Energy Efficient Refiners-An Experience at JK Paper Mills

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ABSTRACT

Refining plays a vital role in the paper making process. It greatly influences the paper quality and productivity. About 30-35% of the energy requirement of Stock Prepn. and Paper Machine is used in refining only. With increasing energy costs, there is a need to understand and adopt energy efficient equipment and controls. This paper analyses certain key aspects of refiner performance i.e specific energy, intensity of refining, specific edge load, size selection, refining parameters, etc and relates the above to our experience at J K Paper Mills.

INTRODUCTION

Refining is a very important step in the paper making process. It greatly influences the final properties of the pulp, thus empowering the papermaker to adjust and optimize his process for quality and productivity.

It is rightly said that paper is made in the "refiners".

With optimized refining it is possible to produce high quality products using less expensive fiber while reducing energy costs.

Besides, with the shift clearly towards shorter fiber and higher machine speeds, it has become more than ever important.

The theory of Refining........... Inside the refiner

It is the process by which fibers are mechanically treated to alter their intrinsic properties. The changes that occur are given in sequence below:

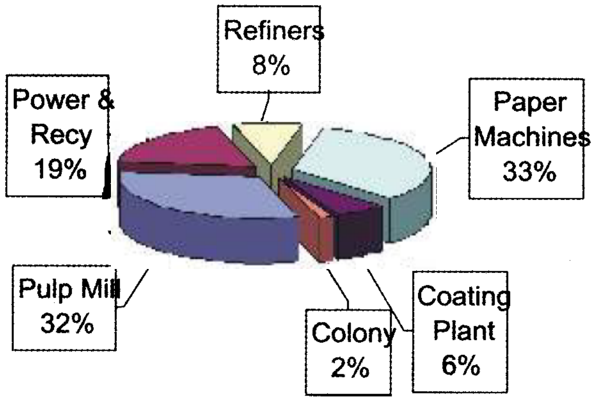
- Increase in the flexibility of the cell wall
- Fibrillation of the fiber surface
- Cutting of the fibers
- Fines generation

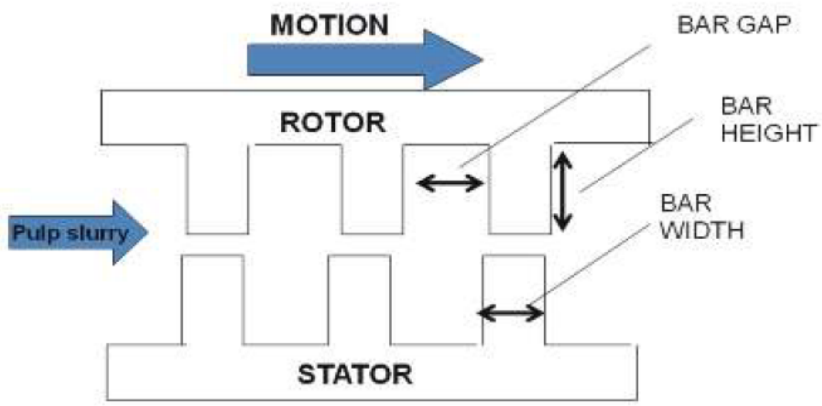
The theory of refining....... Amount of Refining

During the refining process, fibers are modified permanently, basically in two ways:

- **Nature of modification** (magnitude of stresses), i.e how

Distribution of Power





Amount of Refining

↓

Refining Intensity (I) x Frequency (N)

↓

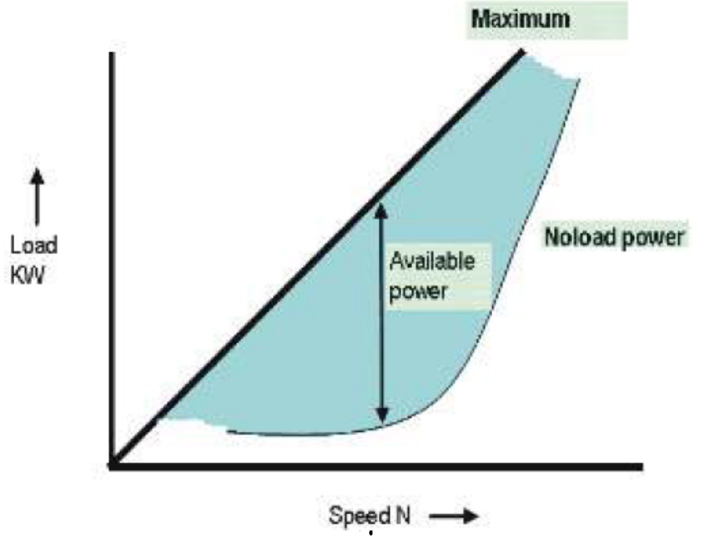
$$\frac{\text{(applied power – no load power)}}{\text{(rpm x bar edge length} \times 60^{-1})} = \frac{\text{(rpm x bar edge length)}}{\text{tons / day}}$$

