Pitch reduction in a kraft aspen integrated mill pulping fresh chips

AMIN MANJI, JOHN KARAGIANNIS, SATISH SALGAR, AND JIM CONSTANT

ABSTRACT: A kraft mill running aspen as its furnish uses approximately 20 metric tons/day of talc. The mill wanted to replace talc in its process because the handling and preparation took 6 work hours per day. The mill had tried various dispersants, but none performed to its expectations. The mill wanted to prevent the brown stock screens from plugging and either maintain or reduce the final pulp dirt counts, without affecting pulp quality.

The mill decided to try a proprietary pitch dissolver/dispersant other than nonyl/alkyl phenol ethoxylates or ethoxylated alcohols. (The latter two pitch dispersants are considered to be carcinogenic.) The following results were obtained:

- Brown screens did not plug during the pitch dissolver/dispersant application period.
- Colloidal pitch decreased by 68% in the final bleached pulp filtrate.
- 3.3% more dichloromethane (DCM) extractives were removed from the bleached pulp during the trial phase (from 76.8% reduction on chip to dry bleached pulp to 80.1% reduction).
- The overall bleached pulp dirt count did not change. The average count remained at 3.4 ppm.
- The pulp ash content decreased from 1.44% to 0.71% as the talc was shut off, a reduction of about 51%.
- The bleached pulp strength factor was unaffected.
- The paper machine efficiency improved by 30 h/month and the wire life increased by 15%.
- Precipitated calcium carbonate (PCC) consumption increased by 0.5%.

Application: This research outlines how pulp producers can achieve goals including low ash pulp, low DCM pulp, or elimination of talc from their process, through use of the proprietary pitch dissolver dispersant tested.

Aspen is one of the most resinous hardwood tree species in the north central United States. The extractive content varys from 1.0%–2.7% for seasoned wood and up to 4.5% for fresh aspen wood [1]. In addition, the ratio of saponifiables[(a)] to unsaponifiables[(b)] is low when compared to other North American wood species. What this implies for kraft pulping is that a large portion of the unsaponifiables will not get dispersed from the fiber into the liquor in the cooking process. Instead, they will be carried further down the pulping process through the bleaching and even into the paper machine area. Some of the unsaponifiables will be dispersed in the bleaching process, but still some will be carried to the paper machine. In the paper machine area the unsaponifiables generally tend to appear after the fiber is fibrillated and crushed in the refining process.

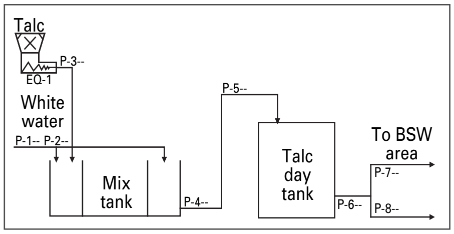
The saponifiable-to-unsaponifiable ratio for fresh aspen is higher as compared to seasoned wood [2]. Consequently, a large amount of the unsaponifiables is dispersed from fresh aspen during the kraft cooking process as the saponifiables act as natural dispersants. Depending on the efficiency of the brown stock washers, some of the dispersed acids, sterols, waxes, and triterpinols get carried down the fiber line to the unbleached pulp screening room. Next they enter the bleach plant where they show up as calcium and magnesium soap deposits (pitch). Thus, mills that pulp fresh aspen chips generally tend to have pitch deposit problems in their unbleached pulp screening room and the bleach plant.

Aspen bark is higher in pitch content than the wood. Consequently, any bark that carries over with the wood into the digester will add to the pitch problem in the process. This problem is further emphasized during the winter months when the wood is frozen and harder to debark. Thus, mills have to ensure the bark content of the wood being fed into the digester is monitored and maintained as low as possible year-round, but much more so during the winter months when fresh aspen chips are cooked and logs are harder to debark.

Depending on the bleaching process, chemicals such as chlorine and chlorine dioxide will react with the unsaponifiables to a varying degree. Elemental chlorine will react extensively with unsaturated fatty acids and the triglycerides to make them sticky [3]. Substituting chlorine with chlorine dioxide reduces the extractives present in the pulp.

