TakingStock
J&L FIBER SERVICES
A PRECISION CASTPARTS COMPANY
The Smart Choice

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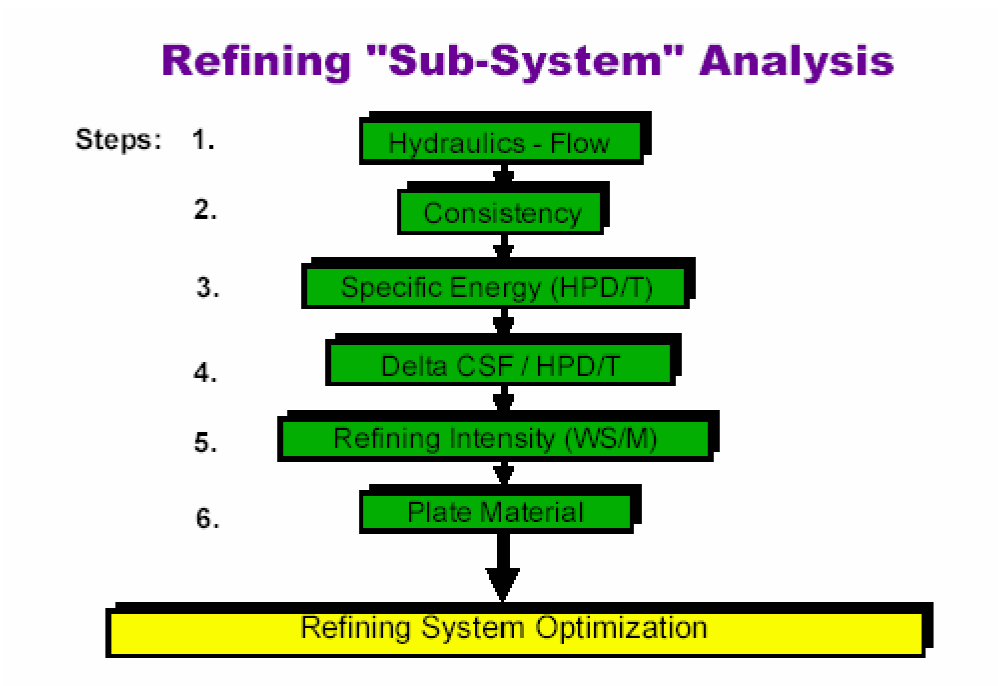
Refining System Optimization –
A Simple Six-Step Process

The refiner is a critical piece of equipment in the paper making process. It is the only piece of equipment in the fiber line that is designed to mechanically enhance the properties of the fiber. Unfortunately, refiners are often neglected and inefficiently operated, negatively impacting quality and paper machine performance. What "goes on" inside the refiner has often been referred to as "Black Magic." Take the "Black Magic" out of refining by applying a simple six-step optimization process. Read on to gain the basic tools for optimizing your refining system.



Step 1: Hydraulics – Flow

Hydraulic conditions are important to the refining process. Proper flow through a refiner combined with proper plate pattern design enables optimal operation and fiber development by maintaining a stable and centered rotor, increasing probability of fiber mat formation, maximizing fiber strength development potential, maximizing plate life potential, and minimizing variation.

If your refiner hydraulic conditions are too low or too high, your refiner may produce the following symptoms:

Symptoms of Low Flow Conditions
Little or no fiber mat between plates
Fiber channeling
High pressure rise (25-50 psi)
Plate clashing
Short plate life
Inefficient refining (power vs fiber development)
Poor strength development
Increased fines generation

Symptoms of High Flow Conditions
Inability to optimize plate design for maximum strength development (compromise)
Short plate life
Pressure drop
Motors maxed out

Double Disk Refiner Capacity Chart
Recommended Flow Ranges for Various Size Refiners
US Units - 60 HZ Speeds

DIA INCHES	MAX POWER HP	NORMAL RPM	NO LOAD HP	FLOW RATES - GPM		
				LOW	MED	HIGH
20	300	900	75	150	250	400
24	450	720	85	250	350	600
26	500	720	120	300	450	800
30	600	600	125	375	600	1100
34	800	514	135	475	750	1400
	1000	600	215	550	875	1650
38	1250	514	215	650	1075	2025
42	1500	450	220	775	1250	2400
	1750	514	330	900	1450	2800
46	2000	450	325	1025	1675	3275
52	3000	400	385	1300	2150	4300
	3000	450	550	1475	2425	4850
54	3000	400	450	1475	2425	4850

To correct the problem, J&L can help evaluate your system and recommend one or more of the following solutions. Each case may require a different solution set.

