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An Analysis of the Fractionating Capabilities of the Black Clawson Selectifier Pressure Screen

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AN ANALYSIS OF THE FRACTIONATING CAPABILITIES OF THE BLACK CLAWSON SELECTIFIER PRESSURE SCREEN

by

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ABSTRACT

The objective of this thesis was to analyze the fiber fractionation capabilities of the Black Clawson Selectifier Pressure Screen. Due to problems associated with the equipment, the actual analysis was not performed. However, it was found that for a set up such as the secondary fiber pilot plant, it is not possible to secure the piping system good enough to permit the use of sonic flowmeters. These meters are intended to be used on piping systems that are free from heavy vibrations.

This thesis attempted to analyze the fractionation capabilities of the Black Clawson Selectifier Pressure Screen. It was felt that by subjecting the screen to varying conditions, that a gereral statement could be made concerning fractionating with pressure screens.

Due to today's increasing concern over economics and the need to optimize a company's papermaking capability/ operation, many secondary fiber mills have investigated fiber fractionation as a way of not only saving money, but also as a means of increasing the quality of the product. In many applications it is expected that a fractionation system can improve the strength of the sheet by increasing the number of long fibers and permit the use of lower cost raw materials. A fractionation system also makes it possible to bypass the refiners with the short fiber fraction which results in less total refining required and little or no further degradation of the short fibers.[1]

A fractionation system works on the principle of providing a barrier that is sized to hold back large fibers but permits small fibers to pass through.[2] In other words, fractionation consists basically of taking a stream of pulp and

splitting it into two different fractions. One stream, the fine fiber fraction, will contain primarily short fibers, small fibers, and various other small particles. The other stream, the long fraction, will contain primarily long fibers, large fiber bundles, and splinters. The difference between these long and short fractions becomes more pronounced as the hole diameter in the fractionator is decreased.[3]

The Selectifier pressure screen has many different sized screens available. These screen plates come with either holes or slots as the perforations. Some of these screens have the capability of screening at 1-5% consistencies. Besides being versatile, pressure screens are reliable, require little floor space, and provide pump through operation.[4]

Principles of operation for the pressure screen are relatively simple. Fibers are fed as a 1-3% slurry into the cylinder and are uniformly deposited on the inside screen surface as it passes the feed position. The water and short fibers are immediately pushed through the screen into the 'accept' port of the screen while the long fibers

are retained on the inside of the screen. In the Selectifier screen, a high velocity (800 rpm) four bladed hydrofoil sweeps along the inside of the screen and lifts the concentrate of retained fibers away from the screen and into the 'reject' port.

For any particular operation, the correct type and size of perforation should be chosen. The size of perforations is referred to as open area. There are several factors contributing to the choice of open area, although the same rules apply for slots as for holes when determining the number of perforations and open area for a screen plate. Some believe that the proper hole diameter and open area is determined by experience with respect to the efficiency of screening required, the length of the fibers, the consistency of the stock, and the overall capacity required.[5] Others state that the selection of holes and open area is determined by the pressure difference of the 'accept' and 'reject' ports of the screen and the length of the fibers.[6]

Pressure screens, when operated at or near their capacity, have the ability to effectively keep the screen plates

clean. There are three main mechanisms used to clean pressure screen plates. These are hydrofoils, paddles or vanes, and variations of a bumped rotor. Hydrofoils, for example, operate at low power but are somewhat limited in their performance at high consistencies. The hydrofoil is also prone to catching debris on the leading edge and forming strings. Paddles, on the other hand, generally perform best at lower consistencies and frequencies, run well with dilution, but are somewhat sensitive to consistency changes. Finally, the bumped rotor has the advantage of providing very high pulsing frequencies. This allows for a stable operation at high consistencies and throughputs. The bumped rotor generally runs at higher pressure drops and speeds.[7]

It has been found that a high velocity across the surface of the screen plate plus high frequency pulsation combine to produce high screening efficiency independant of inlet conditions.[8] Additionally, for best results, the consistency of the inlet stock should be kept as constant as possible.[9]

The operating principles of the pressure screen are straightforward. If more concentrated long fractions are required, they will be obtained by increasing the fines flow. This essentially removes more fines and gives more concentrated long fractions. It follows that if more concentrated fines are required, they will be obtained by increasing the long fraction flow. If neither the desired concentrations of long and short fractions can be obtained by changing the flows, then the hole size in the fractionator must be changed.[10]

EXPERIMENTAL PROCEDURE

The objective of this project was to evaluate the fractionation performance of the Selectifier screen. For this particular run, a 50% virgin hardwood, 50% virgin softwood mix were to be fractionated on the Selectifier pressure screen. This pulp was broken up in the hydrapulper and pumped over to chest 5 in the secondary fiber pilot plant. The quantities of pulp and water used and the corresponding calculations appear in table 1.