This study was conducted at an integrated bleached aspen pulp mill in the north central United States. The mill used approximately 20 kg/ton of talc in the brown stock and bleaching areas to mask and detackify the pitch in its process. Talc is used at three locations in the mill: the discharge of the #3 brownstock washer (BSW), the discharge of the E_{op} bleaching stage, and the discharge of first chlorine dioxide stage bleach washer leading into the bleached high density storage tanks. The split of talc between the two areas (BSW/bleaching) is 33/67. The large amount of talc consumption is due to pulping fresh aspen during the winter months, which generates pulp with high pitch content. The large amount of pitch creates a problem for both the pulp and the papermakers.

On the pulping side, the pitch deposits on the doctor boards and



1. Talc make-down system.

Points	Four Days mL/min	Two Days mL/min
A	380	230
B	200	130
C	50	0
D	50	50
Total Dosage	680	410

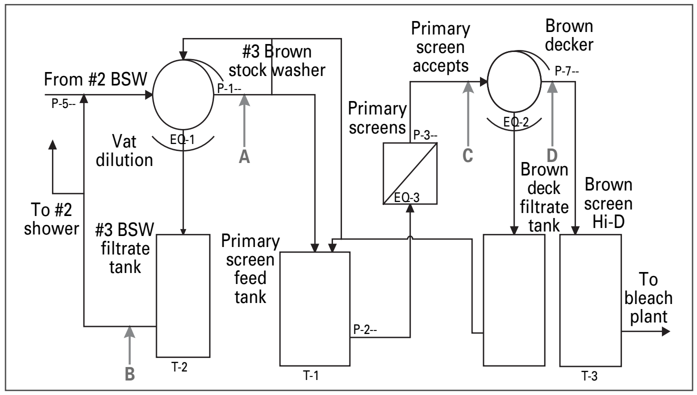
I. Pitch dissolver/dispersant dosage rate.

washer wires, which subsequently impedes drainage and reduces the wire life in the brown stock area. The pitch also deposits at various other locations in the piping system and dislodges abruptly during a pH or temperature shock. The pitch deposit may also thicken to the point where the stock flowing past it through the pipe brushes it off the wall and dirties the pulp. The pitch also deposits inside the fine screen baskets, blocking the holes and subsequently decreasing production capacity.

In the bleaching process, the dirt appears after the E_{op} stage leading into the D_1 stage and on the discharge of the last washing stage due to the recycling of contaminated white water into the upper pond. The paper machine white water containing colloidal pitch, stickies from the recycle furnish, clay, and residual precipitated calcium carbonate constitutes approximately 40% of the total wash water charge into the D_1 washer. The recycling white water was analyzed and found to contain approximately 0.05%–0.15% solids.

On the paper side, the pitch shows up after the pulp is refined and fibrillated. The pitch deposits on the refiner plates, press section doctor blades, felts, and wires. Consequently it reduces the machine operating efficiency, increased steam consumption on the dryers, and promoted slime growth in the quiescent zone in the wire pit. To alleviate the problem in the machine area, diatomaceous earth is applied to the wire pit on an as needed basis.

The talc system (**Fig. 1**) is comprised of a three compartment solution make-down system. A 15% W/W basis talc solution is prepared and transferred to a 10,000 gallons day tank. From the day tank the solution is supplied to the brown stock washing and the bleach plant areas. A 1000 tons/day production requires approximately 20 one-metric-ton bags. The mill has complained about handling all this talc. Before being made into a solution, powdered talc is handled eight times from the time it is received in the mill to the time it is made into a solution. Apart from handling the talc, the plastic bags and the pallets also must be stored and discarded appropriately. All these tasks together require six work-hours daily.



2. Unbleached screen room.

The pulp mill has tried various dispersants. Those either did not work to the mill's expectations or released the deposited pitch and further amplified the dirt and pitch problem in the final pulp to such an extent that off-grade pulp was produced.

Most of the pitch problems on the brown side are deposits on:

- the fine screen baskets, which get plugged, and consequently the production capacity decreases
- the pipes between the brown stock washer repulper and the fine screens, where the deposited pitch dislodges abruptly due to the stock flowing past it or releases during a pH or temperature shock and dirties the pulp
- the brownstock washer and decker vats, doctor boards and repulper screws.

In the bleach plant, the pitch and dirt appears after the D_1 washer due to the recycling of contaminated white water. The mill has mentioned that the white water recycle line from the machines sometimes becomes plugged, requiring the mill to switch to hot filtrate as wash water on the D_1 upper pond flow.

