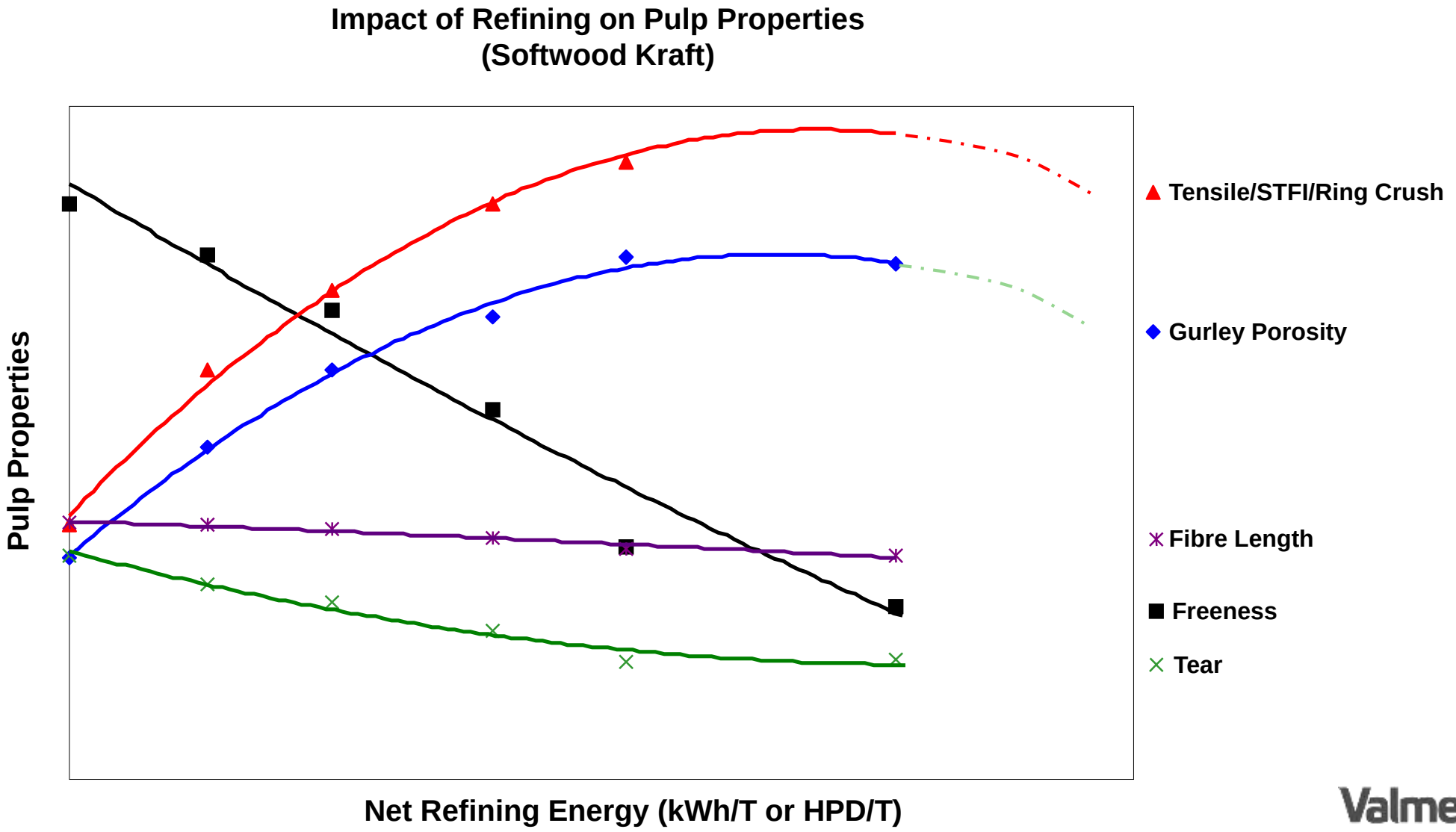
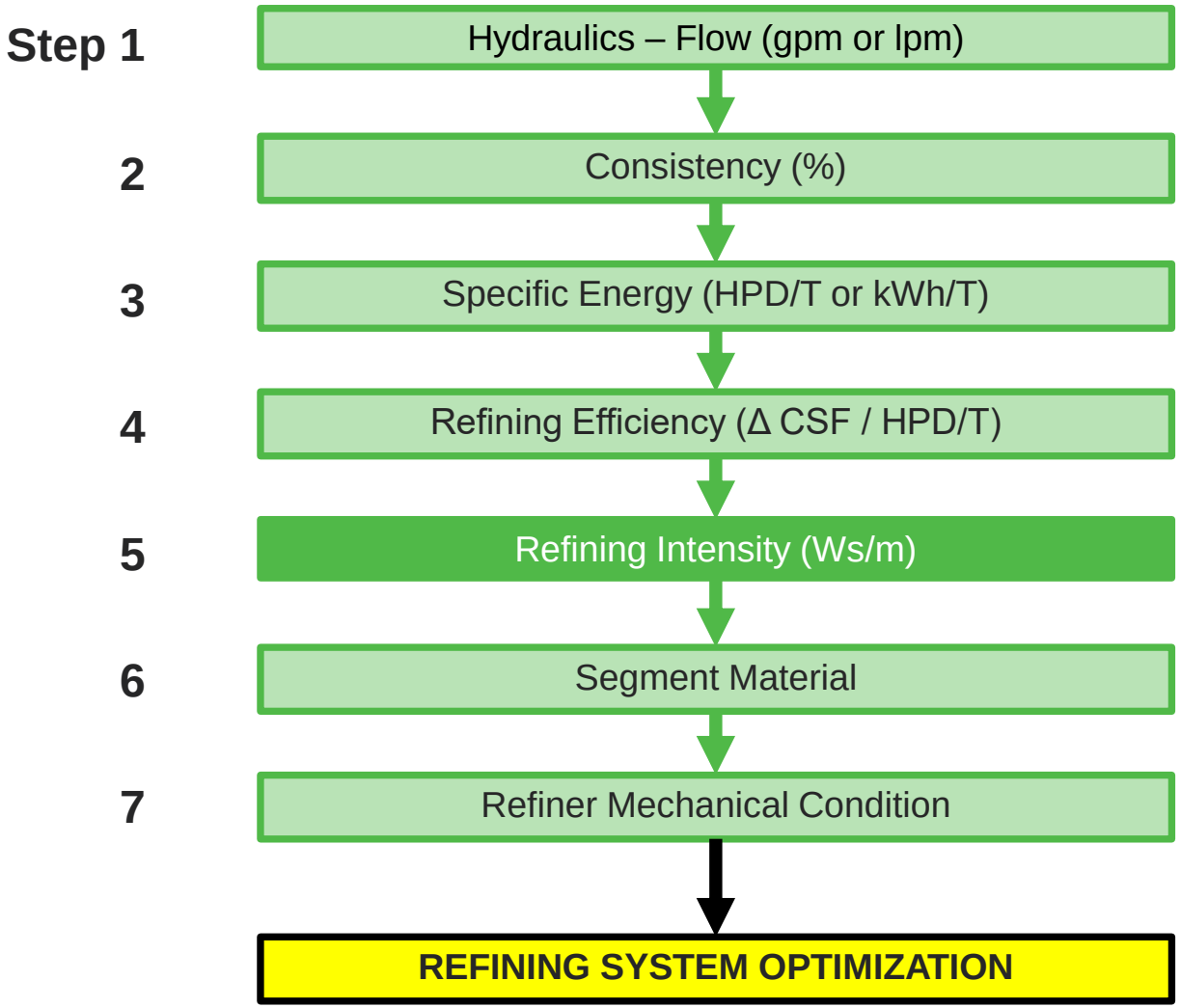
Effects of refining on fiber properties



