9-1983

Press Section White Water Reuse

James Michael Tacey
Western Michigan University

PRESS SECTION WHITE WATER REUSE

by

James Michael Tacey

A thesis submitted to the
Department of Paper Technology
in partial fulfillment
of the
Degree of Bachelor of Science

Western Michigan University
Kalamazoo, Michigan
September, 1983

Keywords: Cyclospray Filter
White Water
Felt Hairs
Fines

ABSTRACT

In today's economy, more and more papermills are becoming increasingly concerned with white water reuse. White water is most frequently used for fan pump dilution, and consistency regulation. This white water usually comes strictly from the tray boxes of the paper machine. It was suggested that the white water from the press section could be reused. It was suggested to me by Dan Kaiser, of Ronningen-Petter, that this could be accomplished by using their Cyclospray filter. The testing run showed that the unit is very effective in removing the fibrous contaminants from the press section water. I found the unit to be very easy to run and relatively maintenance free. This means that it would not put an extra burden on the mill personnel. I then did further work at Ronningen-Petter to verify my original results. The results of this testing can be found in the addendum at the end of this report.

INTRODUCTION AND BACKGROUND

Papermills are becoming increasingly concerned with closing up the process water system of their papermachines. As fresh water supplies dwindle and government regulations on effluent become annually more severe, virtually every mill could benefit from increasing the reuse of the white water or any process water of their papermachines. According to D.C. Haynes of Buckeye Cellulose, "Today, good management demands that white water be recirculated to a maximum use without separation of the components and, after separation of the fiber and filler, that the clarified water be recirculated."[1]

White water is most frequently used for fan pump dilution, consistency regulation, sheet knock-off showers and return wire roll showers. In some instances fresh water may have to be used instead of recycled water. High pressure felt cleaning showers have typically used fresh water but with the introduction of some self cleaning showers this may change. Showers which find the most successful application in the white water service are the self cleaning types such as the Bird Aquapurge or the Broughton self cleaning shower. If fresh water use could be reduced on the wet end of the papermachine (including the press section) by utilizing the water from the press section, felt cleaning systems and seal water, a significant savings in material and energy could result. Not only could the water be reused, but the mineral filler content could also be reclaimed. The press section is usually the last place for which recycling is attempted. Some are straining this water to remove felt hairs and other fibrous contaminants and then recycling this water along with the other white water.[2]

Another area with considerable recycling potential is the seal water for vacuum pumps. Seal water for vacuum pumps is one of the greatest users of make-up water on the papermachine.

Ronningen-Petter Division of Dover Corporation, located in Portage, Michigan, has produced a high solids (up to 2000 ppm) filter for use on papermachine whitewater systems. This filter, the Cyclospray T, has been under development for four years and in production for three and has found successful operation in the plastics and metal industries for liquid/solid separation. The filter has also been installed at Plainwell Paper Company in Plainwell, Michigan. The filter was used to filter white water from the clear leg of the saveall to produce wire shower water returning the rejects to the cloudy leg of the saveall.

Ronningen-Petter's Engineering Manager, R. B. DeVisser, suggested that this unit could be used successfully to filter felt hairs, fibers, fines and fillers from the Uhle box and press section water. However, we need only to remove the synthetic felt fibers to be able to reuse this water as white water. Because the felt fibers and papermaking fibers are similar in length in the press water, the filter will not be able to distinguish between them and both will be removed by the filter.

Previous Press Water Recirculation

Although mention can be found of instances where a mill is straining and recirculating its press water, the literature search did not show any specific methods for this. Chesepeake Corporation in West Point, Virginia, installed an AES 3600 series filter by Albany Engineering Systems.[4] This filter is a gravity flow strainer that removes impurities in process water. The AES 3600 is currently being used in three paper mills in the United States.

The AES 3600 screen is available in sizes ranging from 55 to 114 inches in diameter. It is capable of handling 800 to 4360 gallons per minute. The process water flows up an annulus, over a wier, and onto a distributor plate where it is spread evenly over a 100 to 150 mesh screen as shown in Figure 1. The screen is constantly backwashed from below by a rotating shower which is fed by the screen accepts; the shower is used to eliminate screen binding and fiber stapling.

Previous Testing of the Cyclospray Filter

The Cyclospray filter went through extensive testing by the manufacturer prior to its use as a white water filter. It was based on this experimental work that the flter would be applied to press water recirculation.

In test runs completed in January of 1980, shredded paper contaminants were added in measured amounts to 100 gallons of water. Samples of each addition level were taken to check the level by a weight difference. The results led to some mechanical modification and to the rejection of prefiltering the shower supply.[5] The filter was also tested at Plainwell Paper Company from June 25, 1980 to August 5, 1980, accumulating 102 total hours of run time over several grades. Good test results led to further testing. The filtered water from the screen was then used for two wire showers and a Jonsson screen shower.[6] Mechanical problems prompted minor changes, and a change in blowoff rate was made because the filter remained in the automatic backwash mode constantly. By January of 1981, the filter was performing well with very little maintenance or operator control. in July, an increase in shower pressure indicated plugging, so the filter was dismantled and inspected. It was found that the 250 mesh stainless steel screen had six splits in the screen, one very severe. This led to the reversal of the main wires in the screen such that they ran vertically instead of horizontally.[7]

EXPERIMENTAL PROCEDURE

In order to run a controlled experiment to determine effeciency of removal, a constant ratio of filler to fiber loading of varying concentrations was used.

The felt fibers were supplied by Ascoe Felts. They are nylon fibers used to make standard press felts. The fibers that came were extremely long (1-3 inches). The felt fibers were shortened in a Wiley Mill at Western Michigan University.

The filter used in this experiment was a pressurized filter manufactured by Ronnigen-Petter called the Cyclospray. The operating variables of the unit are:

1. Inlet Flow Rate
2. Outlet Flow Rate
3. Blow-Off Flow Rate
4. Filter Medium Mesh and Type
5. Contaminant Loading Level and Type

The removal effeciency of the filter was measured by comparinging inlet ash loading to outlet ash loading.

The filter was tested using three different contaminant levels and four different screen mesh sizes. All experimental runs were conducted at the Western Michigan University Secondary Fiber Pilot Plant with the assistance of Carl Shuster, and Dr. Richard B. Valley.

Equipment Preparation

The Cyclospray unit comes as a complete package to the customer. The package consists of a filter assembly, pump, gear box, motor, DeltaGard Controller, and all the necessary pressure monitoring equipment.

Two different power supplies are required for this unit. The control unit takes a 120 volt AC line. The 7½ horse power motor can use either a 240 or 480 volt AC three-phase connection. The unit is not supplied with a starter so it was wired into the control panel of the Recycling Pilot Plant. The air supply is connected to the air filter/regulator/lubricator located on the left side of the control panel.

The unit was piped into the #5 chest in the Pilot Plant. The #5 chest was chosen because of the magnetic flow meter on the chest discharge pump. The inlet of the Cyclospray was connected with a three inch flanged pipe to the chest flow meter. The outlet must be back pressured. A three inch flanged gate valve with a throttling plate was connected on the discharge side of the Cyclospray. A three inch flanged pipe was then connected to this gate valve and put into the top of the #5 chest. The discharge line required a one inch NPT connection. This was fitted with a "T" and two ball valves so that a sample could be taken of the discharge line. This discharge line was then put back into the top of the #5 chest so that the fibrous contaminants were constant by recirculation.

The Cyclospray comes equipped with a sample line on the accept side of the filter. I found it easier to sample the accepts right out of the accept line discharging into the chest. The magnetic flow meter is equipped with a by-pass valve and this is where the inlet was sampled.

Start Up

The unit start-up was carried out with clean water in accordance to Ronnigen-Petter's Cyclospray manual which is as follows:

1. Check to be sure all bolt and hose connections are tight.

2. Check the backwash sequence, as follows:

   Turn the control panel switch to "on". Do not turn on liquid flow or motor. Push the manual start button and hold depressed for 2-3 seconds. The butterfly valve on the outlet should move from open to closed, and the one inch ball valve on the discharge should move from closed to open. (If the valves work the opposite way, reverse the two air lines from the W-10 valve. This will correct the situation.)

3. Flush the pump and hose system, as follows;

   Uncouple the quick coupler connecting the pump hose to the shower inlet hose (top of the filter). Next, couple the plugged female coupling (supplied separately) to the male coupling at the top of the unit. Point the hose away and turn on a partial flow of liquid to the unit. Once liquid is flowing out of the hose, turn on the pump and allow it to run for 15-20 seconds. Shut off pump and all liquid flowing to the unit. Remove female coupler and recouple shower hose in place. This procedure protects the shower nozzles from initial plugging due to loose dirt in the piping.

4. The filter unit is now ready to be put into operation.

Sample Preparaion

The press section water was made up in the 5000 gallon #5 chest. The press section water consisted of 95% filler content, 4% papermaking fiber and 1% felt making fiber. The filler content itself consisted of 80% filler clay and 20% calcium carbonate. The papermaking fiber added was a bleached softwood kraft. The exact concentration of each component for every make-up can be found in Table I of the Appendix.

To make up the press section sample, 1000 gallons were added to the chest. To this, the filler contents was added and allowed to disperse for 15 minutes. The fibrous contaminants were then added and allowed to disperse for an additional 30 minutes.

In an effort to try and "tag" the fibrous contaminants, all the cellulose paper making fibers were dyed with a direct purple dye. This was done in an effort to quantify how much fiber was coming through the accept side of the filter.

Operating Procedure

The experiment was begun by closing the magnetic flowmeter valve and opening the by-pass valve. The chest pump was then turned on and allowed to circulate through the pump and back into the chest without going through the filter. The control valve on the Cyclospray was then closed and the magnetic flow meter valve opened slowly. When the unit developed inlet pressure, it was started. The by-pass valve was closed down to approximately 5% and the flow meter and backpressure valve were adjusted to a flow of 180 gpm and a pressure of 35 psi.

The filter was allowed to run for 15 minutes to achieve steady-state operation. during this 15 minutes, the filter was observed to see how many times it went into the backwashing mode. After 15 minutes, samples were taken of the inlet, outlet, and the reject line, using one quart, screw top sample jars. Each sample jar was filled to the top, sealed and labeled for testing later. At sample time, inlet flow rate, inlet and outlet pressure, and shower pressure were noted for future analysis. Outlet and discharge flow rate were not checked because the unit is designed to run at a 93% flow effeciency. After the sample was taken, the unit was manually backwashed twice and then fresh water was run through the unit. This was done in order to completely clean the filter so that the filter medium could be changed. The fresh water diluted the sample slightly, but this was considered minimal. The filter medium was then changed and the experiment repeated with the new filtering media.