↓

Net Power/ ton/day

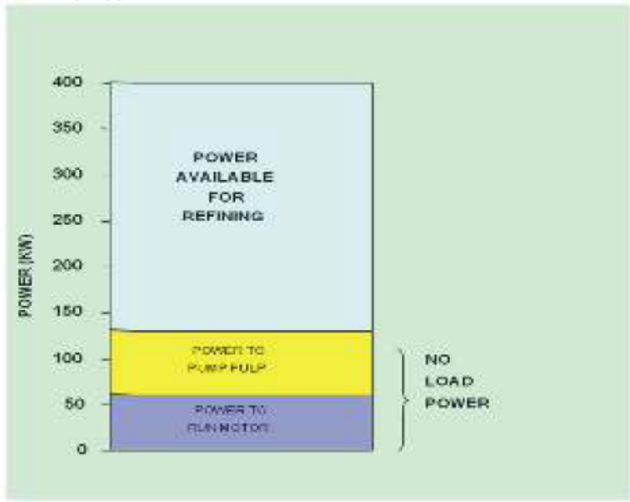
J K Paper Ltd.
Unit: J K Paper Mills, P.O. Jaykaypur-765 017 (Orissa)

Theory of Refining.............No Load Power

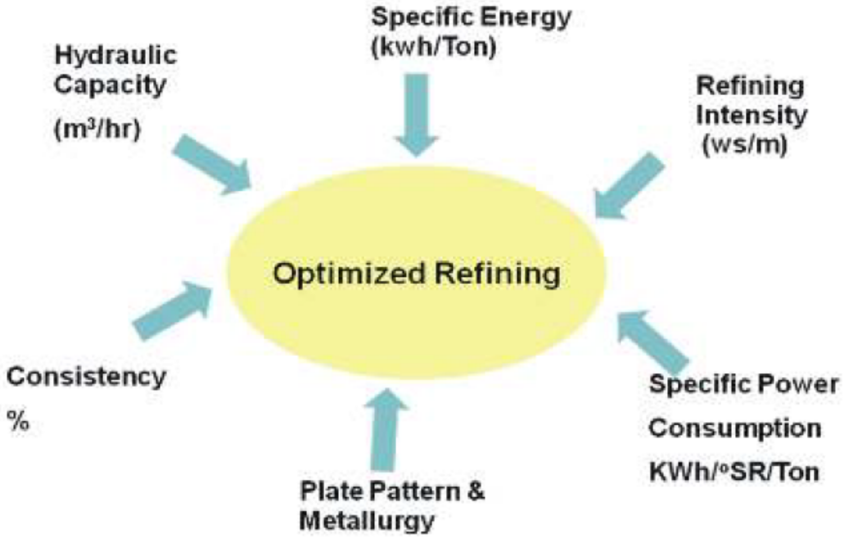


Theory of Refining ......No Load Power

......in a 400 KW DDR



Theory of Refining ......Factors



Refining System.........Hydraulic Capacity

Optimized flow will increase refiner efficiency.

FLOW	*SYMPTOMS*	*HOW TO AVOID?*
LOW FLOW	• *Pressure buildup* • *More fines generation* • *Plate contact leading to low tackle life* • *Poor refiner efficiency*	• *Lower capacity refiner* • *Increase flow and provide recirculation*
HIGH FLOW	• *Insufficient pressure* • *Less tackle life* • *Improper refining*	• *Higher capacity refiner* • *Increase consistency*

hard the fiber is hit.

- Extent of modification (frequency of application of stresses), i.e how often the fiber is hit.

The product of these two gives us the amount of refining that has occurred.

The theory of refining....... (Specific Energy)

Specific Energy determines the amount of refining that is applied to the pulp.

Net Specific Energy (KWh/t) = Pe (KW) / Throughput (t/hr)
Where,
Pe (Net Power) = Total power No load power.

