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Optimization Of Low Consistency Disc Refiners

Developed by the Technical Group, J&L Fiber Services

OVERVIEW

- A paper mill can optimize its low consistency refining operations on two fronts:

1. Monitoring and eliminating as many detrimental hydraulic, mechanical and process conditions as possible.
2. Ensuring that the proper plate designs and alloys have been selected.

- Working together, paper and refiner plate manufacturers can develop strategies to optimize individual paper mills.
- C90 is a new alloy from J&L offering guaranteed unbreakability and outstanding corrosion resistance.

Proper Design, Installation and Process Controls All Affect Performance

The floating rotor disc refiner is an important tool for the paper maker.

Not only does it permit him to modify fiber to suit his needs, but most important, it can develop the *maximum strength potential* of a given pulp for the requirements of a given grade of paper.

All too often, however, the full potential of the refiner is not realized. In many cases, this is because of misconceptions about the refiner's function and the operating strategies that should be employed.

Getting the most out of a refining installation begins with optimizing its many interrelated variables, including:

- Hydraulic Requirements
- Refining Intensity
- Process Controls and Variables
- Mechanical Condition of the Refiner
- Refiner Plate Design
- Refiner Plate Alloys

Let's look at each of these variables and their impact on the refining process:

1. Hydraulic Requirements

Proper hydraulic requirements must be met to assure that a fiber pad is maintained between the plates sufficient to:

- transfer energy to the fiber without undue fiber destruction
- provide adequate retention time and turbulence between the plates for the proper intensity of the refining

Flow rate, refiner size, refiner speed and plate design are all elements of the hydraulic balance of a disc refiner. Since the refiner acts as a pump, it is important that these elements are balanced so that plate gap, turbulence and retention time between the plate are maximized.

- *Flow Rate* – Typically, the flow rate of the refiner is mandated by the demand of the paper machine. Flow rates can be increased by adding a recirculation line from the discharge of the refiner back to the suction side of the pump.
- *Refiner Size and Speed* – The disc diameter and the speed affect the pumping characteristics of the refiner. However, these variables are not easily changed.
- *Refiner Plate Design* – In view of the limitations of the above variables, plate design becomes even more critical to the hydraulic

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requirements of a system, particularly the design of the bar and groove area, as well as bar angle.

Pumping Effect as an Indication of Hydraulics and Other Key Factors

The influence of hydraulic balance on a disc refiner is frequently underestimated and even overlooked in many installations. The pumping effect of a refiner (differential pressure) is an excellent indication of the pumping capacity, the proximity of the rotor to the stator, plate life and even the ability to reach optimum fiber properties.

Monitoring Delta P is Essential

Properly functioning inlet and discharge pressure gauges are absolutely essential for optimum refiner operation. Monitoring the delta P of a given refiner provides critical information about the refining condition. The greater the pressure rise across the refiner, the closer the plates are running together and the greater the fiber damage.

Also, with high-pressure rise across the refiner, there is always intermittent plate-to-plate contact which increases plate wear and fiber damage. The greater pressure rise also increases the velocity of the stock across the plates, reducing retention time, and minimizing the turbulence in the grooves.

Since refiner diameter, refiner speed and throughput rates are not easily changed, refiner plate design becomes the critical tool for maintaining proper delta P.

2. Refining Intensity

Refining intensity is measured by the number of impacts and the intensity of the impact on the fiber.

Optimum fiber modification takes place when the fiber is impacted enough times, with enough intensity to break down the S1 layer of the fiber wall. This promotes internal swelling, flexibility, and fibrillation.

The optimum intensity will vary depending upon the species, pulping process, virgin fiber vs. secondary fiber, and grade of paper being produced.

3. Process Control and Process Variables

Refiner process control is another frequently overlooked, but important, element in total refining optimization. Inlet pressure control, consistency control, throughput monitoring and specific energy control are the key process control variables.

When wood species, pulp type, etc., are consistent, specific energy control is recommended. When the fiber supply is varying, a more reactive type of refiner control scheme is called for, such as *couch vacuum* or *on-line freeness control*.

4. Mechanical Condition of the Refiner

The primary elements of the mechanical condition of the refiner are:

- Free-floating Rotating Assembly
- Providing Equal Refining on Each Side of the Rotating Disc
- Rotor/Stator Parallelism (TRAM)
- Ensuring Equal Distribution of Horsepower Loading Across the Face of Each Disc

5. Refiner Plate Design

Given the difficulties of being able to control all of the many process variables that were discussed above, refiner plate design becomes extremely critical. The key design parameters, relative to delta P (refiner pressure control) are: groove depth, groove profile, number of bars, total pumping angle, holdback vs. pumping angle (Fig. 1 and Fig. 2).

The intensity of refining that is required should determine the *bar width/groove relationship*, or pitch. However, groove width should be altered to optimize the throughput rate. This can be done without changing the pitch or intensity by altering the bar width correspondingly.