The experiment consisted of three contaminant loadings; 500 ppm, 1000 ppm, 2000 ppm and four filter meshes: 250 mesh, 500 mesh, 33 micron, and 25 micron. The actual contaminant loading was slightly different than this and can be found in Table II. Each contaminant trial and problems encountered during the run will be discussed separately. After all the filter media were run on the one contaminant loading the chest was drained thoroughly washed to remove all the fibrous contaminants and the new contaminant load was made up.

<u>500 ppm</u>

The 500 ppm sample was run with only three screen sizes. At first, it was thought that the 25 micron screen would be too small to run, so it was not used. Later work showed that this was not true. No problems were encountered during these runs. The filter did not go nto the back wash mode during any of the 15 minute trials. This was mainly a learning period for myself and time did not permit me to repeat this set of data.

1000 ppm

The 1000 ppm trial went smoother than the 500 ppm. The trial was run with all four available screen sizes. It was found that the filter cycled once in 15 minutes on the 500 and the 250 mesh. The 33 and 25 micron screen ran with no appreciable pressure drop from the inlet to outlet. This cycling could be due to the fact that the 250 and 500 mesh screens use a much larger diameter string to make up the weave; thus, having a rougher surface area. The fiber becomes entangled in this surface and the rotating shower is unable to knock it off under pressure. The filter is then blinded and the filter develops a pressure differential from inlet to outlet and goes into the back wash mode. This does not happen on the 33 micron and 25 micron because these screens are much finer and smoother in design and do not lend themselves to fiber stapling.

2000 ppm

In an attempt to increase the fiber loading only, the 1000 ppm sample was saved and another 1000 ppm of just fiber was added to bring it up to 2000 ppm total. The 500 mesh screen was then put in the unit and the filter was started up. It must be mentioned that this trial took place the day after the 1000 ppm trial. During this initial 2000 ppm trial, of which 50% was fibrous material, the filter never came out of the backwash mode. It was then thought the filter could not handle this load so the chest was dumped and thoroughly cleaned. A new press section water sample was then made up with the 95-4-1% ratio and the trial was repeated. Again the filter failed to come out of the backwash mode. Upon inspection of the discharge line, it was found that the unit was not rejecting any material. the unit was then immediately shut down and the discharge line dismantled. It was completely plugged. The line was completely cleaned and the trial started over. Due to lack of material (felt fiber) the 50/50 blend could not be rerun. The 2000 ppm run on the 95-4-1 exhibited the same type of behavior as the 1000 ppm. The filter cycled on the 250 and 500 mesh screen. I also noticed that the 33 micron and 25 micron screen developed 5-10 small tears in each. This was due to the constant handling that was required in these trials.

Test Procedures

Approximately 200ml of the sample was poured into a graduate and the exact volume determined. The sample was then filtered through a Whatman #42 Ashless Filter paper using a Buchner Funnel. The filter paper had been previously dried and weighed. The filter paper was put into a 105°C oven and allowed to dry for four hours. After drying the filter paper the sample was again weighed as accurately as possible. This was repeated for all the samples taken.

The samples were then inspected using a microscope to see if the felt hair could be identified. The felt fraction could not be identified, so this objective was not pursued any further.

Before ash was determined on the samples, a filler correction factor had to be determined. This was done by taking a known amount of dry filler and ashing it in the furnace. The difference in weight was then calculated into a correction factor. The factor was found by averaging five different samples. It was found to contain 0.800 lbs. ash/lb. filler. The samples were then ashed in a 900^{o}C muffle furnace. The ash was then weighed and corrected by the correction factor. The results of this testing can be found in Table II of the Appendix.

DISCUSSION OF RESULTS

Theoretically, the unit should remove only those contaminants larger than the screen mesh. The Klondyke filler clay and Hydrocarb 30 are of similar particle size. The clay is a fine water washed and the calcium is 90% less than four microns. The filter theoretically should remove only the fibrous contaminants and allow all the filler material through. Therefore, the slope of the inlet vs. accept line should be one, and the corrected ash weight of the accepts divided by the dry weight of the accepts should be 100% for complete removal.

Table II gives the actual percent efficiency of removal. As was expected, the efficiency improved as screen size decreased. You may also notice that as screen size decreases, the percent filler in the rejects increases. This means that more filler stripping takes place at these lower screen sizes. This is because more fiber is trapped on the screen, reducing the effective open area of the screen, entraining more filler material in the blow off stream.

Figure 1 is a graph of #/min. inlet vs. #/min. outlet The slope of this line should be .930. This is the flow rate efficiency of the Cyclospray unit in general. This particular unit had an efficiency factor of 94.5%. This is very close to the general figure and is well within experimental error.

Figure 2 is a graph of the inlet ash vs. accepts ash. This graph shows which filter medium is most effective. The 500 mesh and 33 micron are very similar in removal efficiency. The 25 micron screen is where a definite increase takes place.

Figure 3 is the graph of inlet ash vs. outlet ash. Theoretically, the slope of this line should be unity. Due to some blow off, it will not be perfect. As can be seen by the slope of .926, this again is the flow efficiency factor (.93). Figures 1 and 3 both prove that the actual factor is indeed 93%. Based on these facts, it can be said that the filter performed to its own performance criteria as stated by Ronningen-Petter.

Table III is the expected filler saving that would have been realized if this would have been in actual operation.

Table IV is a worksheet for total savings that one could expect from recycling the press section water. The exact formulas for this worksheet can be found in Appendix II of this report. As can be seen by the payback period, this filter with even a very low ash press water will pay for itself in less than three months.

CONCLUSIONS

The Cyclospray unit is very effective in removing fibrous contaminants from press section water. I would recommend installing this unit on the press section of a paper machine with the 33 micron screen. The 33 micron and the 500 mesh showed very similar removal efficiencies, but due to the less backwashing problems of the 33 micron, this is the recommended media.

I found this unit relatively maintenance free. The unit did not need constant supervision either. It could be set up and running and only need periodic checking. This means it does not put an "extra burden" on the mill employee so it is easier for him to accept it. If the general mill person accepts a new piece of equipment, it seems to function much better for the mill.