This pitch problem is significantly accentuated during the winter when the mill pulps fresh aspen chips. Analysis of the wood extractives between summer and winter has shown extractive variation of 0.8% (average winter wood extractive content [fresh chips] = 2.2%; average summer wood extractive content [aged chips] = 1.4%).

The objective of this trial was to evaluate a pitch dissolver/dispersant[(c)] added at the following six locations during the winter months when fresh aspen chips are processed:

- #3 brownstock washer (BSW) repulper
- #3 brownstock washer filtrate pump discharge
- #4 brown decker vat
- D_o washer discharge
- D_1 upper pond flow
- D_1 inlet box recirculation line

We wanted to find out how well the additive would dissolve the deposits in the system and colloidal pitch in the filtrate, thereby eliminating further deposition in the unbleached screen room and pitch carry over from the bleach plant to the paper machines.

We added the pitch dissolver/dispersant at high dosage rate for three days while the talc was shut-off in the brownstock area in one day. Talc addition was reduced as follows: from 5.9 kg/ton to 4.1 kg/ton at the start of the trial; 8 hours later the addition rate was decreased to 2.3 kg/ton. This addition rate was maintained overnight. The next morning the flow was shut-off completely. During the rest of the trial phase, the pitch dissolver dosage was optimized and operators monitored the brown screen operation.

After two weeks of operating in the brownstock area, the mill agreed to extend the trial into the bleach plant. Again, the pitch dissolver application rate was initiated at a high dosage rate for

Description	Colloidal Pitch Bleached Pulp Million/mL*	DCM Extractives Removed Bleached Pulp, %	Dirt, ppm	Ash, %	Strength Factor	Primary Screen Delta Pressure, psi
Talc 19-20 kg/ton. Pitch dissolver 0 kg/ton.	73	76.8	3.3	1.44	541	8.7
Talc 0 kg/ton. Pitch dissolver 0.85 kg/ton.	23	80.1	3.8	0.71	536	8.9
% Change	68.5 % lower	3.3 % More removed	No change, SD > 0.5	50.7 % lower	No change	No change

II. Overall result summary. ***Colloidal pitch is counted as Million colloidal pitch particle/mL of filtrate.**

three days while the talc application was shut-off within two days. Talc was initially reduced from 13.6 kg/ton to 9.1 kg/ton. After 24 hours of operation, the talc was further reduced to 4.55 kg/ton and completely shut-off after another 6 hours of operation. At this point, the mill was totally off talc.

During the pre-, post-, and trial phases, we monitored the following parameters:

- Colloidal pitch counts at various locations
- Bleached pulp dirt
- Bleached pulp ash content
- Bleach plant inlet and final bleached pulp extractives
- Final bleached pulp physical properties
- Unbleached screen pressure differential

PROCESS FLOW DIAGRAM

Unbleached screen room

Figure 2 shows a simplified process flow diagram of the mill's unbleached screen room.

The brown stock area comprises of three washers and a brown decker. All these washers are vacuum drum washers having a diameter of 13.5 feet and a length of 20 feet. The average pulp loading on these washers is 1.3 tons/ft^2. The stock from the last brown stock washer discharges into the primary screen feed tank where the consistency is maintained at about 2.5%. The stock is fed to the primary screens at 1.75% consistency.

The screening system is a four-stage cascade system containing 0.81 mm holed basket for aspen and 1.27 mm holed basket for softwood having an open area of approximately 12% on the primary stages. The secondary and tertiary baskets are also holed and have a hole size of 1.57 mm and 1.85 mm respectively. The quaternary screens are Johnson's vibratory screens having a hole size of 2.39 mm.

The accepted stock from the primary screen flows to the #4 brown decker vat. The filtrate discharges into the #4 filtrate tank and is distributed mainly to the #3 brown stock washer showers and the primary feed tank for screen inlet consistency control. The thickened washed stock from the brown decker discharges into the brown-screened high-density storage chest.