Refining 7 Step “Sub-System” Analysis



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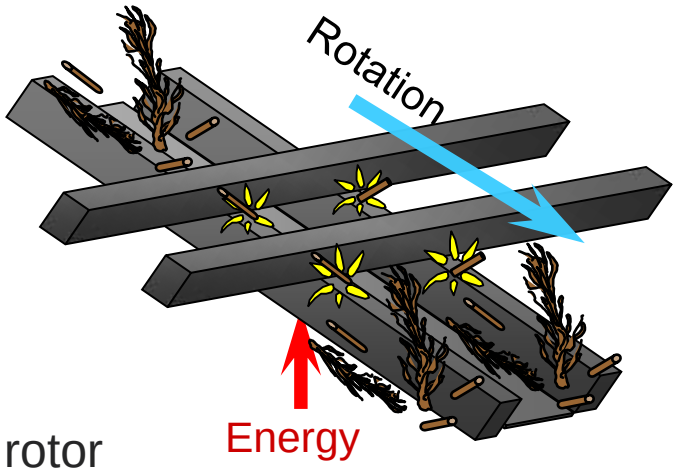
Refining intensity (Specific Edge Load theory – SEL)

- Definition: a term used to define “how” the energy is applied to the pulp
- A measure of how severely the energy is applied
- The amount of energy (watts) applied across one meter of a refiner segment’s bar edge and transferred to the pulp in one second (Ws/m)

Pattern Design Plays Key Role

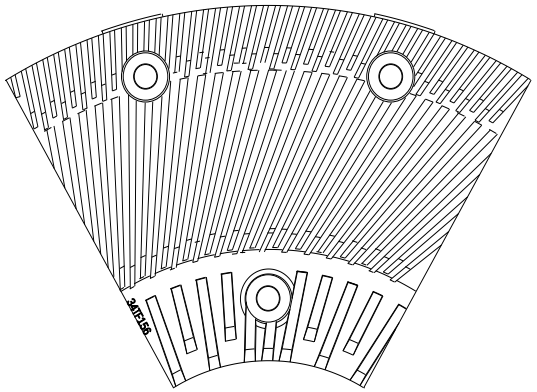
$$\text{Intensity (Ws/m)} = \frac{\text{Motor Load (kW) - No Load (kW)}}{(\text{km Bar Edge Crossings/Rev})\ (\text{RPM})\ (1\text{min}/60\text{sec})}$$

Cutting Edge Length (CEL)
km of bar edge crossings per revolution



- Refiner pattern identity
- Bar edge length measurement
- DD Refiners: based on a full filling (4 Circles) and one full rotation of the rotor
- Energy transfer points: Motor → Shaft → Rotor → Segment → Bar edge crossing → Fiber
- Determines brushing (fibrillation) or cutting