TABLE I

White Water Make-up

500 ppm

1000 gals = 8,345 # of H_2O

filler = 95% = 4.0 # filler
fiber = 4% = 0.17 #
felt hairs = 1% = 0.03 #

1000 ppm

filler = 95% = 7.9 #
fiber = 4% = 0.33 #
felt hairs = 1% = 0.08 #

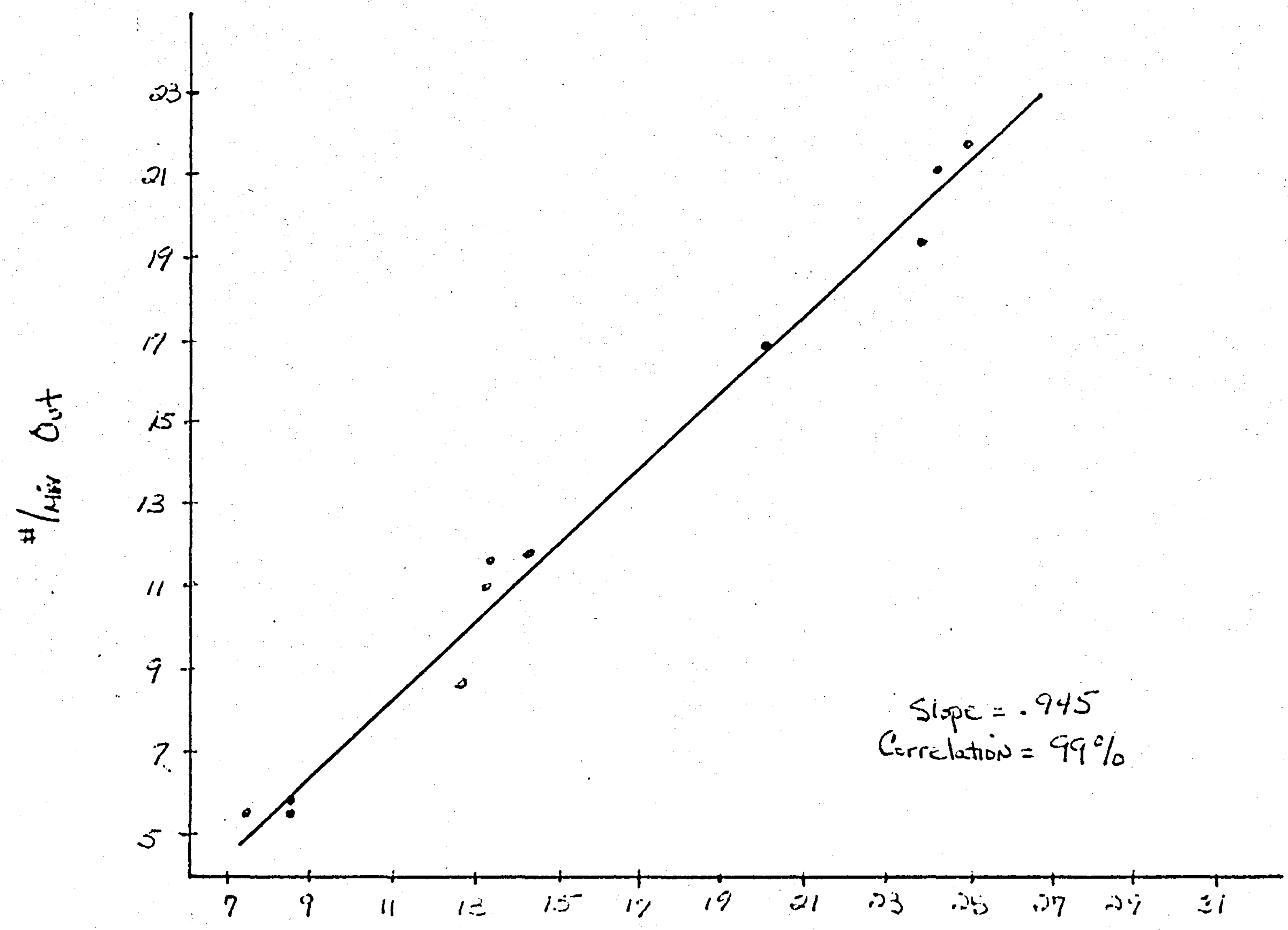
2000 ppm

filler = 95% = 15.9 #
fiber = 4% = 0.70 #
felt hairs = 1% = 0.20 #

TABLE II

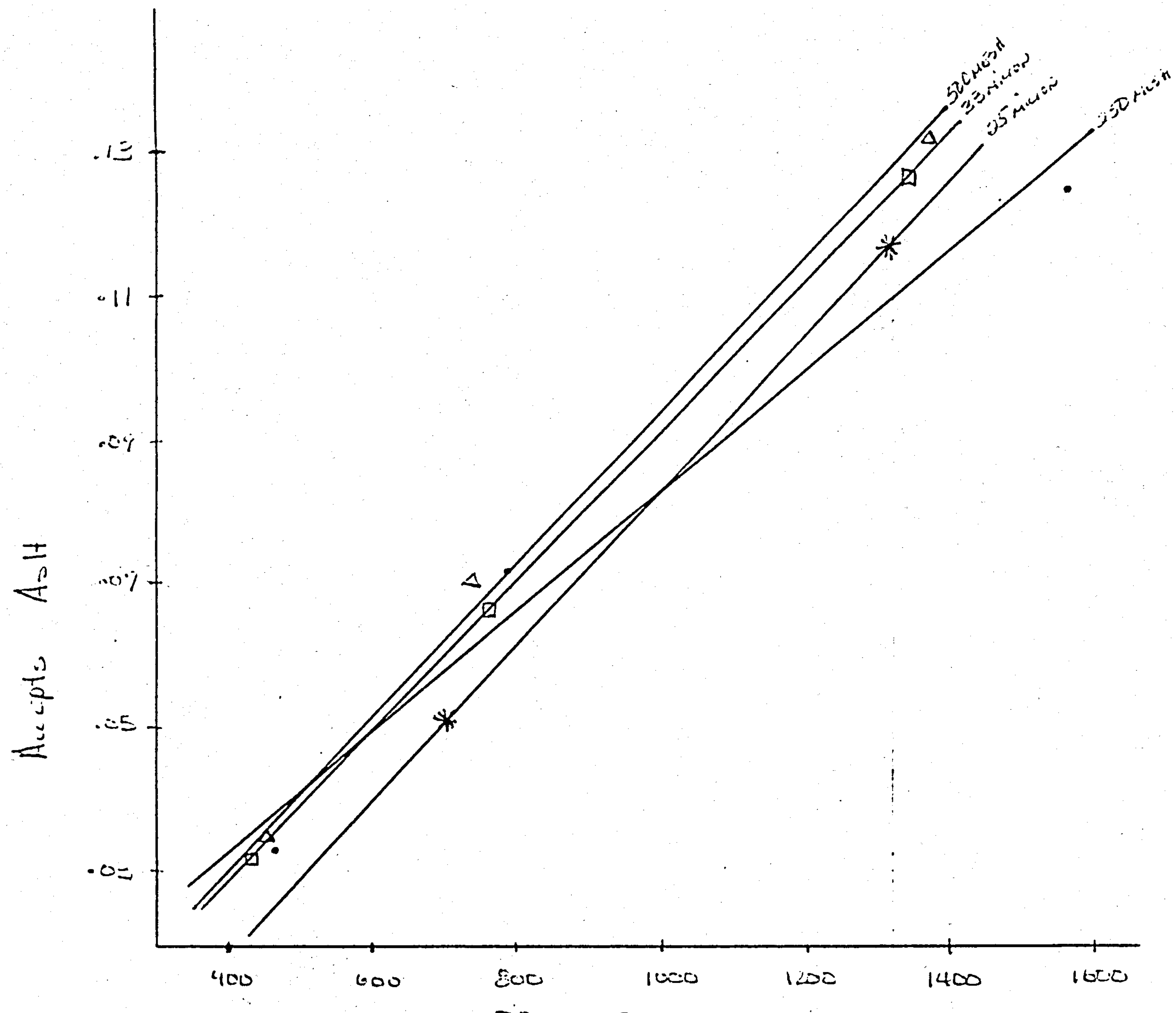
Screen Size	PPM (INLET)	lbs/min	Dry wt Filler + Fiber Accepts	Corrected Ash Accepts	% Removal	Rejects	% Filler in Rejects
250 MESH	470	8.5	.033	.031	94%	.104	37.6%
500 MESH	470	8.5	.035	.035	99+%	.100	42.5%
33 MICRON	470	7.4	.034	.028	82%	.180	41.1%
250 MESH	790	14.2	.071	.070	98.6%	.126	54.1%
500 MESH	740	13.3	.070	.069	98.6%	.132	53.7%
33 MICRON	740	13.3	.066	.066	99+%	.138	48.8%
25 MICRON	700	12.6	.052	.052	99+%	.143	47.0%
250 MESH	1570	28.3	.124	.118	95.2%	.176	72.6%
500 MESH	1370	24.7	.132	.128	97.0%	.188	73.2%
33 MICRON	1340	24.1	.127	.127	99+%	.234	67.4%
25 MICRON	1320	23.8	.116	.116	99+%	.143	49.0%

Figure I



#/Min Out
5
7
9
11
13
15
17
19
21
23
7
9
11
13
15
17
19
21
23
25
27
29
31
Slope = .945
Correlation = 99%

Fig 2



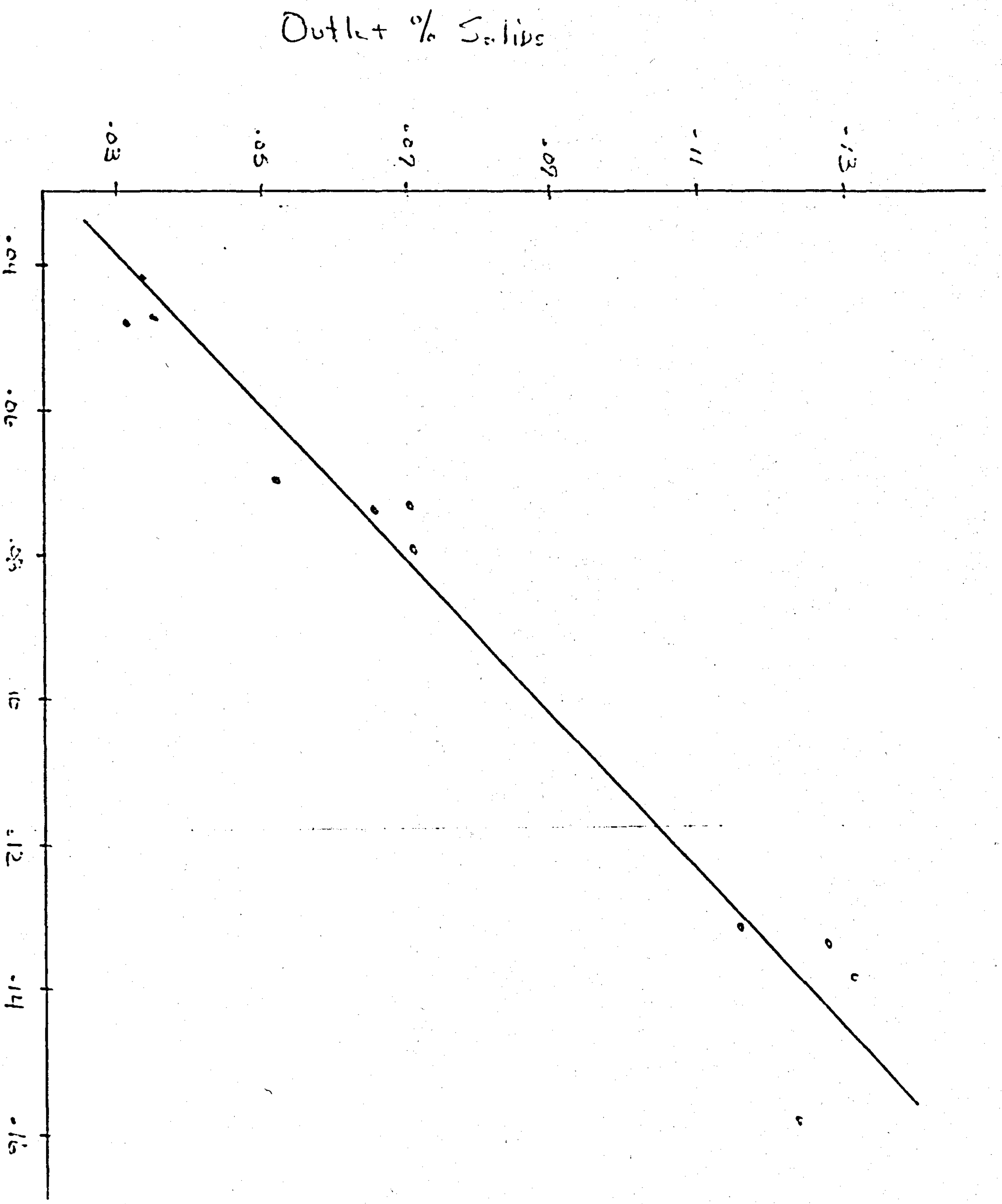


Fig 3

TABLE III

Filler Savings

Mesh	PPM (Inlet)	Filler Accepts (%)	Savings /year
250	470	.031	15,000
500	470	.035	16,900
33 mic	410	.028	13,500
250	790	.071	34,250
500	740	.069	33,300
33	740	.066	31,800
25	700	.052	25,100
250	1570	.118	57,000
500	1370	.128	61,700
33	1340	.127	61,300
25	1320	.116	56,000

TABLE IV

TOTAL Press Section Savings

Basis 180 gpm
335 operation days
.031% Ash installed cost of filter $20,000
.065% Ash
.125% AsH

Waste Treatment Savings (All)

180 x 335 x .225	=	13,600

Heat loss Savings

180 x 335 x .98	=	59,000
TOTAL	=	72,600

Filler Savings

$\frac{.031\%}{100}$ x 180 x 335 x 800	=	15,000
.00065	=	31,350
.00125	=	60,300

TOTALs & Simple Payback Period

.031% Ash	TOTAL/yr	$87,600
	Payback	2.74 Months
.065% Ash	Total/yr	$103,950
	Payback	2.3 Month
.125% AsH	TOTAL	$132,900
	Payback	1.8 Months

Appendix II

FORMULA FOR PRESS SECTION SAVINGS

The following formulas were used to determine the constants used in the savings formula for the CycloSpray Filter ad.

1. Waste Treatment Savings - We need to know the following:

   a. the flow from the press section in GPM (a variable)
   b. the number of minutes in a day 1440 (a constant)
   c. the number of days in the operation (a variable)
   d. the cost to treat one gallon of water - \$240./million gallons ÷ 1,000,000 = \$.00024/gallon - (a constant)
   e. the efficiency of the CycloSpray - 93% (a constant)
   f. a correction factor for the cost/1,000,000 gallons treatment cost - 0.7 (a constant). this was done assuming maintenance would be required with or without the reduced flow.