Solutions for Low Flow
Recirculation
Parallel to series
Pattern change
Holdback
Smaller refiner

Solutions for High Flow
Pump change
Series to parallel
Additional and/or larger refiner
Consistency increase

Step 2: Consistency

Refining requires getting the fibers onto the bar edge in order to be refined. Optimum fiber consistency maximizes the probability of getting the stock onto the bar edge.

Proper consistency can impact refining in many of the same ways as proper hydraulic conditions. A refiner running at low consistency will cause little to no fiber mat between plates, inefficient refining, poor fiber development, fiber cutting, plate clashing and short plate life. High consistency causes plate plugging and poor fiber development. In order to maintain proper consistency, run your refiner at the recommended range of consistency based on fiber type. If you have trouble maintaining proper consistency, call J&L for assistance.

Consistency Guidelines for Various Fiber Types	
Fiber Type	Recommended Range of Refining Consistency
Unbleached Softwood Kraft	3.5 - 4.5%
Bleached Softwood Kraft	3.5 - 5%
Bleached Hardwood/Eucalyptus Kraft	4 - 6%
OCC	3.5 - 5%
Mechanical Pulps	4 - 6%
Unbleached Semi-Chem Hardwood	4.5 - 6%
Mixed Waste	4 - 6%

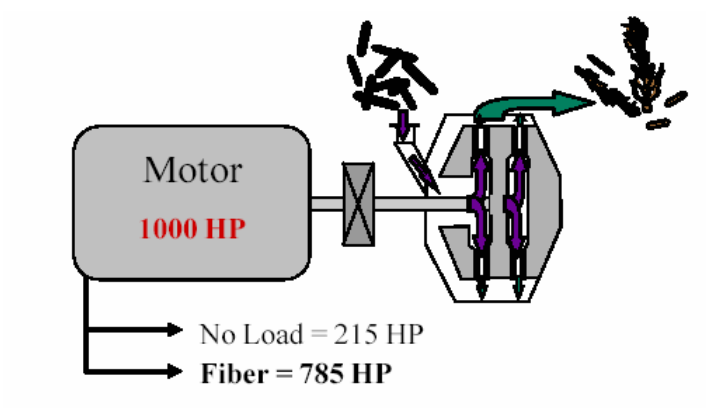
Step 3: Specific Energy (HPD/T)

The amount of energy transferred from the refiner's motor to the fiber is considered "Specific Energy." Each fiber type has an optimal Specific Energy level which will result in maximum fiber development.

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

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

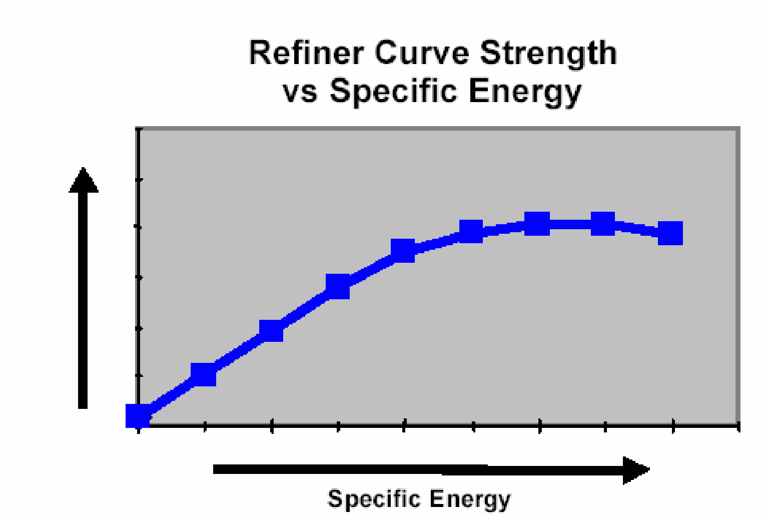
No Load is energy required to spin the rotor in a pulp slurry. To calculate No Load, the equation is No Load (HP) = (3.083 X 10-13)(Dia4.249)(RPM3), where Dia is plate diameter in inches and RPM is refiner motor speed.