A special caution when altering groove depth for flow control: While no appreciable negative effect will occur when groove depth is reduced for lower flow rates, *increasing* groove depth poses some risks. First, it is less efficient than increasing groove width. Second, it can have a negative effect on energy efficiency, because increasing groove depth increases the no-load energy required to spin the rotating element in the stock slurry.

Bar angle is significant to the extent that it affects the delta P, and is a tool for hydraulically balancing the refiner.

The relatively infrequently used practice of running the plates in the *holdback* position can effectively compensate for low flow conditions which are detrimental to fiber quality, plate life, etc. During holdback, the intersecting bar angle between the rotor and the stator is moving towards the center line of the refiner rather than towards the periphery of the disc, as in pumping position. “Holdback” will increase the turbulence in the grooves and the plate gap (Fig. 2).

6. Refiner Plate Alloys

Because the pump-through refiner runs at very tight plate gaps, on the order of three fiber diameters, the tendency for plate-to-plate contact is very high. Many other process conditions exacerbate this problem, thus *plate-to-plate contact is the primary cause of plate wear* in most installations.

Without plate-to-plate contact, a refiner plate in nearly any low consistency application could last well in excess of one year. But conditions in most mills reduce average plate life to three to five months, and often as little as one month.

Bar breakage, corresponding plate breakage, excessive downtime and damage to the refiner and downstream equipment are the result. While a mill can strive to eliminate the causes of plate breakage, these upsets can, and will, happen from time to time.

Refiner plate alloys can play a significant role in combating this problem. However, neither the white irons (nihards and high chromes), nor the 400 series stainless steels are the proper choice for low consistency refining. While both offer excellent abrasion resistance (an important factor in high consistency applications), neither category offers significant resistance to impact and breakage, the primary cause of plate failure in low consistency refining.

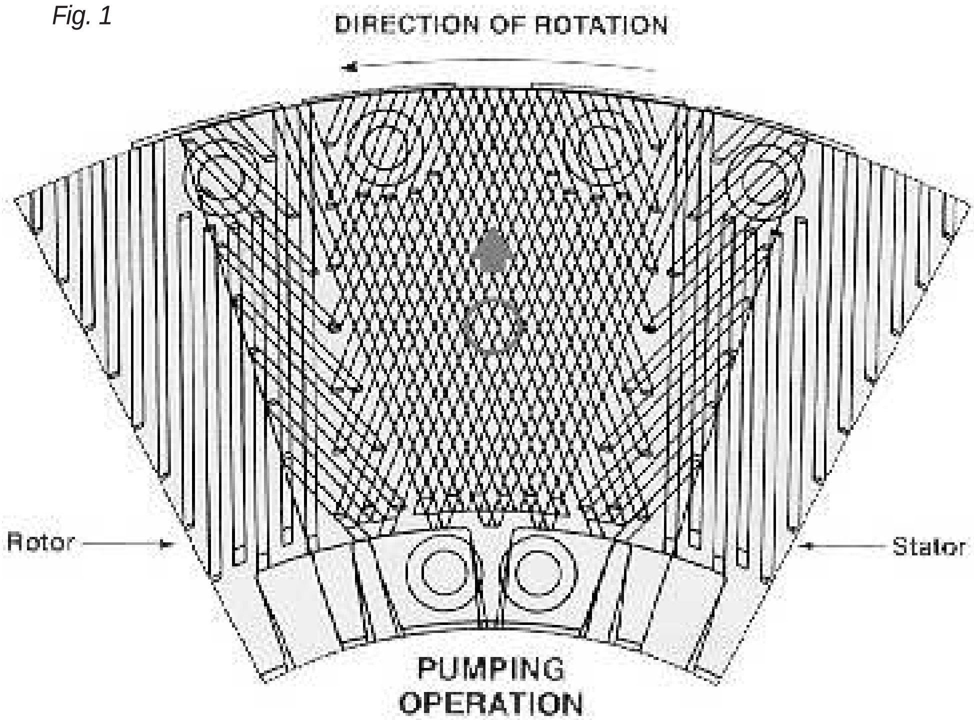
Surprisingly, both alloy groups are used all too frequently for low consistency operations.

Fortunately, new refiner plate alloys that have been developed to resist or *eliminate* plate breakage, are now available. They can play a pivotal role in offsetting adverse process conditions.