400# pulp@ 15% moisture

400 x .85 = 340#b.d. pulp

60# H_2O

$$340\# \text{ pulp} \times \frac{\text{gal.}}{8.345\#} = 40.74 \text{ gal. b.d. pulp}$$

$$\frac{40.74}{.04} = 1019 \text{ gal total @ 4\% consis.}$$

1019-40.74= 978 gal H_2O to add plus steam to bring to 3.5% consistency.

-Begin with 400# pulp

-Dilute with 978 gal. H_2O

-With stock in chest 5, heat to 110°F which should bring stock down to 3.5% consistency.

The equipment lay-out will be as shown in figure 1, located in the appendix. The screen plate used in the Selectifier will be the .018" slots. It can be seen from figure 1, that the stock is continuously recirculated to the same chest. The important control points along this loop are the accept and reject flowmeters and the pressure difference indicator on the pressure screen.

For a pressure screen there are three basic controlling factors. These three factors are: the opening size and spacing in the cylinder, consistency of the feed material, and the percentage of each classification taken from the unit.[12] For this project the screen plate has been set using a .018" slotted plate. The consistency of the stock is one of the varied parameters and the flowmeters are going to be used to vary the percentage of each classification taken from the screen. Therefore, all of the basic controlling factors have been covered.

When the stock has been broken up and pumped to chest 5, it must be heated to 110^{o}F and diluted to 3.5% consistency. Once this has been done the temperature should be held constant at 110^{o}F for the entire run. Another important constant is the pressure difference across the screen. This valve should be kept in the range of 5-7 psi throughtout the run. The pressure difference can be read off of a gauge on the control panel.

With the stock at $3\frac{1}{2}\%$ consistency and $110^{\circ}F$, the run is ready to begin. As can be seen in table 2, there are five different accept/reject flowrates for each consistency. These flowrates are to be obtained by adjusting the valves associated with each flowmeter. When varying these flowrates it is important to keep the pressure difference in the 5-7 psi range by making the necessary adjustments.

From table 2, it can be seen that the first flows are 20/80 accept/reject, respectively. When this ratio has been accomplished, samples are to be taken from both the accept/reject lines as well as from the inlet (stock chest). This sample procedure is to be done for each respective flow rate. Thus, 15 samples will be acquired for each consistency level.

When all five flowrates have been accomplished, the stock is diluted by $\frac{1}{2}\%$ and heated as necessary to keep it at $110^{\circ}F$. Then the same steps as described above are to be carried out. From table 2, one can see that the endpoint for dilution is $1\frac{1}{2}\%$. When this point is reached and the samples are all collected, the run is complete.

The second phase of the project is to analyze all of these samples to determine if the splits were the same as the flowrate ratios might indicate. This analysis will be done with the Clark Classifier according to T 233,

RESULTS DISCUSSION

This project, as described in the preceeding experimental procedure, was not carried out to completion. This was a direct result of a malfunctioning computer system in the secondary fiber pilot plant. Without this computer system there is no way to read or record the values obtained from the magnetic flowmeters.

There was, however, some work done in the secondary fiber pilot plant in an attempt to carry out the aforementioned project. It was thought that the flows could be obtained on the accept and reject lines by using sonic flowmeters instead of the magnetic flowmeters. Since I had previously worked for Allied Paper Inc., they let me borrow their sonic flowmeters in an attempt to carry through with this experiment.

The piping was then set up similar to what is shown in figure 1. The only difference was that the magnetic flowmeters were not being used. The flows were to be controlled by the valve located on the reject side of the screen.

Upon completion of the piping, the pulp was broken up and pumped over to the stock chest. Instead of heating up the stock first, it was decided to do a practice run. This turned out to be a wise choice since the pressure created within the system forced the pipes to jump around and spew pulp onto the floor. This experience indicated

the need for a more secure piping system, one that restrained the movement of the pipes.

The next piping lay-out included the flowmeters as orginally planned but they were to function only as valves. The remaining pipes were tightly secured to prevent any undesirable movement.

The pulp that was left from the previous run, although diluted to about 2%, was then run through as a test of the piping system. The operation ran smoothly until the pneumatic valve on the accept line cut off and created a tremendous amount of back pressure and blew the pipes apart. It was then decided to use the good flowmeter as a valve for the accept side and to use the valve on the screen for the reject flow, thus eliminating the bad flowmeter.

When this set up was complete, the stock was again run through the system. This time the system worked smoothly. The sonic flowmeters were then connected on the accept and reject sides, respectively. The flowmeters were responding to any changes in flow that they were subjected to. The stock at this point had been diluted to approximately 1½% consistency so a new batch had to be pulped. This completed the second day of preleminary work of setting up the equipment and insuring its proper operation.