Net Refining Requirements for Major Grades				
Grade		HPD/UST	KWH/UST	KWH/MT
Linerboard	Base Top	5 – 7 10 – 12	89 – 125 179 – 215	99 – 138 197 – 237
Sack, Bag		12 – 14	215 – 250	237 – 276
Medium	Virgin HWD Waste Tickler	6 – 10 2 – 3 1.0 – 1.5	107 – 179 36 – 54 18 – 27	118 – 197 39 – 59 20 – 30
Fine Papers	Hardwood Softwood Tickler	4 – 6 6 – 8 1.0 – 1.5	72 – 107 107 – 143 18 – 27	79 – 118 118 – 158 20 – 30
Foodboard, Milk Carton	Hardwood Softwood Tickler	2 – 3 3 – 4 1.0 – 1.5	36 – 54 54 – 72 18 – 27	39 – 59 59 – 79 20 – 30
News	SB Kraft Groundwood	2 – 5 2 – 3	36 – 89 36 – 54	39 – 99 39 – 59
Grades w/ OCC	OCC	2.5 – 5.0	81 – 117	89 – 128

Specific Energy – Maximize Fiber Strength

Strength



Let J&L show you how you can maximize your fiber development by optimizing Specific Energy.

Step 4: Freeness Drop / HPD/T

Freeness Drop (CSF) per horsepower-days per ton is a great measure to determine the refiner(s) efficiency and if it is operating correctly. An efficient refiner will maximize fiber development with minimal energy.

Delta CSF / HPD/T= CSF In – CSF Out ÷ HD/T

FREENESS DROP / NET HPD/T

Guideline Chart for Various Furnishes

UNBL. SOFTWOOD KRAFT	
NORTHERN U.S.	15 - 25 CSF / Net HPD/T
SOUTHERN U.S.	15 - 30 CSF / Net HPD/T
BL. SOFTWOOD KRAFT	
NORTHERN U.S	25 - 50 CSF / Net HPD/T
SOUTHERN U.S.	25 - 60 CSF / Net HPD/T
BL. HARDWOOD KRAFT	
MOST SPECIES	60 - 100 CSF / Net HPD/T
EUCALYPTUS	45 - 50 CSF / Net HPD/T
SECONDARY FIBER	
OCC	40 - 70 CSF / Net HPD/T
MIXED	50 - 70 CSF / Net HPD/T
NEWS	20 - 35 CSF / Net HPD/T

If you have low freeness drop / HPD/T, call J&L for a refiner audit. J&L will check for tough fiber, low or high flow conditions, low consistency, improper pattern application, worn out plate, mechanical problem with refiner, improper plate installation.

Step 5: Refining Intensity (WS/M)

How energy is applied to the pulp is called Intensity. Intensity impacts the quality of the fiber produced. Fiber types vary greatly and each responds more efficiently to a given intensity range. Typical softwoods respond better to a higher intensity (less bar edges for a given power) as opposed to hardwoods which respond better to a lower intensity (more bar edges for a given power.) The amount of energy (watts) applied across one meter of a refiner plate's bar edge and transferred to the pulp in one second is Specific Edge Load (SEL) refining intensity. Plate pattern design plays a key role in optimizing refining intensity.