Unbleached screen room control strategy

The unbleached screen room control strategy is as follows:

The stock from the #3 BSW repulper flows to the primary screen feed tank. The primary screen feed tank operates on level control. Thus, as the level in the primary screen feed tank increases, the screen accepts valve opens, allowing more stock to flow through it and subsequently the level in the screen feed tank decreases to the target level set point. If the level in the screen feed tank decreases, then the valve closes, allowing stock to accumulate.

	Revs	CSF	Tear Factor (TF)	Breaking Length (BL)	Burst Factor	Strength Factor (TF x BL)
BLEACHED PULP						
Pre-Trial	0	549	69.5	6.19	31.5	430
	1000	476	69.5	7.56	43.5	525
N = 6	2000	441	73.0	7.92	46.5	578
	4000	370	72.5	8.67	47.0	629
Trial	0	574	68.8	5.88	28.3	405
	1000	509	73.0	7.43	42.0	542
N = 4	2000	468	71.5	8.17	47.0	584
	4000	402	72.5	8.47	51.3	614

III. Bleached pulp physical properties.

	Chips, %	Brown Decker, %	Bleached Pulp, %	% REDUCTION Brown Decker, %	% REDUCTION Bleached Pulp, %
Before	2.00	0.72	0.47	64.0	76.5
After	2.11	0.71	0.42	66.7	80.1

IV. DCM extractives.

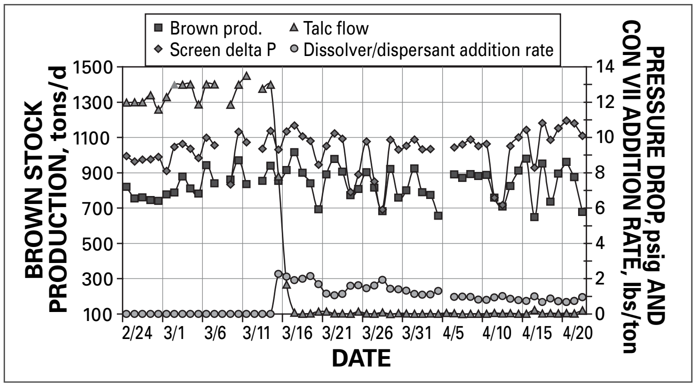
The screen feed tank level fluctuates with the production variation, thus the pressure drop across the primary screen also varies with the production.

PROCEDURE

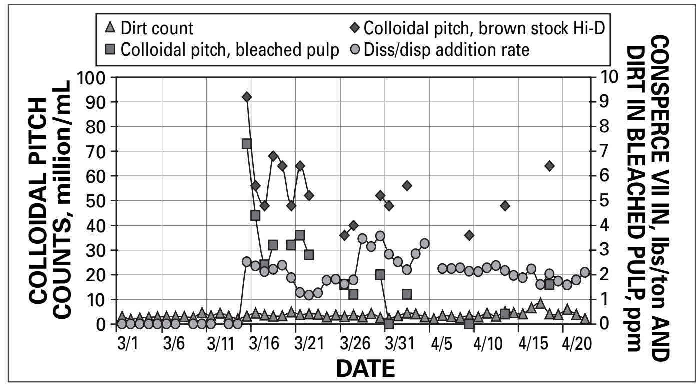
The points marked A to D on Fig. 2 indicate the feed points for the pitch dissolver. The addition rate was determined from an average production rate of 1000 tons/day. This addition rate was maintained constant, even if the production varied. The pumps were controlled manually and it was safer to add the pitch dissolver based on the maximum production rate. The trial was initiated on March 15, 2001. The dosage rate was varied in the BSW area, as shown in **Table I**.

After six days, the flow rate was further raised from 50 mL/min to 100 mL/min to the #4 repulper to start preparations for switching the pitch dissolver/dispersant application to the bleach plant. This condition of 460 mL/min was maintained for an additional four days. On the fifth day addition to the bleach plant was initiated at the following locations:

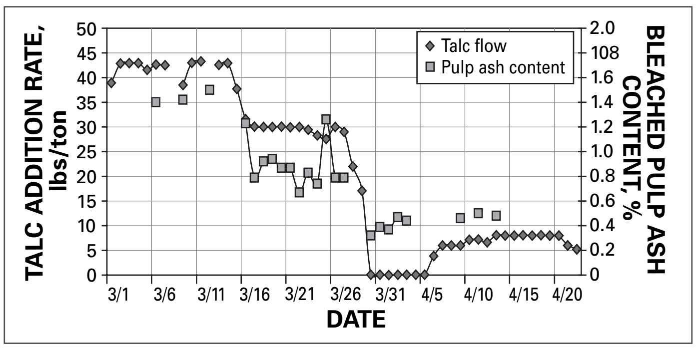
- D_0 washer discharge chute
- D_1 upper pond flow and white water dilution to the discharge chute.