J&L C90 alloy is the ultimate among all of the new generation alloys. The result of years of research and development, *C90* offers virtually all of the advantages – and more – of J&L's benchmark C40 alloy:

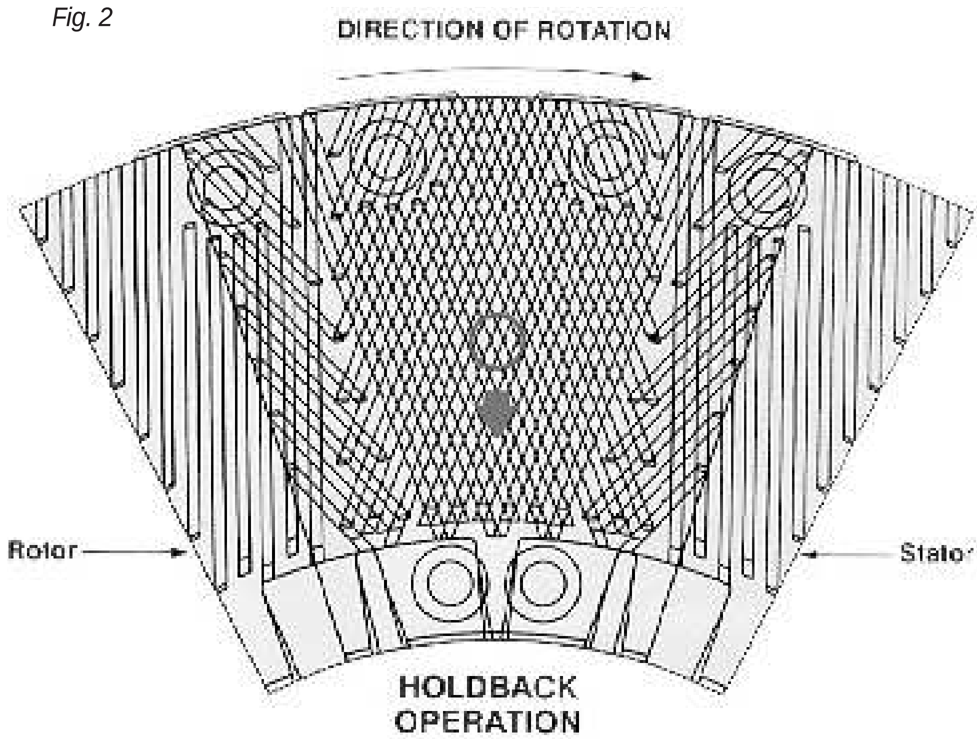
C40 was the top performer among the remarkable 17-4pH

Fig. 1



The points of bar intersection move toward the discharge of the plates, "with" the centrifugal force.

Fig. 2



The points of bar intersection move toward the inside of the refiner, "against" the centrifugal force.

stainless steel alloys that were introduced several years ago. It set a new industry standard with its *guaranteed unbreakability*, outstanding corrosion resistance and good abrasion resistance.

C40 was well worth the additional cost in materials, considering the significant savings that were realized through the elimination of breakage-related refiner downtime and damaged equipment.

Yet *C90* offers all of these qualities and more: the ability to maintain a *sharp bar edge* throughout an extended plate life. The sharp bar edge optimizes refiner performance by minimizing the axial loading pressure and specific energy required, while providing *consistent pulp quality* throughout the life of the plate.

In a relatively short period of time, this innovative alloy has become the industry's new benchmark, the only alloy that could supplant the long-time industry leader, the J&L C40.

(The comparative performance of these alloys relative to fracture toughness and abrasion, corrosion and cavitation resistance was discussed in detail in Optima, Vol. I, Number 4.)

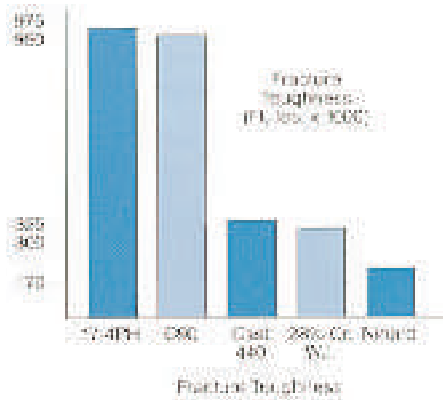
Summary

A paper mill can optimize its low consistency refining operations on two fronts:

- Monitoring and eliminating as many detrimental hydraulic, mechanical and process conditions as possible.
- Ensuring that the proper plate designs and alloys have been selected.

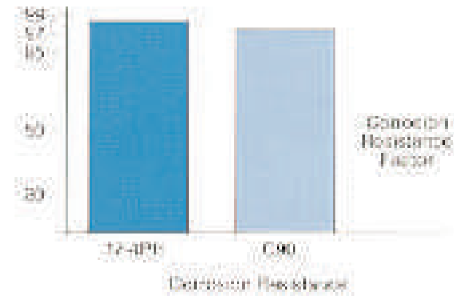
By working together, the paper maker and the refiner plate manufacturer can develop strategies to optimize the unique needs and performance of a particular paper mill.

Fig. 3



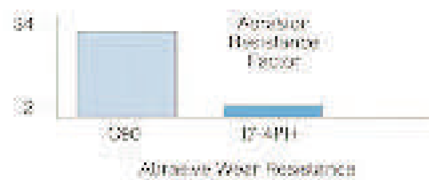
The J&L C40 and C90 are guaranteed unbreakable.

Fig. 4



The J&L C90 maintains the superior corrosion resistance of C40.

Fig. 5



The J&L C90 alloy has far greater abrasion resistance than 17-4pH and compares closely with other cast alloys.

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