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

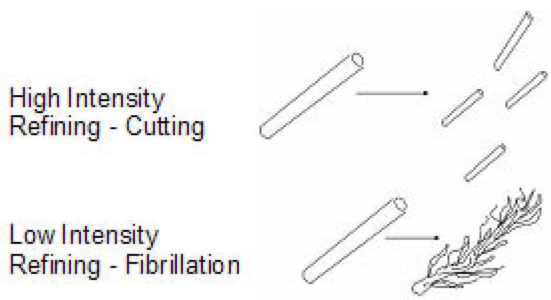
Typical SEL Range for Various Fiber Types

Fiber Type	Typical SEL Range WS/M
Unbl. Northern SW Kraft	2.5 - 4.5
Unbl. Southern SW Kraft	2.5 - 4.5
Bl. Northern SW Kraft	1.5 - 3.5
Bl. Southern SW Kraft	1.5 - 3.5
Semi-Chem HWD	1.0 - 2.5
Bl. HW Kraft	0.5 - 1.0
Bl. Eucalyptus Kraft	0.5 - 1.0
TMP Post Refining	less than 0.5
OCC	.75 - 2.5 (As low as possible w/out Plugging)
Mixed Waste	.75 – 1.5
Deinked News / Magazine	less than 1.0

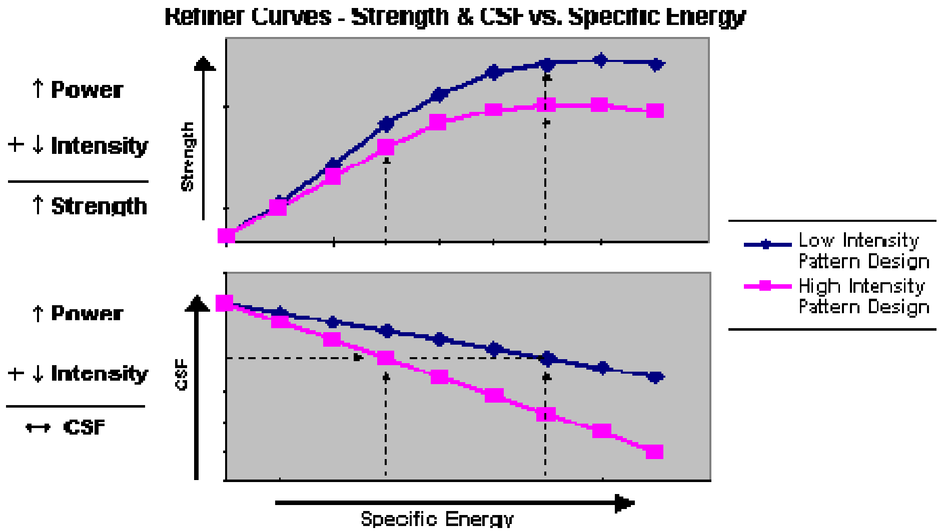
If refining intensity is lower than recommended, potentially poor fiber development will occur. All fibers require a certain intensity level to break down their walls. In addition it will cause unaffected fiber length and inefficient freeness drop.

On the other hand, if refining intensity is higher than recommended, it will result in severe fiber cutting, plate clashing, short plate life and poor strength development.

Impact of Intensity on the Fiber



Increase Strength & Minimize CSF Reduction



If improved fiber quality is needed in your mill, J&L can recommend the best plate pattern to optimize your refining intensity.

Step 6: Plate Material (Alloy)

Refiner plates are consumable and need to be replaced at various time intervals. Selecting the optimum alloy for given operating conditions results in maximum refiner plate life. Selecting the wrong alloy leads to plate failures which are detrimental to refining performance. Bar breakage, plate wear and bar edge rounding can increase variation, reduce plate life, increase costs, and create inferior fiber quality.

To correct the problem and extend plate life, it is important to select the right plate material. For problems of bar breakage, select a low carbon stainless steel (LCSS) alloy. It's virtually unbreakable. In cases of excessive bar wear, use a heat treated LCSS. In addition to being unbreakable it offers good wear resistance. Finally to maintain sharp bar edges which guarantee to improve fiber quality, the answer again is a heat treated LCSS. A heat treated LCSS alloy will re-sharpen during operation.

Call your J&L Representative. Together with J&L's Technical Support, he can assist you in applying this Six-Step Process to ensure optimal performance of your refining system.

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