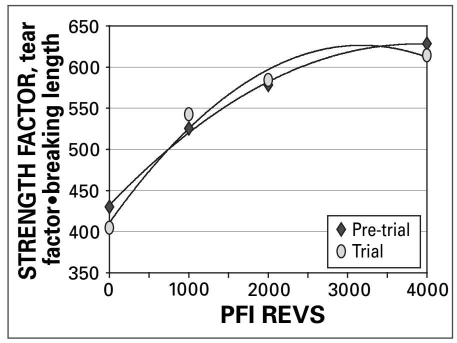
3. Effect of pitch dissolver/dispersant on BSW primary screen pressure differential.



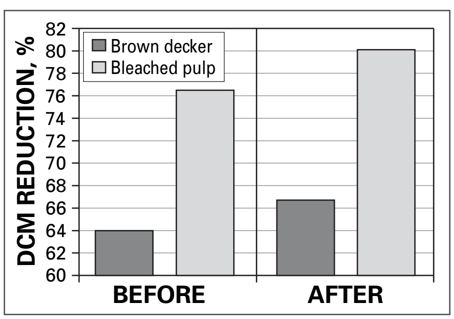
4. Effect of pitch dissolver/dispersant on colloidal pitch counts.



5. Effect of talc elimination on bleached pulp ash content.



6. Effect of pitch dissolver/dispersant on bleached pulp strength factor.



7. Effect of pitch dissolver/dispersant on DCM extractions.

The total addition rate for the brownstock washing and bleaching area was 1010 mL/min, with the addition rate into the bleach plant being 650 mL/min. This condition was maintained for two days; on the third day optimization of the addition rate began for these areas.

MILL TRIAL

Results

Results are presented in **Tables II–IV**, and **Figs. 3–7**. Table II summarizes the testing that was done and confirms that the colloidal pitch decreased upon pitch dissolver/dispersant addition to the process. The colloidal pitch decreased by 68% and 3.3% more extractables were removed from the bleached pulp with the talc completely eliminated from the process.

The dirt count in the final bleached pulp remained unchanged. This implies that most of the dirt in the pulp is due to other kinds of debris and not pitch. The pitch observed in the hand-sheet was mainly bark, carbon, and shives.

Eliminating the talc from the process also lowered the ash content in the pulp—as one would expect—by approximately 51%. The reduction in ash may have been even greater had the mill been using hot filtrate for washing on the last bleaching stage instead of recycled white water from the machines.

The pulp strength factor (defined as tear factor x breaking length) was also determined for treated and untreated pulp. The average of the four-point curve shows no difference in the strength factor.

In the brownstock area, eliminating talc causes the BSW screens to plug and the pressure differential to increase. This was not evident after the talc was replaced with the pitch dissolver/dispersant.

The results in **Figs.3–7** show the effects of the pitch dissolver on the various parameters that were monitored on a real-time basis over approximately five weeks.

Figure 3 shows the effects on the primary screen pressure differential from eliminating talc. The results show that after the talc application was shut-off in the BSW area, the primary screen pressure differential did not change and it followed the brown pulp production rate, as expected. The optimized application rate for the BSW area is 0.27 kg/ton.

Figure 4 shows the effects of the pitch dissolver on the colloidal pitch count off the brown screen high-density and the bleached high-density storage chests. As expected, the colloidal pitch count decreases upon the addition of the pitch dissolver; the count off the bleached high density storage chest is lower than off the brown screened high-density storage chest.

The apparent increase in dirt between March 15 and 20 actually reflects a system upset in the BSW area that caused the mill to shut down from 2–5 hours. During this period, the dirt level increased, but was brought under control within an hour of start-up. The final dirt blip during this period was also due to shutdowns in the bleach plant and the BSW area. Samples were collected immediately upon start-up and the results indicated higher dirt count. Had it not been for pitch dissolver/dispersant addition, the dirt counts would have been much higher.