   To calculate waste treatment savings, we can combine the constants and the formula becomes:

   Flow (in GPM) x days/yr x min/day (1440) x cost/gal (.00024)

   x efficiency (.93) x correction factor (..7)

   Simplified, the formula now reads:

   Flow (in GPM) x days/yr x \$.225 = Savings Per Year

2. Savings In Filler - We need to know the following:

   a. the flow from the press section in GPM (a variable
   b. the weight % of filler vs the weight of water from the press section, stated as ash content (a variable)
   c. the number of operating days per year (a variable)
   d. the number of lbs. of water/gallon - 8.3 (a constant)
   e. the number of minutes in a day, 1440 (a constant)
   f. the cost of filler clay (per lb.) = 145/ton ÷ 2000 = \$.0725/lb(a constant)
   g. efficiency of the CycloSpray - 93% (a constant)

To calculate filler cost savings, we can combine the constants and the formula becomes:

Flow (in GPM) x days/yr x ash content x Wt of water (8.3 lb/gal) .

x cost of clay ($.0725/lb) x efficiency (.93) x no. minutes/day (1440)

Simplified, the new formula now reads:

Flow (GPM) x days/yr x ash content x $800 = Savings/Year

3. To calculate the savings from heat loss, we need to know:

a. flow in GPM (a variable)
b. operating days/yr (a variable)
c. cost to heat water $2.25/1,000,000 BTU's - it takes 1 BTU to heat 1 lb. of water 1^{o} F., therefore, it cost $.0000022/lb (<u>a constant</u>)
d. weight of water - 8.3 lb/gallon
e. No. of ^{o}F. the water must be heated - 40^{o} F. (<u>a constant</u>)
f. the number of minutes in a day, 1440 (<u>a constant</u>)
g. efficiency of CycloSpray - 93% (<u>a constant</u>)

To calculate the heat savings, we can combine the constants and the formula becomes:

Flow (in GPM) x operating days/yr x cost to heat 1 lb of water

($.0000022) x wt of water (8.3) x temp increase of water (40^{o} F.)

x no. minutes in a day (1440) x efficiency (.93)

Simplified, the formula would now read:

Flow (GPM) x operating days per year x .98 = Savings/Year

REFERENCES

1. Haynes, D. C., "Water Recycling in the Pulp and Paper Industry", Tappi, Vol. 57, No. 4, 1974 (pp. 45-52).

2. Ibid.

3. Ibid.

4. Woodward, E. R., "New Gravity Screen Makes Reuse of Waste Water Practical at Paper Mills", Pulp and Paper, Vol. 52, No. 3 (pp. 93-95).

5. Rishel, J. and Kriper, J., Unpublished Ronningen-Petter Test Results, (1/6/80 - 1/9/80).

6. Ibid.

7. Ibid.

In today's economy many industries want to reuse as much process water as possible. The paper industry is no exception to this trend. Not only is the paper industry trying to close up their water systems, but they are also attempting to reduce their effluent leaving the mill. To do this, it is often necessary to remove entrained solids in the water systems. The Cyclospray can be a very useful tool for removing these solids.

One of the first places the paper industry looks for recycling is the white water system of the paper machine. White water has been typically reused directly for shower water. When using this white water, the shower nozzles plug and have to be manually cleaned. If the long fiber can be removed from the white water, the showers will not plug up as often. Tests were run to find the effects and limitations of the Cyclospray filter as it pertains to the paper industry. These findings will be explained in detail according to the screen mesh used.

60 Micron Nylon

250 PPM unrefined bleached hardwood kraft (BHWK) ran very well into the 300 GPM range (Figure 1) without backwashing. The removal efficiency of the filter was fairly good. The filter removed most of the long fiber while still leaving behind the fines.* The rejects were ten times more concentrated than the incoming material.

*Fines are small pieces of fibers (approximately 5-20 micron). They are very desirable to keep in the paper machine system as they contribute a very large surface area in relation to their size. This improves retention on the paper machine wire as well as increasing the bonding strength of the web.

250 PPM Total Solids

This white water make-up contained 100 PPM unrefined BHWK and 150 PPM clay filler. This make-up ran 300 GPM (Figure 2) with no incidence of backwashing. The cut level of this run was very good. 94% of the clay was recovered on the accept side of the filter with a 98+% removal of the fibrous contaminant (the reject line was concentrated better than six times over the inlet solids).

250 PPM Newsprint (Groundwood)

The groundwood used in this test was a low freeness (150 Canadian standard freeness) unbleached groundwood. The filter would not handle more than 150 GPM (Figure 3). Any additional flow caused immediate blinding of the filter media. One the average, the filter removed 68% of the incoming solids. This number may look low, however, it is actually quite good considering there can be upwards of a 30% fines content in groundwood pulp (the reject line was concentrated 7.5 times the inlet).

500 PPM Newsprint

The white water make-up was double the above mentioned make-up. This caused the unit to backwash continuously at flow rates as low at 50 GPM (Figure 4).

250 PPM Plainwell Furnish

The fiber furnish from Plainwell was 30% hardwood, 40% softwood, and 30% broke at a freeness of 310 CSF. Maximum flow rate was 115 GPM (Figure 5). The removal efficiency was only 50% by weight. Under a microscope, the removal efficiency appeared much better than that. Very little information could be gathered on the filler content of this sample.

500 PPM Plainwell Furnish

At this solids loading, the Cyclospray could only handle 100 GPM (Figure 6). At 100 GPM the reject concentration was about six times the inlet.

1,000 PPM Plainwell Furnish

The Cyclospray was capable of running on 50 GPM of this particular white water solids loading. Again, only 50% removal was achieved, but filler and fines loading have to be taken into account. The cut, by visual inspection, seemed very good.

500 PPM Total Solids

This make-up contained 100 PPM BHWK and 400 PPM filler clay. The Cyclospray ran extremely well with this white water make-up. The filter ran 350 GPM (Figure 7) with no problem. The cut was also extremely good. The accept solids ash contained 350 PPM. This means that only 50 PPM of the clay was being lost to the reject side of the unit.

As a group, the 60 micron nylon screens performed reasonably well. The screen produced good cuts on the fiber size and still allowed high flow rates. The unit did not seem to be limited by the 60 micron media. The unit appeared to be much more dependent on the material being filtered.

44 Micron Nylon

250 BHWK. The Cyclospray ran well at this fiber loading and screen size. It was capable of running 250 GPM (Figure 1) which is only 50 GPM less than what it ran at 60 micron nylon. The removal efficiency seemed better with the 44 micron nylon than with the 60 micron. Reject concentration was slightly higher than the 60 micron test.

250 PPM Total

This white water makeup contained 100 PPM BHWK and 150 PPM clay filler. The unit again was only 50 GPM less than its 60 micron counterpart (Figure 2). The increase in removal efficiency could very easily justify this reduction in flow rate.

250 PPM Newsprint

The newsprint blinded the Cyclospray at any flow rate over 100 GPM (Figure 3). Again, the 44 micron had better retention than the 60 micron, which partially accounts for the reduction in available flow rate.

500 PPM Newsprint

The system backwashed continuously at all flow rates (Figure 4).

250 PPM Plainwell Furnish

The Cyclospray ran up to the 100 GPM range before it went into constant backwash (Figure 5). This again is a 50 GPM decrease in the flow that the Cyclospray is capable of handling. The cut level was very similar to the 60 micron screen.

500 PPM Plainwell Furnish

The 44 micron expressed the same characteristics as the 60 micron did before it went into the backwash mode continuously (Figure 6). They both had the same flow rates and approximately the same filtering efficiency, with the 44 micron running slightly better.

1000 PPM Plainwell Furnish

The Cyclospray could handle only 50 GPM at the most. The 44 micron screen had better retention than the 60 micron screen, but usually at a cost of 50 GPM. The difference would probably warrant the use of the 44 over the 60 as long as the reduction in flow rate was acceptable. The reduction in flow rate appeared to attributable more to increased retention than to restricted flow because of screen opening.

33 MICRON NYLON SCREEN

250 PPM BHWK

This set up was very similar to the 44 micron run. The same maximum flow rate of 250 GPM was achieved (Figure 1). The removal efficiency was 98+% with this particular fiber make-up.

250 PPM Total

This make-up was 100 PPM BHWK and 150 PPM clay filler. This also ran up to a maximum flow of 250 GPM (Figure 2). The accept ash showed considerably more filler stripping than did the 44 micron.

250 PPM Newsprint

The newsprint blinded the filter at flow rates higher than 100 GPM (Figure 3).

250 PPM Plainwell Furnish

The filter showed a performance similar to the 44 micron run. They both handled 100 GPM at this solids loading (Figure 5).

500 Plainwell Furnish

The Cyclospray would not run without backwashing every 15 minutes at flow rates above 50 GPM (Figure 6). The fiber cut on the 33 micron screen was very good. The accept samples showed no long fibers under the microscope.

1000 PPM Plainwell Furnish

System backwashed continuously at this solids loading. With the 33 micron screen, the unit started to show signs that flow rates were becoming fabric limited. This means that the open area of the screen was not large enough to get the higher flow rates. The fiber cut in the 33 micron was very similar to the 44 micron screen cut. In most cases, the 44 micron screen should be able to be used where the 33 micron screen was previously used.

25 Micron Nylon Screen

250 BHWK. With the 25 micron screen installed, the Cyclospray maximum flow rate was 150 GPM (Figure 1). Removal efficiency was 98+% with some fines removal taking place.

250 PPM Newsprint

The Cyclospray backwashed continuously at 50 GPM (Figure 3).

250 PPM Plainwell Furnish

The Cyclospray could only run under 30 GPM without backwashing excessively (Figure 5). A fair amount of filler and fines stripping took place in this run.

500 PPM Plainwell Furnish

The Cyclospray backwashed every 20 minutes at 50 GPM. This was considered borderline to acceptable. In some limited applications, this would be considered ample up time.

The 25 micron screen limited the flow rate of the Cyclospray to less than 100 GPM. This makes it a low volume filter media. I do not think this screen would have much use in the paper industry except in limited applications in a small specialty paper mill.

20 Micron Nylon Screen

250 PPM Total. This white water sample contained 100 PPM BHWK and 150 PPM filler clay. With this low concentration of fiber the Cyclospray was capable of 250 GPM (Figure 2).

10 Micron Nylon Screen

250 PPM BHWK. The highest obtainable flow rate with this screen was 50 GPM (Figure 1). This screen produced a higher initial pressure drop than any of the other screens.