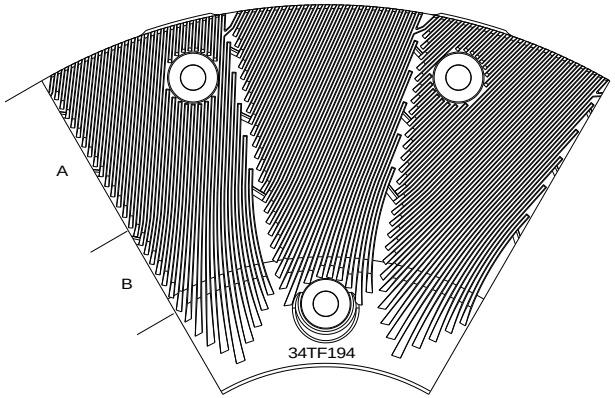
34TF156/157



Bar code: 2.8, 3.9, 4.0

11.5 Km/Rev

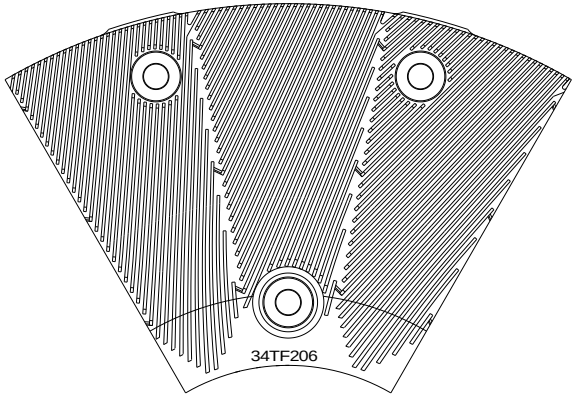
34TF194/195



1.2, 1.8, 4.0

45 Km/Rev

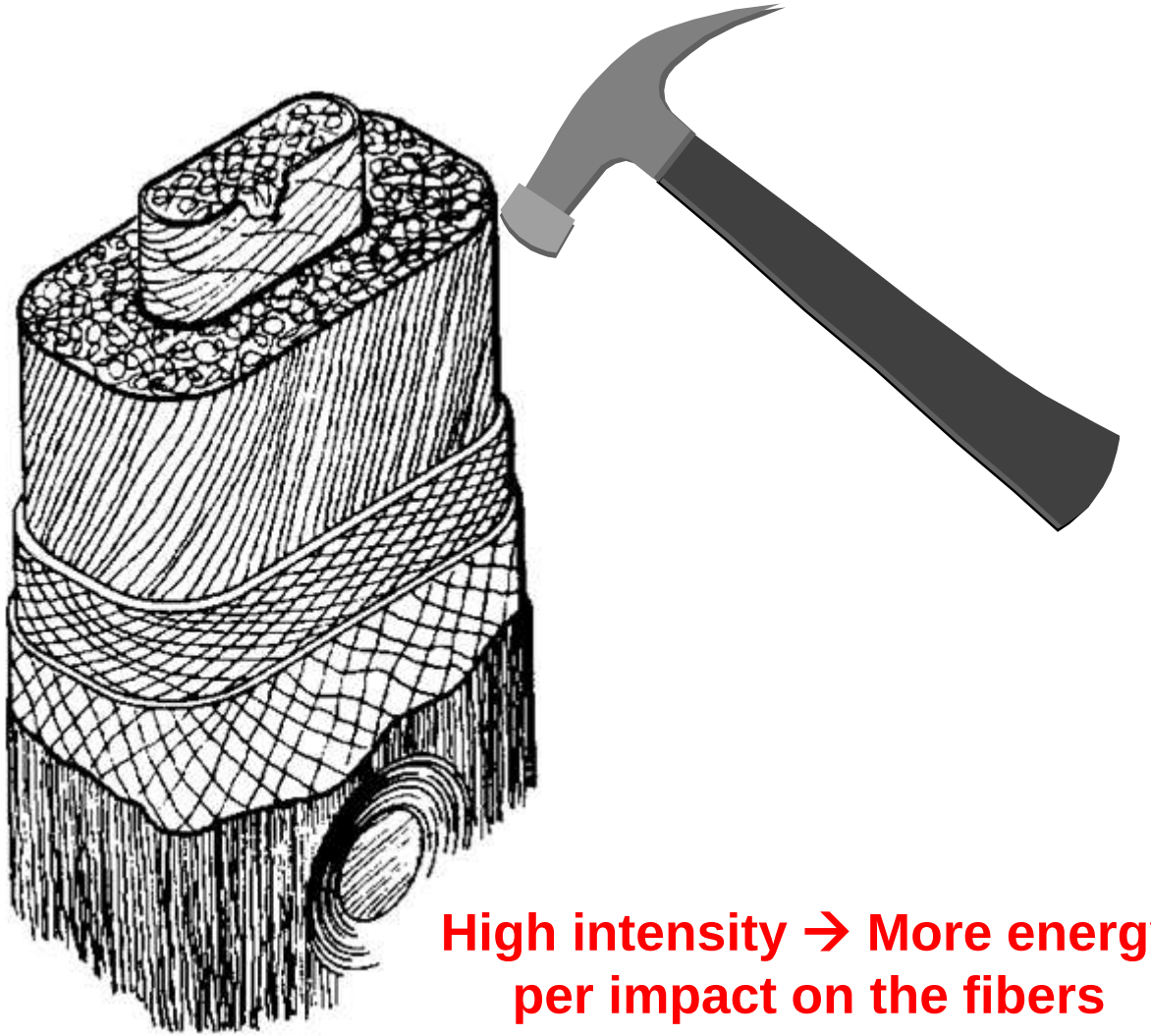
34TF206/207



1.1, 1.6, 5.2

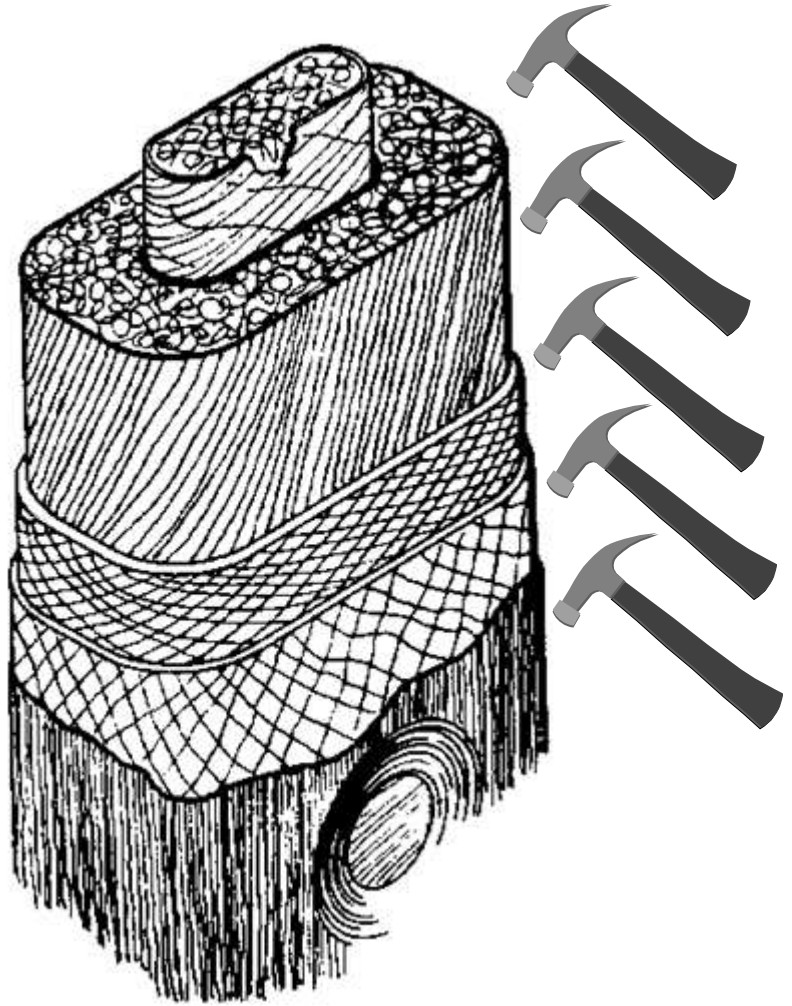
69 Km/Rev

Refining intensity

