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OVERVIEW

- Using little capital, significant energy savings can be achieved simply by optimizing one's existing mechanical pulping process
- Energy savings opportunities can be found in virtually every area of the pulp mill

Energy Savings

Developed by the Technical Group, J&L Fiber Services

Introduction

Many areas of the mechanical pulping process can be explored for energy saving opportunities. Typically, over 50% of the cost associated with the manufacture of mechanical pulp is energy. Improving the efficiency of energy utilization in the manufacture of mechanical pulp can result in dramatic savings. This Optima briefly touches on many ideas for such improvement.

Wood Chips

Chip Size & Uniformity. Correlations between pulp quality and chip size/variation have been established. By controlling the size distribution of the wood chips on a continuous basis, higher efficiencies and improved quality can be achieved [1]. A study [2] comparing chip size vs. pulp quality and specific energy is represented in Table #1. This study suggests a 8+% reduction in energy is possible by controlling chip size.

Table #1

Chip Size =	L, +8mm or ~-3/4"Williams	M, +4mm to 8mm or ~-3/4-5/8"Williams	S, -4mm or ~-1/4" Williams	Mix =1/6L + 2/3M + 1/6S
Specific Energy	121.70	121.80	95.60	112.00
Burst Factor	2.27	2.52	2.05	2.53
Tear Factor	9.30	9.30	8.30	9.40
Break Length	4753	5042	4337	5072
L Factor	52.60	55.60	49.90	55.50
Somerville	0.10	0.03	0.22	0.01

Note: Ideal = 3.6 to 6.0 mm or ~1/2 to 3/4" Williams (13-19mm Screen Fraction)

Oversize chips can be sliced or conditioned into an ideal size in order to improve pulp quality and reduce energy use. The chipping process, chip handling and conditioning must be considered when working to improve mechanical pulping energy use.

Refining

Refiner Plate Pattern Optimization. Many parameters of the refiner plate pattern can be adjusted to decrease operating variation. These parameters include: bar angle, dams, taper, and materials. Studies are in process for curved inner rings, controlled dam height (ID to OD), and dissimilar patterns for stator and rotor. In multi-stage refiner arrangements, the patterns of the primary, secondary and other stages should be selected to provide complementary performance.

Uni-directional Plate Trial. A trial [3] with uni-directional primary stage design 65YHP108 was completed at a TMP mill producing pulp for LWC paper. Trial plates ran three months, and during that period the normal primary plate pattern was used in a reference line primary stage. Standard secondary stage plates were used in both lines. The trial was performed by running the plates under normal conditions, i.e., same refining consistency, same load, slightly higher throughput, and no optimization of operating parameters was done. A comparison between these two lines (three months average from standard daily

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Table #2

Primary design Secondary design	65YHP108 Standard	Standard Standard	Change
Primary stage SEC, Mwh/t	1.02	1.30	-21%
Secondary stage SEC, Mwh/t	0.76	0.97	-21%
Total SEC, Mwh/t	1.78	2.27	-21%
CSF after primary, ml	320.0	402.0	-20%
STFI shives after primary, %	3.6	6.4	-44%
CSF after secondary, ml	130.0	133.0	-2%
STFI shives, %	0.73	1.03	-29%
Average fiber length, mm	1.43	1.57	-9%
Bauer McNett +16, %	15.0	19.3	-22%
Bauer McNett -200, %	14.7	13.1	12%
Tear index, mNm2/g	7.09	7.73	-8%
Tensile index, Nm/g	39.6	41.6	-5%

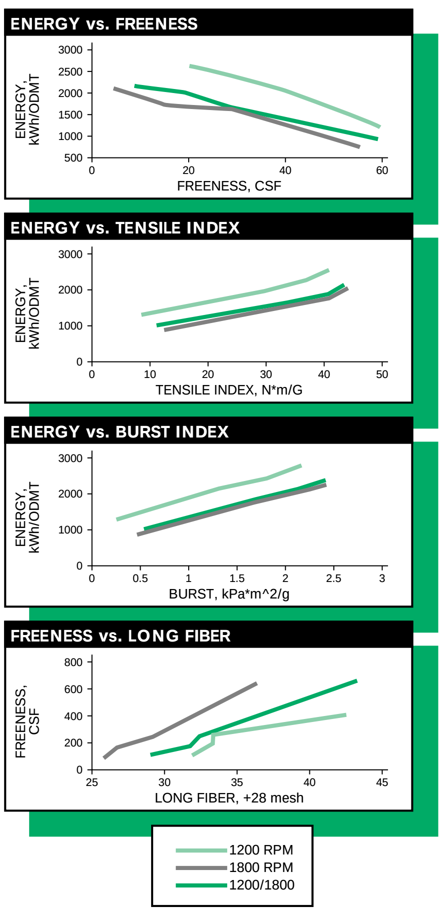
measurements) is illustrated in Table #2.