The 20 and 10 micron screens are not very practical for the paper industry. They are both highly susceptible to plugging from filler build-up on the screen. This is because of the small open area of the two screens. The 20 micron has an open area of about 7% and the 10 micron a 3% open area.

60 MICRON POLYPROPYLENE SCREEN

500 PPM Newsprint

System backwashed continuously at 50 GPM (Figure 4).

500 PPM Total Solids

The Cyclospray had no difficulty running at 350 GPM at this fiber loading (Figure 7). The cut looked good with very little filler stripping and long fiber carry-over.

1100 PPM Total Solids

This white water mixture contained 100 PPM BHWK and 1000 PPM Calcium Carbonate ($CaCO_3$) filler. The filter ran with no backwashing up to 300 GPM (Figure 8). The pressure drop at 300 GPM was 9 PSI. This is slightly higher than what was expected.

44 MICRON POLYPROPYLENE SCREEN

500 PPM Total Solids

The solids make-up of this sample was 100 PPM BHWK and 400 PPM clay filler. The unit went into backwash at flow rates greater than 250 GPM (Figure 7).

1100 PPM Total Solids

Again, the solids content of this sample was 100 PPM BHWK and 1000 PPM $CaCO_3$ filler. This sample could not be run at flow rates greater than 200 GPM (Figure 8) without excessive backwashing.

Figures 9-11 are typical photographs of the inlet, outlet, and rejects of the Cyclospray. The make-up for these samples was 100 PPM BHWK and 400 PPM clay filler. The pictures were taken with 400X magnification. The inlet pictures show the relative concentration of the long fiber and filler. The outlet pictures show tht the long fiber has been removed leaving only the small fines behind. You can also see a slight increase in the concentration of the filler content. The reject pictures show an increase in the long fiber content. Based on the number of fibers in each case, the reject line is 6-10 times more concentrated than the inlet line.

Tests were run to compare the performance of the nylon screens to the polypropylene screens. The screens were tested using a white water make-up of 100 PPM BHWK and 400 PPM clay filler. I found that removal efficiency was almost identical between the nylon and the poly screen. Shower efficiency was slightly better on the nylon. The poly having a larger diameter thread is more durable than the nylon. Because it is more durable, it is less likely to be damaged by operator neglect than the nylong screen. This is a big problem with the nylon screen. If the operator happens to bump the screen against the side of the body as he is lowering the shower assembly back into the body of the Cyclospray filter, it can produce a tear that would allow contaminants to pass through. At the very least, it can cause a weak area that will cause premature failure of the screen.

Since the nylon screen is thinner, it needs to be cleaned more efficiently by the shower. It is also more susceptible to shower shredding. This occurs when the nylon strands weaken to the point of failure.

A test was also run to compare the performance of a 25-30 micron and a 15-20 micron multi filament polypropylene twill weave screen. A fiber/filler mixture of 100 PPM BHWK and 400 PPM filler was used. Neither screen ran satisfactorily. They both blinded immediately on start-up and stayed in the continuous backwash mode. Then a sample white water similar to Dunn Paper Company was made up. This contained 500 PPM BHWK, 50 PPM $CaCO_3$ filler, and 10 PPM Titanium Dioxide (TiO_2). Dunn was looking for a fine micron screen with very good removal. For this reason, the 15-20 micron screen was the only screen tried. The filter seemed to run well up to 150 GPM. These results were deemed invalid when it was found that the sample did not containe enough fiber to cause screen blinding. I found this by examing inlet, accept, and reject samples, and found no difference between the three. I then concluded that all the fiber in the system was on the screen. In a mill situation there would be a constant flow of fresh contaminant that would build up and cause screen blinding. The multi filament screens also have a higher pressure drop than the mono filament screens with all else being equal.

Fiber is by far the parameter that most affects the Cyclospray filter, as it pertains to the paper industry. Refining is, therefore, the most important factor of the fiber. Generally speaking, as the degree of refining increases, freeness decreases the flow rates capable through the Cyclospray decrease. I also found that a groundwood pulp (most commonly used in newsprint) tended to blind the Cyclospray filter at low PPM levels. Freeness is a measure of the ability of the pulp slurry to drain water. Thus, as freeness decreases, the time it takes for a given amount of water to pass through the fiber mat increases. In the Cyclospray, this translates into: given a particular fiber, as the freeness decreases so does the flow rate that can be handled by the Cyclospray. Fiber degradation can also effect the operation of the Cyclospray filter. Ex: an unbleached pulp would be easier to filter than a bleached pulp.

Paper making filler seems to have a negligible effect on the Cyclospray. I found that an increase of filler from 400 PPM up to 1000 PPM caused a decrease of only 50 GPM in available flow. It did not in any way hamper the removal efficiency of the unit. I did find, however, that the higher the filler level the earlier the screen would blind off due to fillr plugging the screen in areas that the shower could not clean. There is a band between the shower nozzles that does not get cleaned by the shower. As this band continues to plug, it slowly grows until it gets to the point where it causes a pressure drop large enough to put the unit into the backwash sequence. When this happens it is usually too late to clean the screen, and has to be taken out and replaced with a new one.

Screen fit affects the way the Cyclospray filter runs. When I first started working, the Cyclospray screens were loose on the perforated backing. This reduced the efficiency of the shower because most of the shower energy was expended in pushing the fabric away from the perforated support basket screen. I then talked to Ron Dyke and Dave Truman about this, and in early

June, Dave informed me that the sewing room was using the wrong template. The screens are now tight on the perforated.

CONCLUSION

The Cyclospray can be a very useful tool in the paper industry. Many factors affect the effectiveness of the unit. Freeness is a big factor. The Cyclospray does not, for the most part, run on a low freeness pulp or with additives such as retention aids and flocculents. These additives tend to reduce the flow rate through the Cyclospray. the Cyclospray does not have to be limited to the white water system of the paper industry. There are many other mill applications for the Cyclospray.

Cyclospray Applications

The Cyclospray can be put to use filtering any water stream containing a contaminant. One of the big users of fresh water in the paper mill is cooling water for bearings. This water is typically not recycled because of heat build-up and contamination. The contamination takes the form of fiber that has leaked past the packing glands on such equipment as the disc refiners. If this stream could be filtered, the water could be used as process water for another area of mill. It could not, however, be used as cooling water because of the heat build-up in the system. This same approach could be used for vacuum pump seal water. Again, the recycled water would have to be used in another area because as water temperature increases, vacuum pump efficiency decreases dramatically. The Cyclospray could also be used very effectively in water and/or fiber short areas of the world.

Many of the third world nation's paper mills have a very limited supply of fiber and water. This area of the world could be a very good market for the Cyclospray.

I think the Cyclospray could be used in these mills to save both water and fiber. The Cyclospray would be very effective on seal water and shower water, allowing both of these to be recycled. The Cyclospray could be applied to the press section allowing that water to be recycled as process water.

To save fiber, the Cyclospray could be installed in the clear legs of savealls, drum thickeners, deckles, and anywhere that fiber is removable from water. The fiber could then be recirculated to the feed end of these units and the filtered water could be used as process water.

Further Testing

Further testing should be done n the are of shower performance on the Cyclospray. Extensive testing should be done on reducing the shower pressure to increase the life of the nylon screens. Preliminary work suggests that on fiber loads less than 200 PPM at 150 GPM and a screen size of 44 micron nylon, it requires only 60# of boost to operate at the same efficiency as 90# of boost.

Suggestions

Presently, it is very easy to tear the screen when installing the lid assembly into the body by pumping the lid assembly against the top body flange. By chamfering the inside edge of the body flange (Dwg. M-30840-SS4), there would no longer be a sharp edge. The chamfered edge would be far less likely to tear the screen than the sharp edge that is presently being used.

Since the Cyclospray is a filter, it is constantly in a wet environment. This allows the Sackett flexible steel couplings to corrode on the shafts of the gearbox, pump, and shower shaft. To reduce the problem on the gearbox and pump, a layer of anti-seize compound could be applied to these shafts. This would not only reduce corrosion, but would also make assembly and disassembly of these components much easier. On the other hand, the shower shaft should not be greased since the grease would get on the screen. It is possible, however, to send out the top half of the Sackett coupling to be teflon coated. It would also reduce the binding effect between the two surfaces in the event an element should collapse. This would save the power shaft.

Another area that is susceptible to corrosion is the bottom unistrut frame. This frame is made of steel while the rest of the frame is stainless steel. I recommend the bottom two struts be changed to stainless steel unistrut. This should greatly lengthen the life span of the Cyclospray frame. While discussing this change with Joe Kuiper, he suggested we also add an angle brace (Figure 12) to the frame of the Cyclospray on the side opposite the reject side. This would serve to stiffen the frame of the Cyclospray.

Another problem area encountered on the Cyclospray was water contamination of the gearbox oil. When the gearbox that failed at Plainwell was dismantled, it was found that it was half full of water. I also found the test unit had water contamination when I replaced the front seal. I strongly recommend that the cyclospray manual require that the gearbox oil be changed at least once a year. And if it's a very wet environment, the oil should be changed twice a year. This is a very simple procedure that takes approximately 15 minutes to do.

Plainwell also crushed a basket in the Cyclospray filter. I installed a new basket and had the system started back up. I found their pump was drawing a vacuum on the filter and that the pump was drawing more water out of the accept line than the Cyclospray could put through, whith I feel is what caused the basket to collapse. I recommend that in installations such as this where a vacuum can be drawn on the accept side of the unit, a vacuum breaker be installed to help alleviate this problem. This is not necessarily a cure, but a method of protecting the Cyclospray in the event of something gong wrong and a vacuum being drawn on that side of the unit.