The optimized application rate for the bleaching area is 0.55–0.60 kg/ton.

Figure 5 shows the effects on the bleached pulp ash content from eliminating talc. The results show that as the talc was shut off from the BSW area to the bleaching area, the pulp ash content decreased from about 1.44% to 0.85% to 0.4%. The ash content of pulp would have been even lower if the mill were using hot filtrate as wash water instead of recycled white water, which contains up to 0.15% inorganics at times. However, the reduction in ash did require the addition of about 0.5% more precipitated calcium carbonate on the paper machines.

Several other benefits were also observed on the paper machine, such as increased machine efficiency (the paper makers have observed a reduction in paper machine breaks by at least 30 h/month on the average) and increased wire life of at least 15% (the wire ran longer on the machines due to improved cleanliness and lower pitch deposition than before).

Table III and Fig. 6 show the effects of the pitch dissolver on the pulp strength factor (the mill uses the equation [tear factor x breaking length] to define strength factor) before and during the trial. The graph shows that there is no difference in the bleached pulp strength factor between the pre-trial and trial periods.

Table IV and Fig. 7 present the results of DCM reduction. The results show that the DCM reduction both at the discharge of the BSW high density chest and the bleached storage chest is higher during the pitch dissolver application period.

Cost implications

The cost implication of applying the pitch dissolver/disperser in the brown stock and bleaching areas are generalized by identifying factors that were affected positively or negatively by this work:

Brownstock washing.

- The wires of the BSW and the decker remained clean. This meant the pulp washers did not lose efficiency over time, which resulted in consistent soda carryover into the bleach plant and a bleach chemicals savings. The mill reports conductivity as a measure of soda loss. The conductivity before treatment varied between 2500-2800 µS/cm and increased to 3500 µS/cm as the wire plugged. During treatment with pitch dissolver/disperser the conductivity varied between 2500 – 2900 µS/cm.

Bleaching.

- Before treatment, the mag flow meter leading into the bleach plant would become coated with pitch giving erroneous pulp production results for bleach chemical application. This resulted in a higher than normal application of bleaching chemicals. During the application of pitch dissolver/disperser, the pitch layer on the flow meter started to disappear, allowing the mill to better control the bleach chemical application. This resulted in a bleach cost savings equivalent to 0.4% as total equivalent chlorine and 0.3% as caustic. The savings also includes the effects of consistent soda loss on the brownstock washers.

Environment.

- Due to lower chemical consumption in the bleaching process, the effluent plant COD loading decreased by 2%.
- Although AOX was not measured, with reduced chemical application in the bleaching process, we expect the AOX to decrease.

Paper Machine.

- The mill started producing pulp with a lower DCM extractive level, which resulted in less extractive carryover to the post-refiners and the paper machine. Due to reduced pitch carryover to the paper machines, the refiner plate life improved by 200–400 h. The useful life of the press section doctor blades—which were getting coated with pitch—almost doubled, and in some cases tripled. In addition, the machine efficiency improved by almost 4% due to fewer breaks and the useful life of felts and wires increased by 15%. However, since the carried over talc from the pulp mill decreased, the precipitated calcium carbonate (PCC) consumption increased by 0.5%.

General Equipment.

- The mill found the process piping, chests, washer doctor boards, and washer repulper screws were clean during shutdowns. The elimination of the talc mixing equipment and positive effects on process equipment reduced the need for maintenance.

Chemical.

- Because the mill replaced talc, the talc cost was eliminated. It also freed mill operating personnel time, which allowed the mill management to allocate staff to more pressing duties.

CONCLUSIONS

The pitch dissolver/dispersant allowed the aspen kraft integrated mill to attain its goal of replacing talc without plugging the brown primary screens during the pitch dissolver/dispersant application period.

Colloidal pitch decreased by 69% and the pulp ash content decreased by 51% in the final bleached pulp filtrate and the pulp respectively after switching to the pitch dissolver/dispersant. The dirt count in the final bleached pulp did not change, implying that most of the dirt was bark, shives, carbon, or black top.
During the pitch dissolver/dispersant application, 3.3% more DCM extractives were from the chip in the pulping and bleaching process.

The bleached pulp strength factor and the dirt count remained the same, implying that the pitch dissolver/dispersant did not affect the pulp quality.