On the begining of the third day the pulp was broken

up, diluted, and heated to the initial conditions described in table 2. The stock was then pumped through the screening system. When trying to adjust the flows to the 20/80 accept/reject rates, it was noticed that the flowmeters were not registering. After inspecting the seal of the probe on the pipe, the location and distance from elbows, and the alignment of the probe, it was realized that it wasn't going to be possible to make the flowmeters function under these conditions.

At the intial condition of 3½% consistency and 20/80 accept/reject flows, one major problem existed. By forcing stock through the screen at such a heavy consistency the whole system was oscillating at such a frequency that it was upsetting the reading of the sonic flowmeters. The adjustment on the meter itself for external noise wasn't able to eliminate the serious vibrations occuring in this system. Therefore, either an erratic or no reading at all was obtained from the flowmeters.

CONCLUSIONS

Although the project was never carried out to completion, the experience gained was benificial. It was determined that it is not possible to make the system stable enough for the operation of sonic flowmeters. One other problem with the

system in general is that there is no provision for a backup unit. Even though this isn't an industrial set up, the difficulty in repairing the existing equipment would seem to dictate the need for some type of temporary back up system.

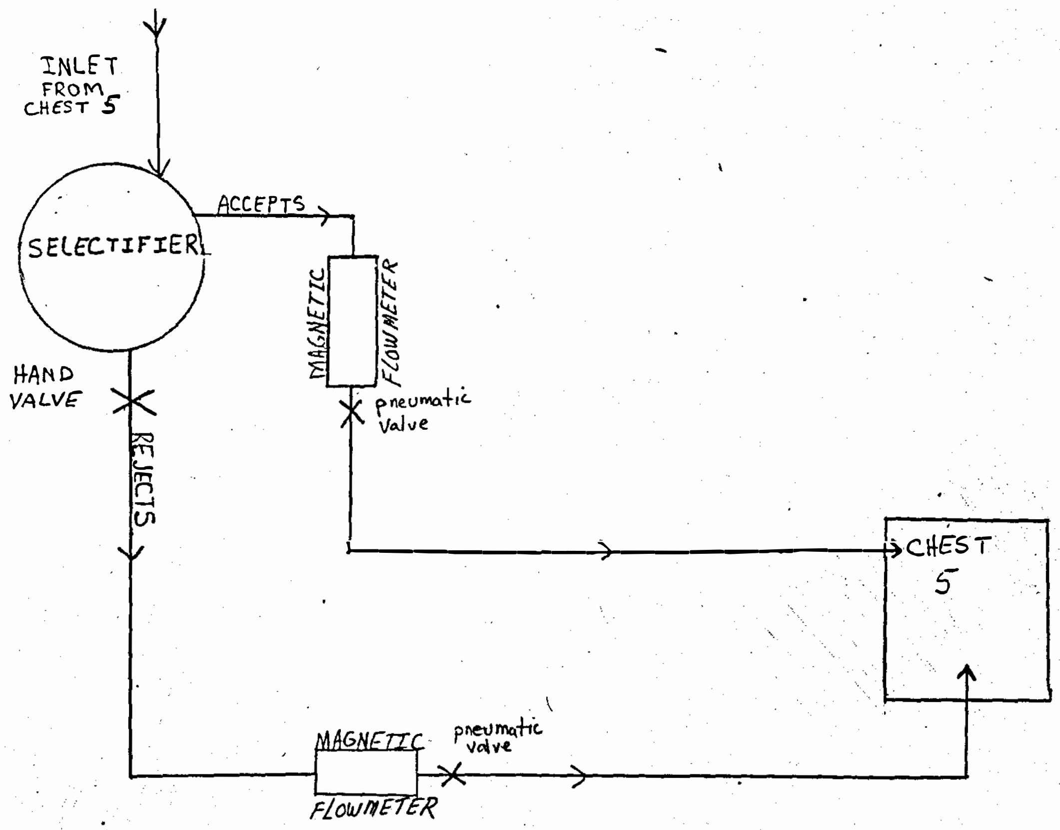
INLET
FROM
CHEST 5
SELECTIFIER
ACCEPTS
MAGNETIC
FLOWMETER
pneumatic
Valve
HAND
VALVE
REJECTS
CHEST
5
MAGNETIC
FLOWMETER
pneumatic
valve

FIGURE 1

CONSTANTS- Temperature @ 110°F
Hydrofoil speed @ 804 rpm
Pressure diff. 5-7 psi

	CONSISTENCY	ACCEPT/REJECT FLOW RATIOS
(begining conditions)	3½%	20/80
	3½	30/70
	3½	40/60
	3½	50/50
	3½	60/40
	3%	20/80
	3	30/70
	3	40/60
	3	50/50
	3	60/40
	2½	20/80
	2½	30/70
	2½	40/60
	2½	50/50
	2½	60/40
	2	20/80
	2	30/70
	2	40/60
	2	50/50
	2	60/40
	1½	20/80
	1½	30/70
	1½	40/60
	1½	50/50
	1½	60/40

Table 2

FOOTNOTE PAGE

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