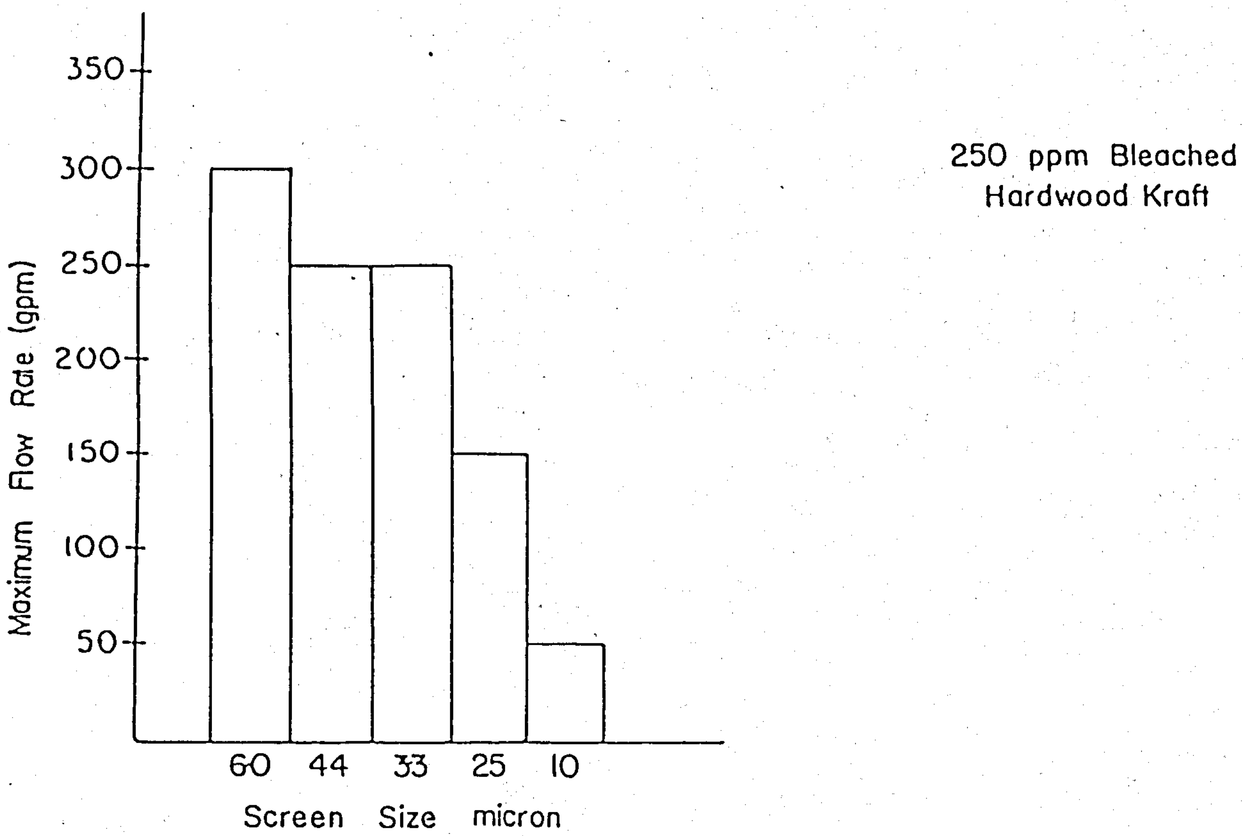

350
300
250
200
150
100
50
Maximum Flow Rate (gpm)
60 44 33 25 10
Screen Size micron
250 ppm Bleached
Hardwood Kraft

FIG. 1

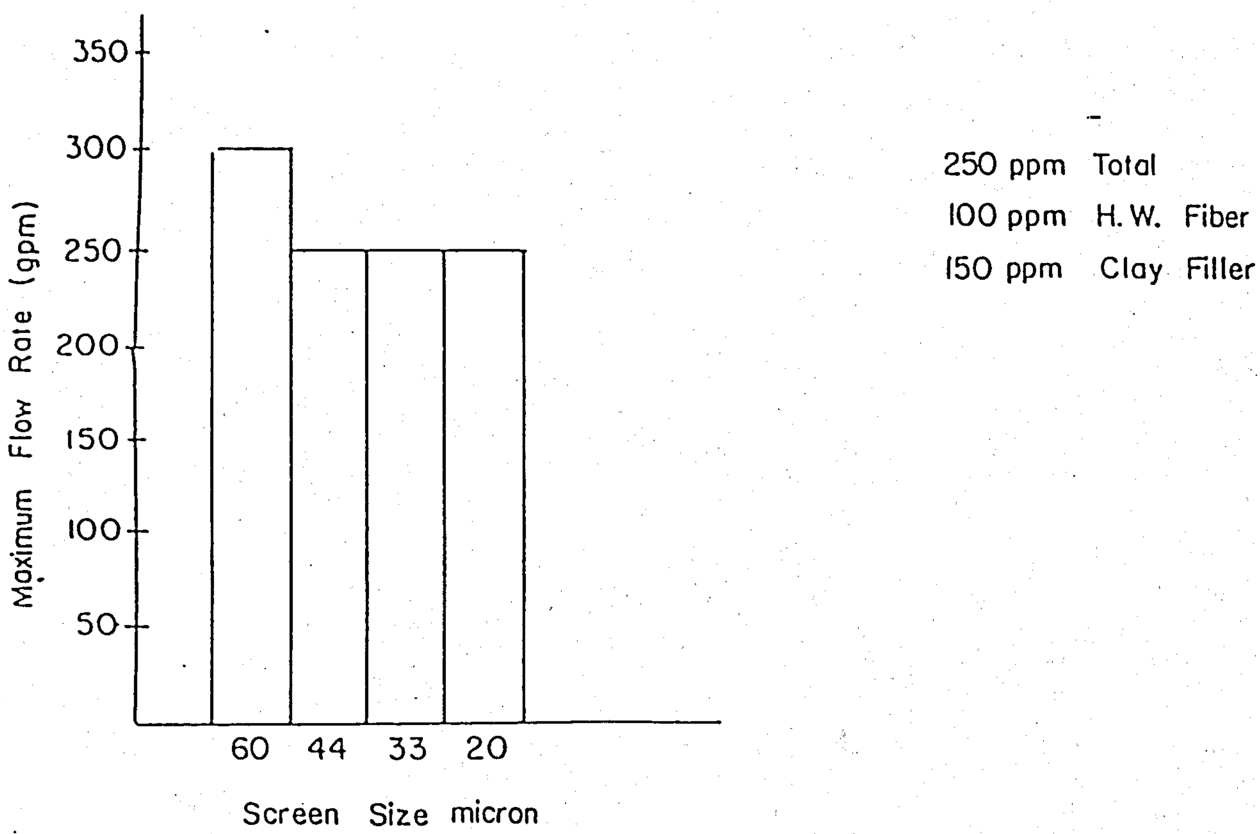
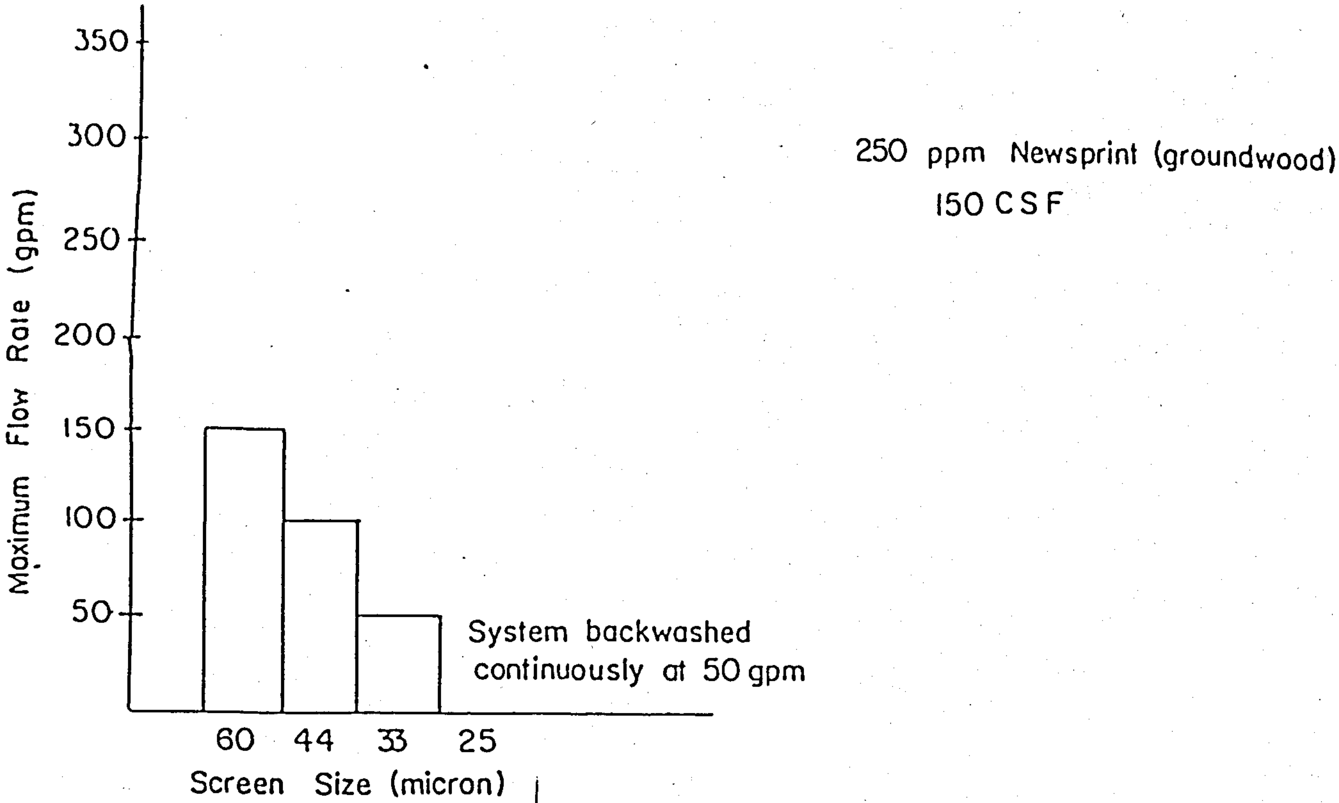
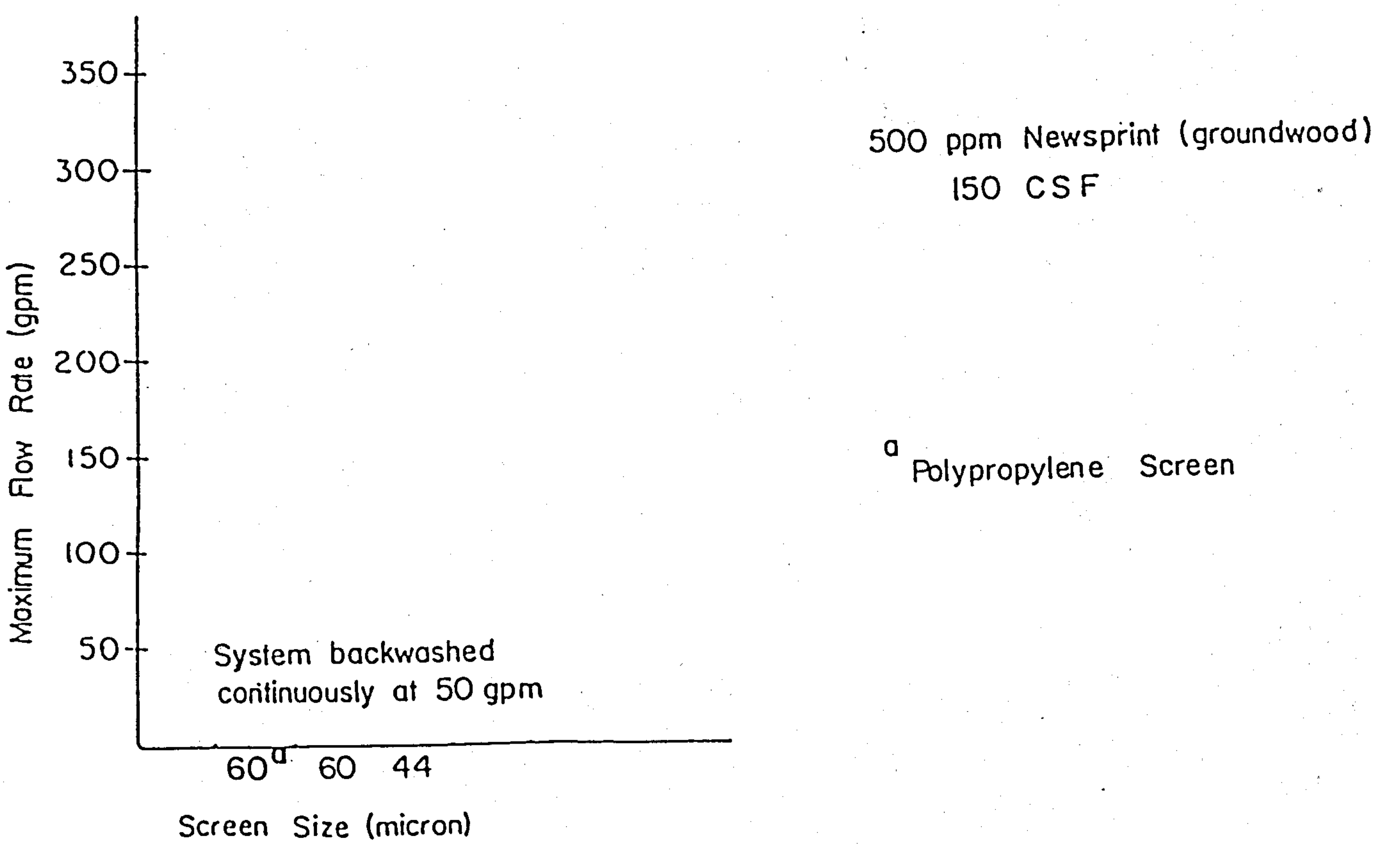