The SEC calculation is for the refiner line only. Not taken into account is the net impact of the reduced steam available for recovery or any changes in rejects system operation. The mill observed that the rejects rate actually decreased due to the lower long fiber content. On the paper machine, higher kraft usage was not necessary despite lower strength properties in the incoming pulp. As a matter of fact, lower long fiber content improved the formation of the base paper so that this on-line coating LWC machine made its speed-record during this trial period.

High Speed Refining. Results of a pilot plant study indicate that approximately 20% power savings is possible by changing to high-speed refining. The study used counter-rotating refiners that were sped up from 1200 to 1800 rpm. The study also considered the benefit of speeding up only one side to 1800 rpm. [4]

Table #3 illustrates some of the reported performance. The pilot study found that operating at 1800 vs. 1200 rpm resulted in a 20-25% energy savings, with no loss in pulp quality. Increasing refining consistency at 1800 rpm had little effect on pulp quality. Operating the

Table #3



feed end only at 1800 rpm provided the same energy savings over 1200 rpm, with pulp quality relatively unaffected. In-mill operating experience has shown there are significant challenges associated with plate pattern optimization.

High Temperature Refining. A mill trial using elevated operating temperatures (160-170°C) in a two-stage TMP system reported a possible energy savings of about 20% [11]. The higher operating temperature will soften the wood lignin, reducing the force necessary to break down the wood structure. Optimum results were obtained when the secondary refiner pressure was in the range of 0.8-0.9 Mpa. To avoid brightness loss, rapid heat-up (<10-15 sec.) of the pulp is required. There was a slight loss in tear index and brightness. Table #4 illustrates comparative pulp quality characteristics of high temperature TMP vs. typical TMP operating temperatures (about 115°C).

Low Consistency Refining. Laboratory data suggest that quality can be maintained or improved while overall energy requirements are reduced by an estimated 15%, through the application of combined high and low consistency (post refining) refining systems, coupled with screening system optimization. The correct application of low intensity, low consistency refining is necessary in order to generate improved fiber properties [5].

Table #5 illustrates a sample of post refining benefits.

Screening & Cleaning

Fractionation and Debris Removal Capabilities, Cleaners vs. Screens.

In nearly every mechanical pulping system, there is a rejects refining system. And, as most mechanical pulping superintendents will agree, the best pulp is achieved from the rejects system. The goal with screening and cleaning in mechanical pulping is to select the appropriate fibers for further treatment (reject refining). If the screening and cleaning system's performance can be enhanced to

Table #4

		High Temperature TMP	TMP
Energy Consumption	kWh/t	1350	1650
Freeness	ml, CSF	150	150
BMcNett +30	%	35	40
BMcNett -200	%	23.5	24
Shive Content	% 4 cut	1.2	1.0
Density	kg/m3	380	380
Tensile Index	Nm/g	35	35
Tear Index	mNm2/g	6.7	7.1
Light Scattering	m2/kg	49	49
Brightness	ISO %	60	62

provide better fractionation, less power can be applied in the primary and secondary refiners.

Handsheets made from cleaner rejects vs. accepts will have significantly lower burst and tear strengths [6]. Cleaners fractionate based upon density and specific surface. Screens fractionate primarily due to the barrier of the screen material, so that it is more difficult for long or coarse material to pass through the screen plate. Screen rotor speed studies have been made in an effort to optimize fiber fractionation [7].

Power Savings by Improving Screening. Power savings of 80kWh/BDMT have been reported after eliminating the cleaner plant and improving the screening systems [8]. In addition, groundwood system pulp quality improved, in terms of shives and long fiber. The paper machine cleaner system must be in good operating condition, in order to prevent spec dirt and grit issues in stock preparation or at the paper machine.