The theory of refining....... (Specific Edge Load)

Specific Edge load is the refining intensity, i.e the work done by the bar edges on the fiber. It is a measure of the severity of the refining. It is calculated from Refining Power (Pe) and cutting edge length (CEL).

SEL (Joules/m) = **Pe** (KW) / CEL (km/s)
Pe = Total power No load power CEL = nR x nS x l x n/60
no. of rotors=nR, no. of stators=nS,
l= avg. length of bars, n = rpm of refiner.

Refining System......... Consistency

Optimizing consistency of the pulp will help in increasing the availability of fibers at the bar edges, where the actual

The consistency to be maintained depends upon fiber type & plate pattern:

CONSISTENCY%	CONSEQUENCES
Low High	• Poor Mat Formation leading to • Poor Plate Life and • More fines generation • Jamming of bar gaps • Low efficiency of refining

Recommended Consistencies of various fiber types

Fiber	Consistency Range %
Softwood Mixed Hardwood Bamboo	2.5 – 5.0 4.0 – 6.0 4.0 – 6.0

Refining System.........Specific Energy
Standard requirement of major pulp types

Fiber	SE (KWh/T)	oSR rise
Soft Wood	100 – 250	20 – 25
Eucalyptus Hardwood	40 - 60	8 – 10
Mixed Hardwood	50 - 80	8 – 10
Bamboo	80 – 100	8 – 12

Refining System.........Refining Intensity
Standard requirement of major pulp types

Fiber	SEL (Wsm^{-1})
S Wood	1.5 – 2.5
Euc. H W	0.2 – 0.4
Mixed H W	0.2 – 0.6
Bamboo	1.0 – 1.5

Refining System.........Specific Power Consumption

Fiber	Sp Power Cons (Net KWh/°SR/T)
S Wood	10 - 14
Euc. H W	4 - 5
Mixed H W	4 - 6
Bamboo	8 - 10

Refiners.............Comparison

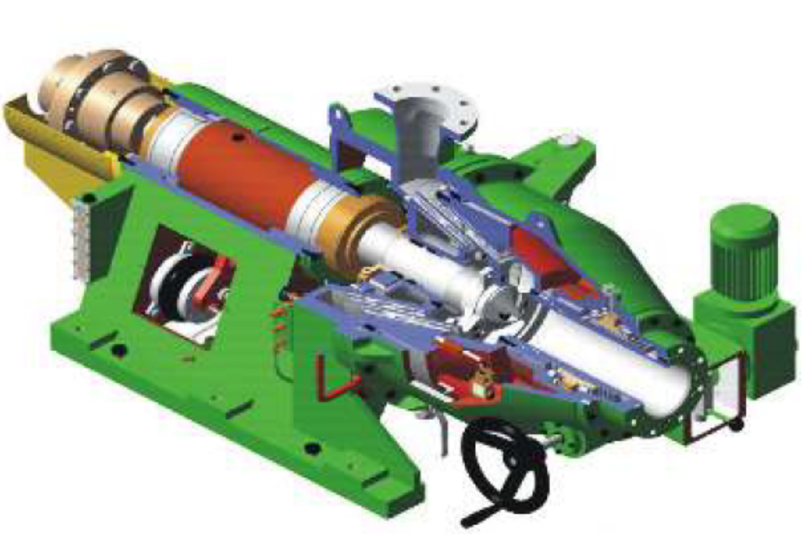
Types of Refiners			
Parameter	**Jordans**	**Disc Refiners**	**Conics**
Refining Efficiency	Low. No load is high	High. Low No Load	High. Low No Load
Refining Intensity	High	Low	Low
Refining Zones	single zone	2/Multi zone refining	2 zone refining
Filling design & flexibility	• Limited patterns • Higher bar height • Less bars / area	• Large no of patterns • Large no short bars	• unlimited patterns • Higher bar height • Longer Life
Hydraulic Capacity	Lower throughput	Higher throughput	High throughput

How the raw materials, refiners & energy requirement changed

	Raw Material	Ratio	Grades Mfd	oSR requirement	Refiners	Specific Energy KWh/T
Upto 1990	Bamboo: Mixed HW	80 : 20	Mostly Maplitho varieties	High (30 - 35)	Jordans	100 - 120
1990 - 2000	Bamboo: Mixed HW	80 : 20	Copier & Maplithos	Low (25 - 35)	Traditional Disc Refiners	80 - 100
2000s	Bamboo: Mixed HW	15 : 85	Copier & Coating Base	Low (25 - 30)	Disc Refiners & TriConic (low angle)	50 - 70