350
300
250
200
150
100
50
Maximum Flow Rate (gpm)
60 44 33 20
Screen Size micron
250 ppm Total
100 ppm H. W. Fiber
150 ppm Clay Filler

FIG. 2



250 ppm Newsprint (groundwood)
150 CSF
Maximum Flow Rate (gpm)
350
300
250
200
150
100
50
System backwashed continuously at 50 gpm
60
44
33
25
Screen Size (micron)

FIG. 3



500 ppm Newsprint (groundwood)
150 CSF
a Polypropylene Screen
Maximum Flow Rate (gpm)
350
300
250
200
150
100
50
System backwashed continuously at 50 gpm
60a
60
44
Screen Size (micron)

FIG. 4

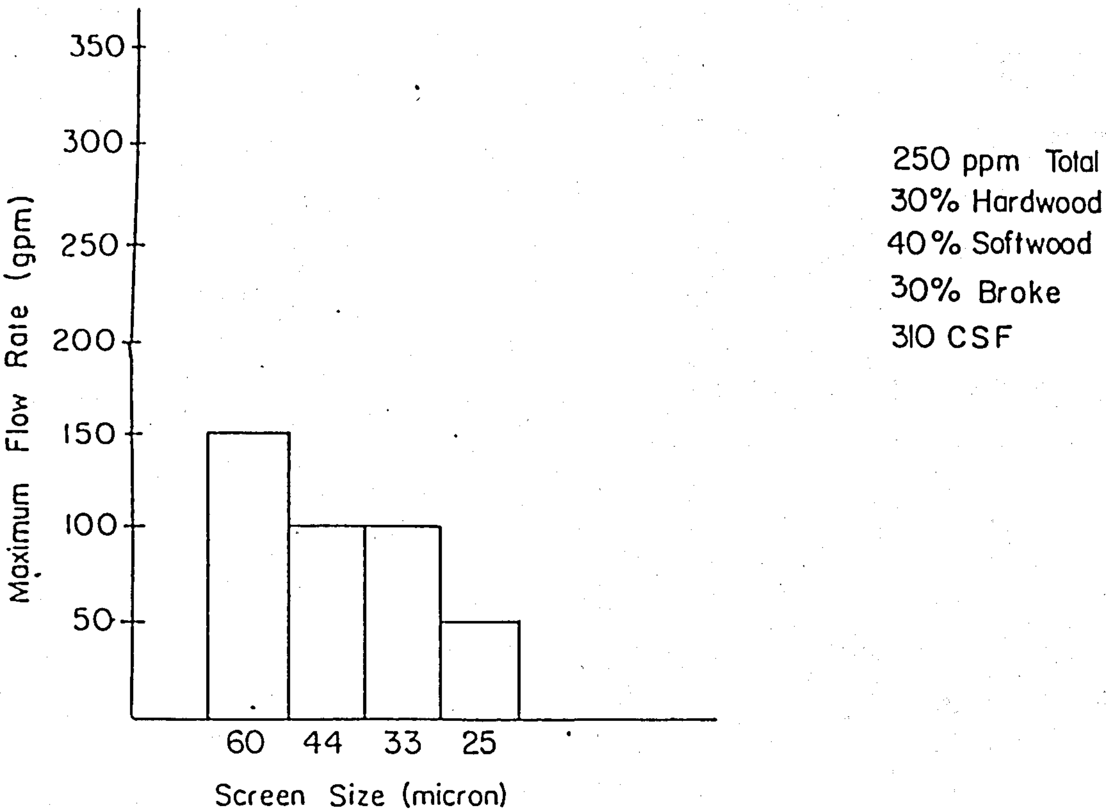

350
300
250
200
150
100
50
Maximum Flow Rate (gpm)
60 44 33 25
Screen Size (micron)
250 ppm Total
30% Hardwood
40% Softwood
30% Broke
310 CSF