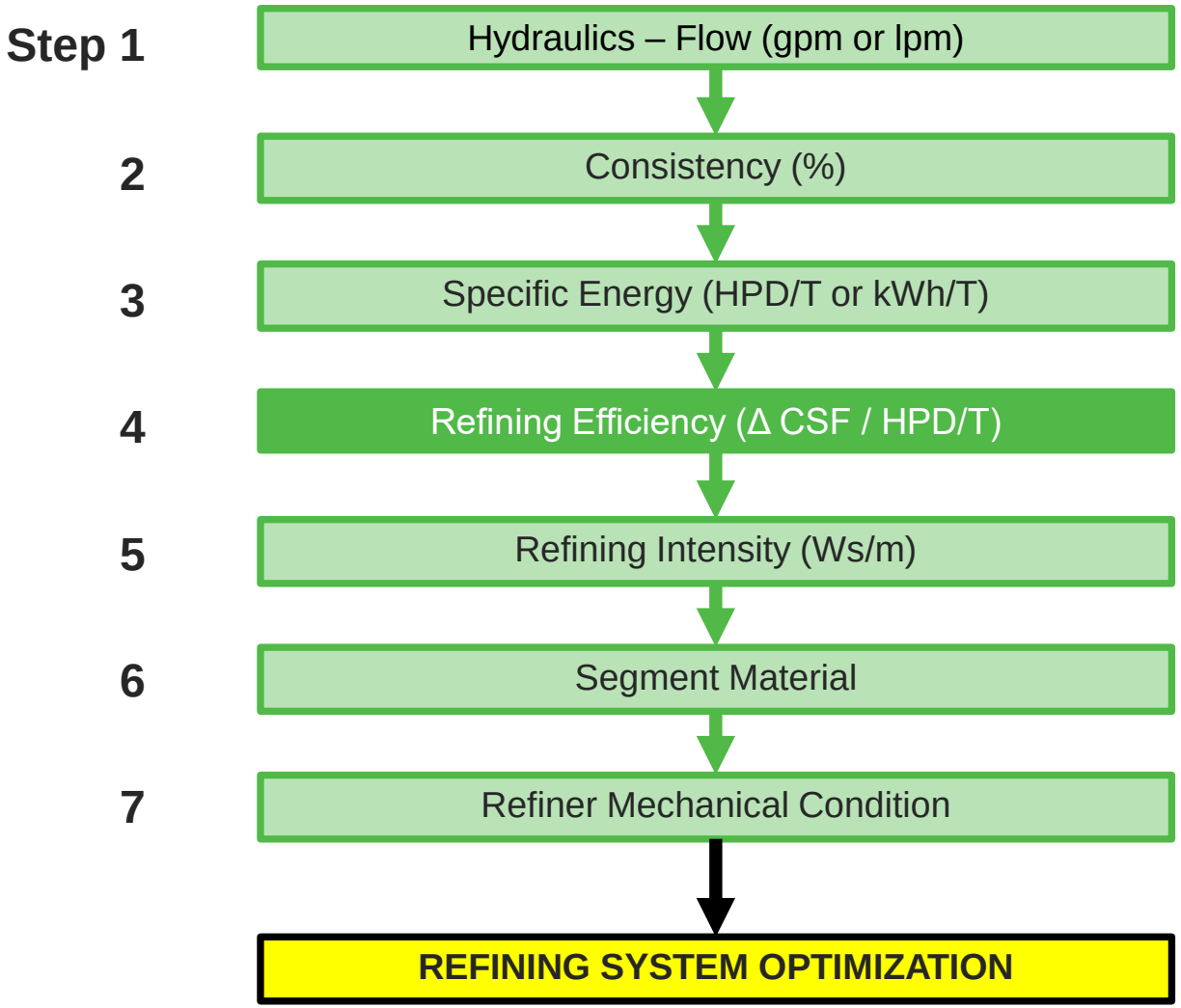


High intensity → More energy per impact on the fibers

Low intensity→ Less energy per impact on the fibers



Refining 7 Step “Sub-System” Analysis



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Refining efficiency: Freeness drop / HPD/T

- Indicator of how much work has been done to the pulp
- Correlates to paper machine drainage characteristics
- A great tool for evaluating refiner efficiency

$$\Delta \text{CSF} / \text{HPD/T} = \frac{\text{CSF In} - \text{CSF Out}}{\text{HPD/T}}$$

$$\Delta \text{CSF} / \text{kWh/T} = \frac{\text{CSF In} - \text{CSF Out}}{\text{kWh/T}}$$