On the papermaking side, the wire life increased by 15% and the machine efficiency was higher by at least 30 h/month. Because talc was eliminated from the process, ash decreased, which prompted the mill to increase its use of PCC by 0.5%.

From the trial it was concluded that for fresh kraft aspen pulp, the minimum dosage of pitch dissolver/dispersant required for the brown stock washing and bleaching areas to effectively prevent the pitch deposition and increased dirt in the pulp while replacing talc is 0.7 kg/ton. **TJ**

NOTES

a) **Saponifiables:** extractives in the form of fatty and resin acids that can react under alkaline conditions to form their salts readily. The process of converting the acid into its salt is called saponification.

b) **Unsaponifiables:** these are compounds such as the sterols, waxes and triterpenoids that cannot be easily saponified.

c) **Pitch Dissolver/Dispersant—CONSPERCE VII$_{nk}$**—CONSPERCE VII$_{nk}$, the pitch dissolver/dispersant used in this study, is biodegradable and approved as Kosher for use with food. It is a water dispersible, yellowish clear liquid with a non-ethoxylated base.

LITERATURE CITED

1. Mutton, D.B., *Wood extractives and their significance to the pulp and paper industry*, Academic Press, New York, 1962.
2. Allen, L.H., *Pulp Paper Can*; October 1988.
3. E.L. Back and L.H. Allen, Eds., "Pitch Control, Wood Resin, and Deresination," TAPPI PRESS, Atlanta, Georgia, USA, Chap. 13, p. 321.

Received: November 1, 2004
Accepted: December 28, 2005

This paper is also published on TAPPI's web site <www.tappi.org> and summarized in the June *Solutions! for People, Processes and Paper* magazine (Vol. 88 No. 6).

INSIGHTS FROM THE AUTHORS

Many products take a similar approach in eliminating pitch in the kraft process. We wanted to come up with a novel approach, which was to dissolve and disperse the pitch in the process. This product took many years to develop, but now we are confident that it performs to expectations.

Eliminating pitch in the pulping process is not new. A lot of work has been done and published on this subject by operating mills, research scientists, and engineers. This work complements what has been done, but it approaches the problem differently. Rather than dispersing the pitch in the process, we dissolve it and eliminate it from the process through the effluent system. This dissolved pitch provides a food source for the proliferating microbes in the effluent system. Some larger molecules of pitch do get dispersed, but this technology ensures that the dispersed pitch does not stick to the pulp or the equipment.

The new product also improves the liquor penetration into the chip and reduces the extractive content of the final pulp. This is evident from the pulp analysis and from reduced knot formation.

The most important aspect of the research was to determine the right surfactant/solvent combination for the product that would work on different kinds of extractive material present in wood from around the world. We also wanted the product to be environmentally friendly and acceptable for food contact. This material has been tried on mixed tropical hardwoods, acacia, eucalyptus, mixed North American softwoods and hardwoods, radiata pine, and aspen. In all cases, the product has out-performed the traditional technology available today.

It was important to come up with technology that was different than the present technology of dispersion. An interesting thing we discovered was that when this product is applied to the process, it does not abruptly dislodge the existing pitch present in the mills. It actually slowly dissolves the pitch, thereby preventing the production of off-grade pulp during its application. Another interesting thing we discovered was that it cleaned the process over time. Therefore, less off-grade pulp was produced after a short, unscheduled down time or a planned extensive shut down.

Use of this product requires the elimination of talc from the process because talc adsorbs the product and renders it neutral.

We believe mills will find many applications for this product:

- As a means to attain low ash, low DCM pulp.
- As an aid in keeping extractives content in the final dissolving pulp as low as possible.
- As a replacement for talc, thus reducing equipment deposits, dirt in pulp, maintenance requirements, chemical demand, and talc-related costs.
- As a way for tissue pulp suppliers to reduce their ash content.

We are presently looking at enhancing the efficacy of the existing product so that it will totally dissolve all the various types of extractives present in woods from around the world.

Manji is technical manager/process and project engineer; Karagiannis is vice president sales; Salgar is technical director; Constant is CEO and president, Constant America Inc., Montreal, Quebec, Canada. Email Constant at jconstant@constantamerica.com.

Manji

Karagiannis

Salgar

Constant