FIG. 5

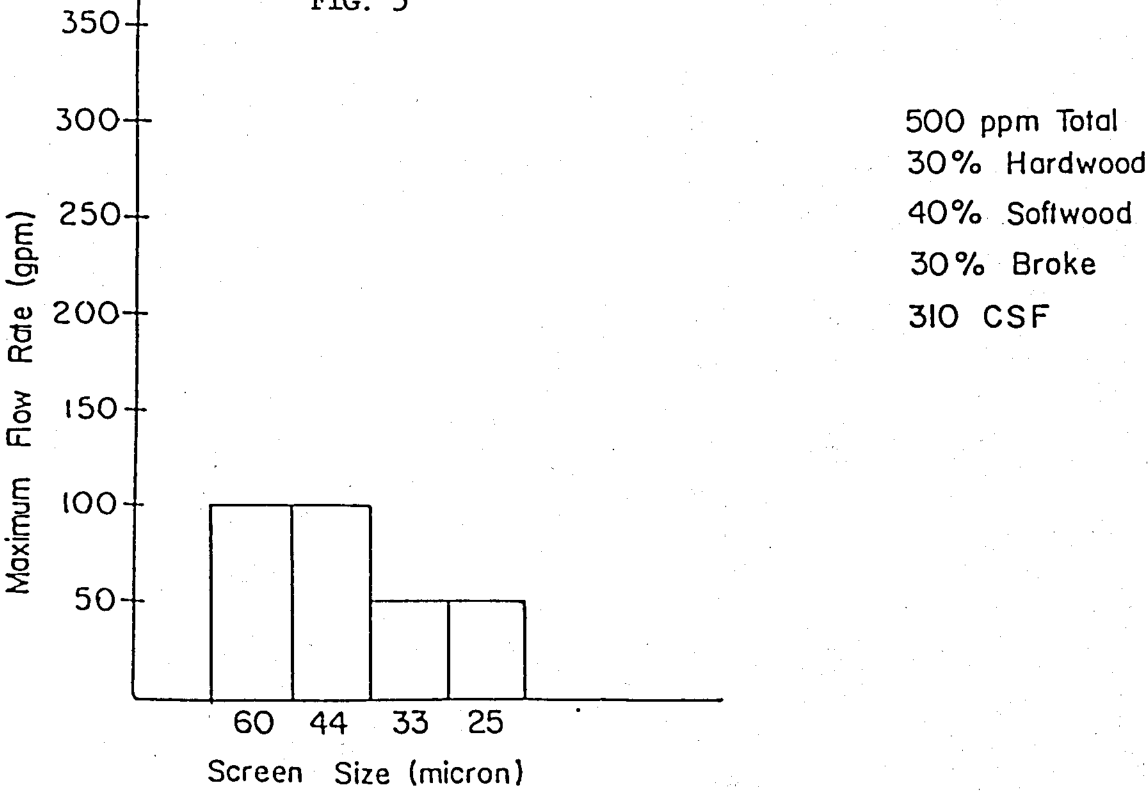
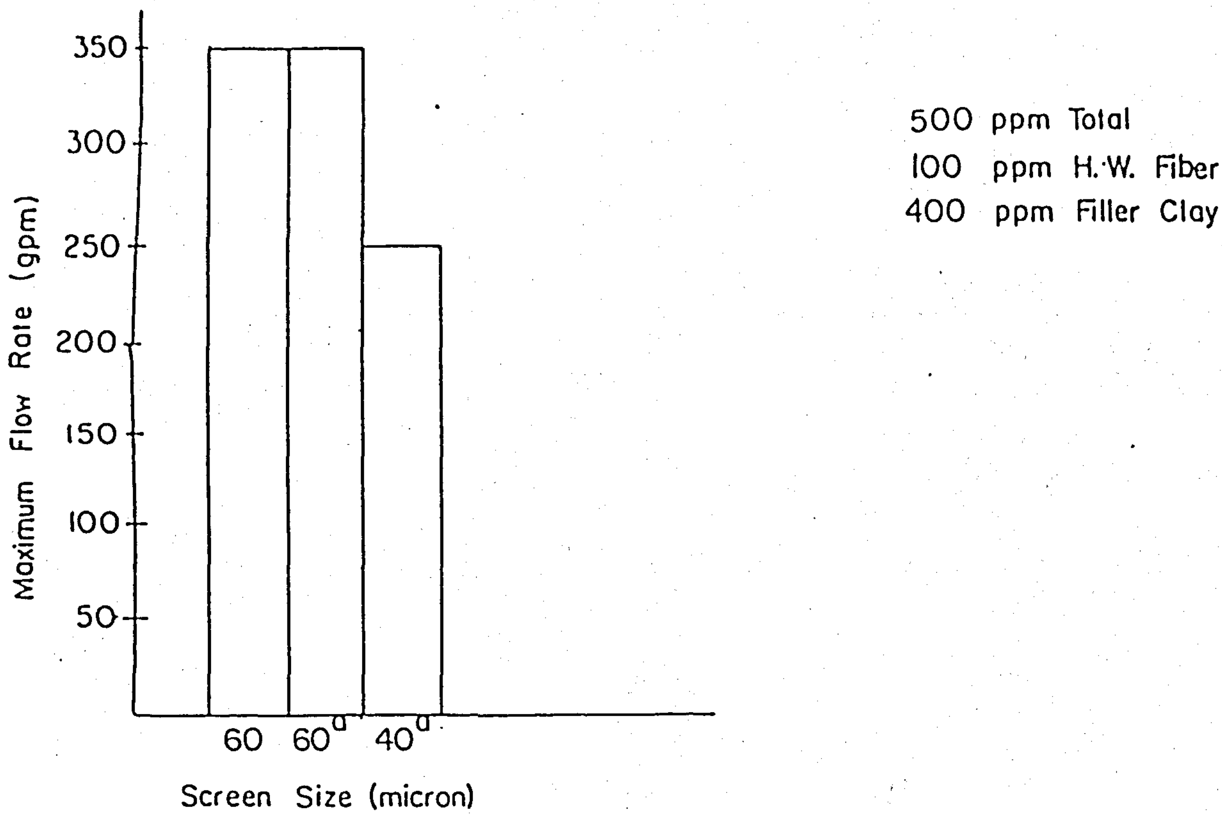
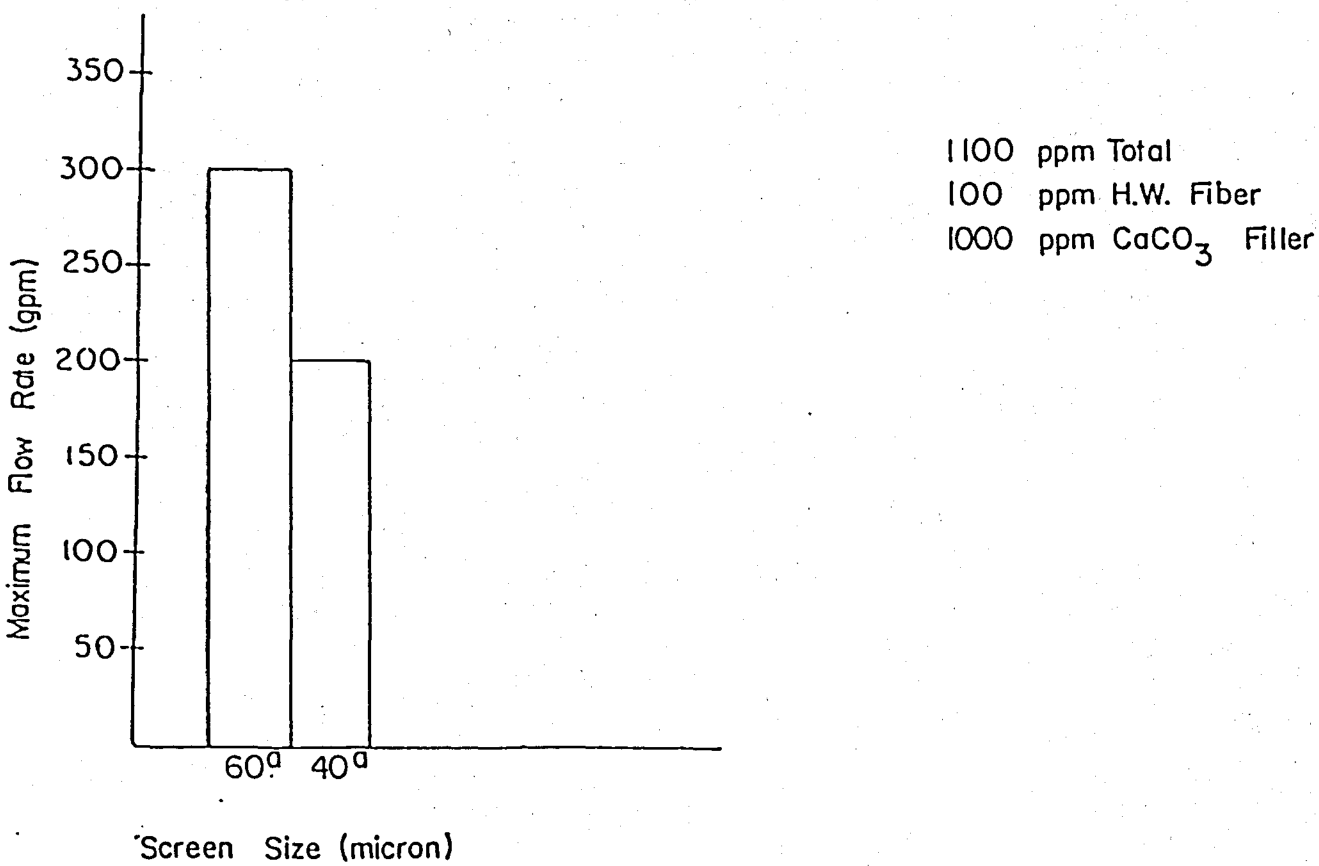

350
300
250
200
150
100
50
Maximum Flow Rate (gpm)
60 44 33 25
Screen Size (micron)
500 ppm Total
30% Hardwood
40% Softwood
30% Broke
310 CSF

FIG. 6



350
300
250
200
150
100
50
Maximum Flow Rate (gpm)
60
60a
40a
Screen Size (micron)
500 ppm Total
100 ppm H.W. Fiber
400 ppm Filler Clay

FIG. 7



350
300
250
200
150
100
50
Maximum Flow Rate (gpm)
60a
40a
Screen Size (micron)
1100 ppm Total
100 ppm H.W. Fiber
1000 ppm CaCO3 Filler

FIG. 8

60 Micron Nylon

FIG. 9

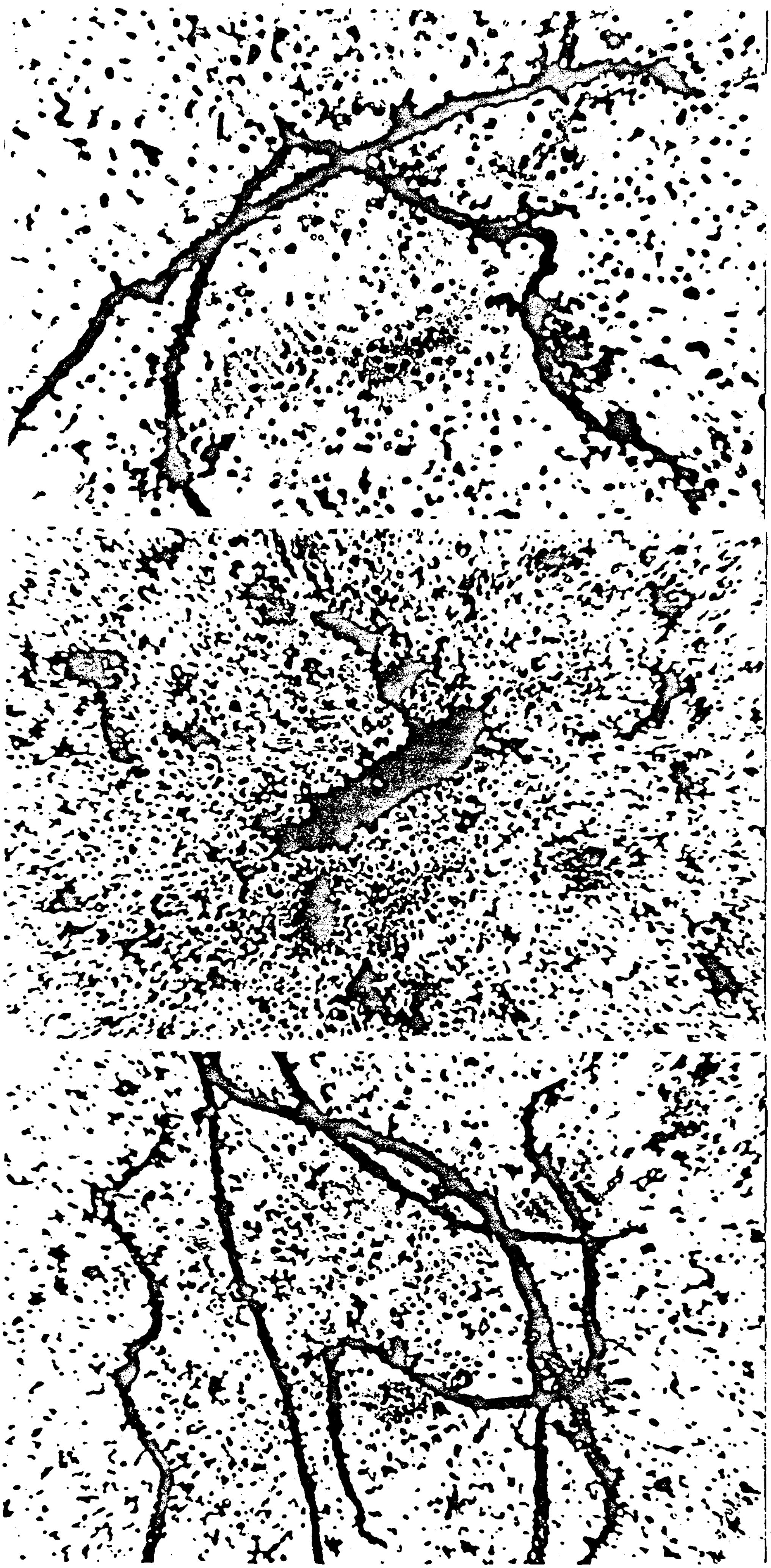
INLET

OUTLET

REJECT

60 Micron Poly

FIG. 10



INLET

OUTLET

REJECT

44 Micron Poly

FIG. 11

INLET

OUTLET

REJECT