Fines A

Freeness, bonding, light scattering, tensile strength, bulk

Fines B

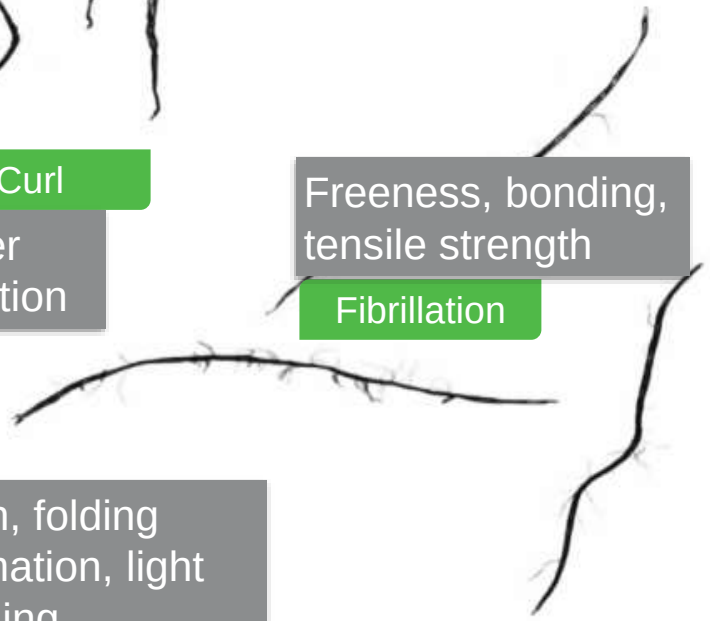
Tensile strength, bonding

Kink

Tensile Tearing strength

Curl

Strength of fiber network, formation



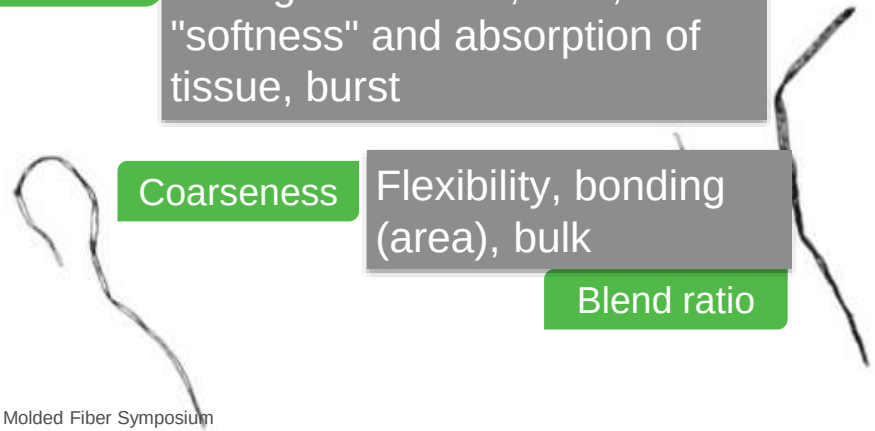
Fibrillation

Freeness, bonding, tensile strength

Tearing strength, folding endurance, formation, light scattering, bonding

Fiber length and width

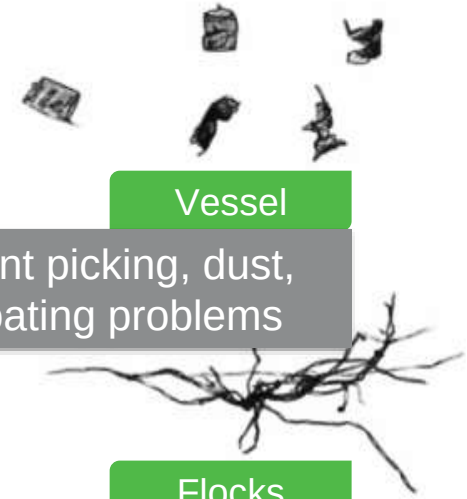