Comparative Energy Consumption / hr

Parameters	UNIT	DDR & TDR	TriConic
Motor Rating	KW	750	450
Operating Load	KW	520	370
No Load	KW	310	190
Net Av Power	KW	210	180
Freeness rise	KW	10	10
Power savings	KW/h		150
Power Cost	Rs/hr	1040	740
Tackle Cost	Rs/hr	110	250
Total Cost	Rs/hr	1150	990
Savings	Rs/hr		160



JKPM Experience...............Data Sheet

	Unit	Jordan	DDR	DDR	TDR	TriConic
MAKE		Voith	Jylhavaara	Jylhavaara	Parason	Pilao
Main Motor Power	KW	120	400	400	350	450
Operating Power	KW	110	360	360	320	370
No Load Power	KW	70	170	200	150	190
Net Power	KW	50	190	160	180	180
Speed	rpm	985	750	750	960	740
Disc Size	inch	----	28	28	24	----
Prod Cap	T/hr	1.2	3.8	3.8	3.8	4
Hydraulic Cap	m^3/Hr	40-100	80-120	80-120	80-120	80-160
Fillings						
Metallurgy		FC	LCSS-FF	LCSS-AA	CS	Cold rolled SS Welded
Bar Width	mm	3	2.8	3	3	2.5
Bar depth	mm	10	7.5	8	8	14
Groove width	mm	3	3.2	4.3	3	3
CEL	km/rev		20	11.3	20	26
Min SEL	**ws/m**		**0.76**	**1.13**	**0..66**	**0.56**
Freeness Rise		4	10	8	8	10
Sp Energy	KWh/T	33	50	42	47	43
Sp. Power Con	**KW/°SR/T**	**8.3**	**5.04**	**5.3**	**5.9**	**4.3**
Total Power	KW/oSR/T	20.8	11.8	11.84	10.5	8.8

refining is done depends upon the fiber type and plate

Refining System.........Specific Energy

The actual amount of power transferred to the fibers is the Specific Energy.

S.E = (Motor Load (KW) No Load (KW))/Rate of flow (T/hr)
Specific Energy requirement depends upon

- Type of fiber being treated
- Amount of treatment required

JKPM Experience

Since inception of JK Paper Mills in 1962, the raw material used as furnish for the manufacture of different grades remained broadly unchanged, until 1998. The commissioning of RDH and Fiberline, dramatically changed the furnish composition from predominantly bamboo to Mixed hardwoods. Morphologically, these two fiber types are entirely different, and therefore, the refining needs and energy requirement is also different.

Keeping in step with the requirement, from time to time, JK Paper Mills has adopted refining technology suitable for the furnish type.

Jordans

Jordans were phased out because:

- Less intensive refining was required
- They could not meet the throughput increase
- More power consuming
- Grade changes

Disc Refiners

Disc Refiners (dual flow) were first introduced in JK Paper Mills in the early 90s. The main reasons for their inclusion are:

- Increased throughput demand
- Higher production rates at machine
- Less Power consumption
- Change in refining requirements due to product mix change

JKPM Experience.............. TriConic

The low angle conical refiners combine the best of both the Jordans and the disc refiners, a typical example of which is the Triconic Refiner

The TriConic RTC 2000 was commissioned in JKPM in 2006 on the PM 1 continuous stock line. The main reasons for its inclusion are:

- Low intensity refining for quality requirement of Coating Base.
- Increase in throughput.

Power Savings (Replace two underutilized refiners of combined capacity of 750 KW with a TriConic of 450 KW).

The energy savings are to the tune of 1300 MWh per annum and cost savings of about 14 15 lakhs per annum

The negative side of the TriConic refiner is :

- Cost of the tackles is very high i.e. about Rs 5.5 lakh/set
- Tackle cost to life ratio is very high i.e almost double the present cost of disc tackles

It is being imported now, and needs to be developed in India.

CONCLUSION

- Focus is towards using more short fiber furnish
- Adoption of low intensity refining technology for, Better quality of refining and Energy saving potential
- Go for higher capacity (Savings on no load)
- Low intensity refining (Savings on specific energy
- Indigenous refiners (to offset the higher cost of imported machines & tackles)