Power Savings due to Changes in Screening Operating Parameters. It is an accepted fact that screen cylinder feed surface contours allow operation at higher feed consistencies [9]. This means the volumetric rate of flow for a given production tonnage will decrease proportional to the increase in feed consistency. As a result, savings in pumping power, white water filtering/pumping and capital equipment are possible. Improved shive reduction is also possible.

The conventional screening system for mechanical pulp consists of a primary screen (P1) through which all the pulp, with the exception of the processed rejects, passes. This screen typically has larger diameter (.062" - .084") holes, and primarily removes large debris. It is about 20 to 40 percent efficient at removing shives. The rejects from this screen are further concentrated in a secondary screen (S1); the rejects from the secondary screen are then sent to the reject refiner. The large diameter of the holes means that a large number of shives pass into the accept stream. In addition, there is a large amount of good fiber that is sent for needless additional refining in the reject refiner, resulting in fines.

Since so much energy can be wasted by refining perfectly good stock by the reject refiner, improving the screening system's efficiency in removing and concentrating shives and stiff fibers should be worked on first. This is accomplished by adding an additional stage in the primary and secondary screens (a P2 and S2 screen), which have fine slots. These screens, with slots ranging from .006" to .014", have the ability to remove shives with 95+% efficiency. This results in more shives and less good fiber being sent to the reject refiner.

The screen in the reject system should also be changed to utilize a contoured slotted screen cylinder. The accepts from this screen can then be fed forward in the system, bypassing the primary screening

Table #5

	Item	Present TMP System	TMP System with Post Refining
Production	BDMT/D	190	220
Primary Stage	Sp. En., kWh/BDMT	1097	933
	Motor Load, MW	8.7	8.5
	Freeness, ml CSF	450-500	525-575
Secondary	Sp. En., kWh/BDMT	960	817
	Motor Load, MW	7.6	7.5
	Freeness, ml CSF	200	250
Rejects	Sp. En., kWh/BDMT	984	950
	Motor Load, MW	2.2 x 2	1.6 x 2
Post Refining	Freeness, ml CSF	None	200
	Motor Load, MW	None	1.0
	Intensity, Ws/m	None	0.35
Total System Power	Gross Total, MW	20.7	20.2
	Corrected for 220 BDM/D	24.0	20.2
	Power reduction	—	15.3%

system, which reduces the load on the P1 and P2 screens.

The high shive removal efficiency of the slotted screen cylinder allows the main line refiners to be run at a higher shive production, i.e., with less energy. The shives are then removed (processed) in the reject system. The added benefit to this is the production of flexible long fibers which can be accepted by the slotted P2 screen. These fibers enhance the tear factor of the end product.

In summary, today's modern screening system utilizes additional units that include screen cylinders with contours and slots, resulting in higher quality pulp, higher unit capacity, and less system energy use. This is accomplished by allowing the mill to be run with a lower energy input in the main line refiners, running the system at higher consistencies, and separating and treating individual sections of the pulp spectrum (12).

Controls

Use of Testers and/or Monitors to Control Pulp Quality. Quality monitors, enhanced automatic testers and improved sensors have improved the pulp mill operator's view into the operation of the process. The old saying, "If you can measure it, you can control it," applies. Reduction in variation will undoubtedly lead to improved pulp quality, lower power use, and higher efficiencies.

Control Tuning vs System Dynamics. There are 5000+ control loops in a typical integrated pulp & paper mill. It has been reported that perhaps as many as 85% of these control loops actually ADD to process variation, rather than reduce the variation! Dilution control on a TMP refiner is critical: One field example found that valve stiction was responsible for 80% of the dilution water flow variation. In another mill, a refiner feed screw was found to be responsible for 25% of a 1.5-2 MW load variation [10]. Tuning of process controls to match system dynamics must be considered with any energy reduction program.

Conclusions

Using little capital, significant energy savings are possible in any given mechanical pulping process simply by optimizing the existing process. Factors to consider include: refiner plate pattern changes, improving control tuning, adding post refining, screen cylinder changes, cleaner system optimization, and improving monitors/sensors. Quality targets need to be clearly identified, and should be used as guidelines to support any energy reduction strategy.

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J&L Fiber Services, Inc. • 809 Philip Drive • Waukesha, WI 53186 USA • Phone 414-544-1890 • Fax 414-547-8166