Formation, light scattering, folding endurance, bulk, "softness" and absorption of tissue, burst



Coarseness

Flexibility, bonding (area), bulk

Blend ratio

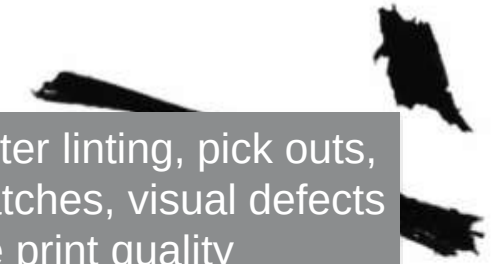


Vessel

Print picking, dust, coating problems

Flocks

Parenchyma



Off set printer linting, pick outs, coater scratches, visual defects and reduce print quality

Shives and Minishives

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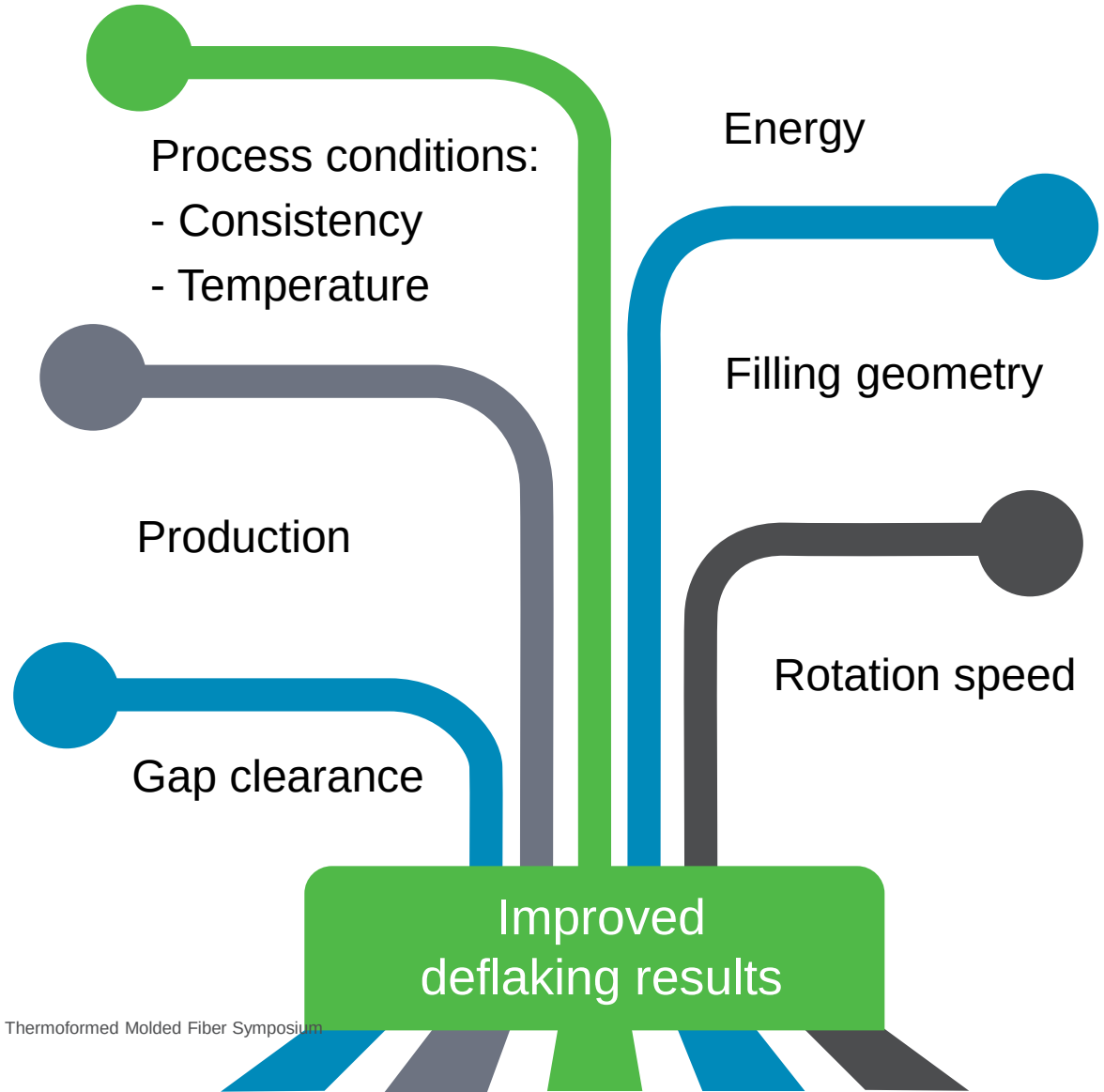
Deflaking

Deflaker

- **Defiberizes** and breaks down fiber bundles
- **Homogenizes** stock
- **Maximizes** the yield of repulped material
- **Controls** the deflaking result with gap adjustments

Deflaking basics

Factors affecting deflaking



Deflaking mechanism

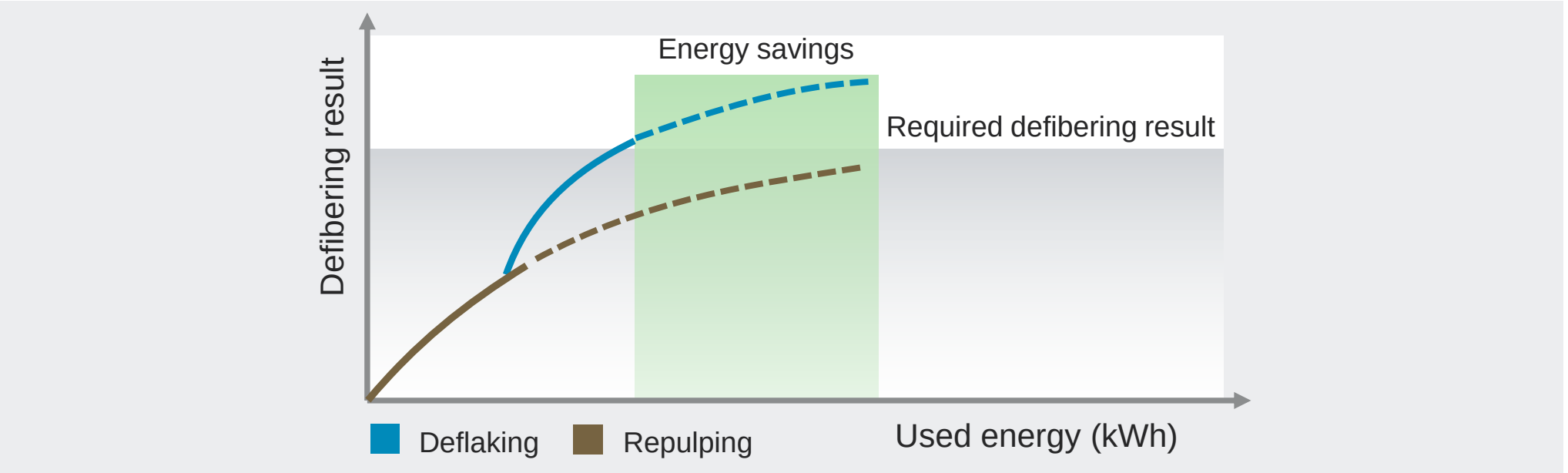
Deflaking mechanism based on internal friction between fibers, not on mechanical action

- The purpose of deflaking is to separate fibers
- The purpose of deflaking is not to affect fiber properties

Internal friction is created by accelerating and decelerating stock flow between a high speed rotating rotor and a stationary stator fillings through narrow gap

- The deflaking result is based on energy used in deflaker to create vortex

Deflaking mechanism



Deflaker has higher hydraulic forces than pulper due to higher peripheral speed and intensity.

Hydraulic forces in deflaker are more effective to break small size flakes and fiber bundles.

Thank you!

Beyond the Basics: Cutting-Edge Stock Preparation for Molded Fiber

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