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SHIVES AND SAND PROFILE INVESTIGATION IN A FIBERLINE SCREENROOM

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ABSTRACT

Modern eucalyptus fiberlines are frequently challenged to produce high quality pulp with a small content of shives and sand. Not only production increases, but also optimization to reduce input costs, require efforts to maintain pulp quality. It is predicted that Brazil's increase in bleached hardwood kraft pulp (BHKP) production will reach 3.5 Mtons/year in 2022. The screenroom area was investigated as it is responsible for removing shives and sand from the pulp. Different periods were investigated in a modern fiberline screenroom plant in order to identify and compare total shives and sand (total ash) profiles. The screenroom system consists of knots separation, primary, secondary and tertiary screening, knots and rejects washers, shive cleaners, sand cleaners and sand separation screw. Knots are sent back to cooking and shives are partially returned to oxygen delignification. The aim of this study was to compare total shives and sand (total ash) profile from different periods. Results of shives profile, shives and fiber losses, shives and sand balances are shown in this study. Shives profile indicated that although the shives content from the digester varied for the different periods, the shives content in screening feed and accept remained constant. A variation is seen in shives discarded from the process for the different periods. More recently, this discard has increased more significantly from the knot washer. Satisfactory efficiency was observed in total shives removal in screening: 89-90% for combi-screens, 95% for secondary screen, 93-95% for tertiary screen and 72-84% for the shive cleaners. For sand (total ash) removal, the overall efficiency did not change significantly and the removal efficiency in fiberline increased from 61.0% to 66.5%.

Keywords: *shives, screenroom, fiberline, profile study.*

INTRODUCTION

The pulp market has been registering production records as the result of strong investments and cost reductions over the years. As such, the main challenge today is to have high quality products with increased production capacity, as most modern mills are achieving. To maintain their competitiveness, mills are strongly pursuing operational excellence, balance and accountability in the use of resources. Figure 1 shows the projected change in bleached hardwood kraft pulp (BHKP) consumption and production for 2018 and 2022 [1]. Brazil detains most of the pulp production for the short term considering the global pulp production scenario, with an increase of more than 3.5 Mtons/year in the next 4 years.

Besides increased production capacities, the pulp and paper industry is highly diversified in terms of products, raw materials, product qualities, distribution channels, and end uses. Prime and extra prime products have restricted quality parameters to keep its high added value, which also impairs an economic and environmentally sustainable production chain. As such, pulp screening is an important operating unit for the pulp and paper industry, as it directly affects end product quality in terms of dirt, shives and sand. The main principle of pulp screening is to physically separate good fibers from impurities that could come from different sources as process and non-process elements. In addition, pulp screening is a key process to reduce solid waste.

Motivated by these reasons, the study about shives and sand began some years ago, in 2013, when the paper on Reduction of Solid Waste from Pulp Mill Fiberline [2] was completed. It presented some advantages of new pulping technology that allow carrying out all pulp screening operations downstream, after oxygen delignification, which also lends several benefits in terms of pulp quality, process economy and environmental emissions [2]. Later on, in 2017, another study was done about Fiberline Screenroom Improvements and benefits for pulp quality [3]. It addressed shives removal, screening efficiency, and sand particle size distribution.

This study has the aim to evaluate and compare shives

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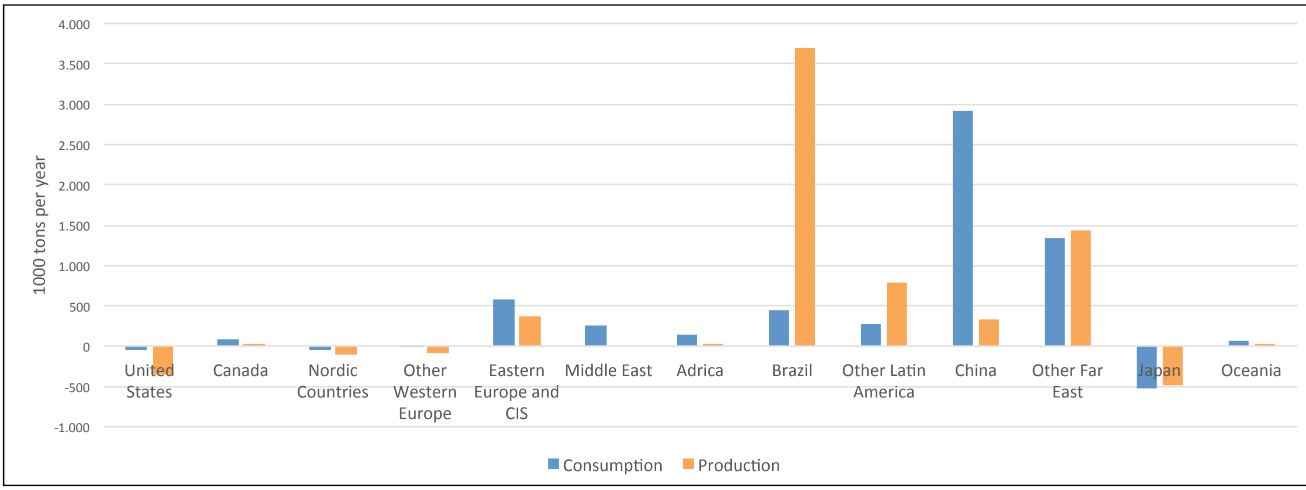

Figure 1. BHKP – Change in consumption and production 2018-2022

and sand profile for a modern bleached hardwood kraft pulp (BHKP) mill that has the screenroom area placed after the oxygen delignification stage. It can also be said that the fiberline process sequence is composed of cooking, drum displacement brownstock washing, oxygen delignification, screening, post screening drum displacement washing and four stages bleaching plant with drum displacement washing between stages. In the screening area, there is a specific equipment for shives removal, called shives cleaners, which consists of many individual thickeners piped together in a bank. The purpose of the shives cleaners is to separate pulp fibers from the reject washer filtrate, having the separation based on centrifugal forces. The fibers are concentrated at the bottom of each thickener. The thickened pulp stream may be returned to feed oxygen delignification stage or to cooking plant.

METHODS

A Fiberline system from a modern eucalyptus bleached-pulp mill was investigated to evaluate shives and sand profiles.

Sampling plan

Figure 2 shows the sampling plan, adapted from [3].

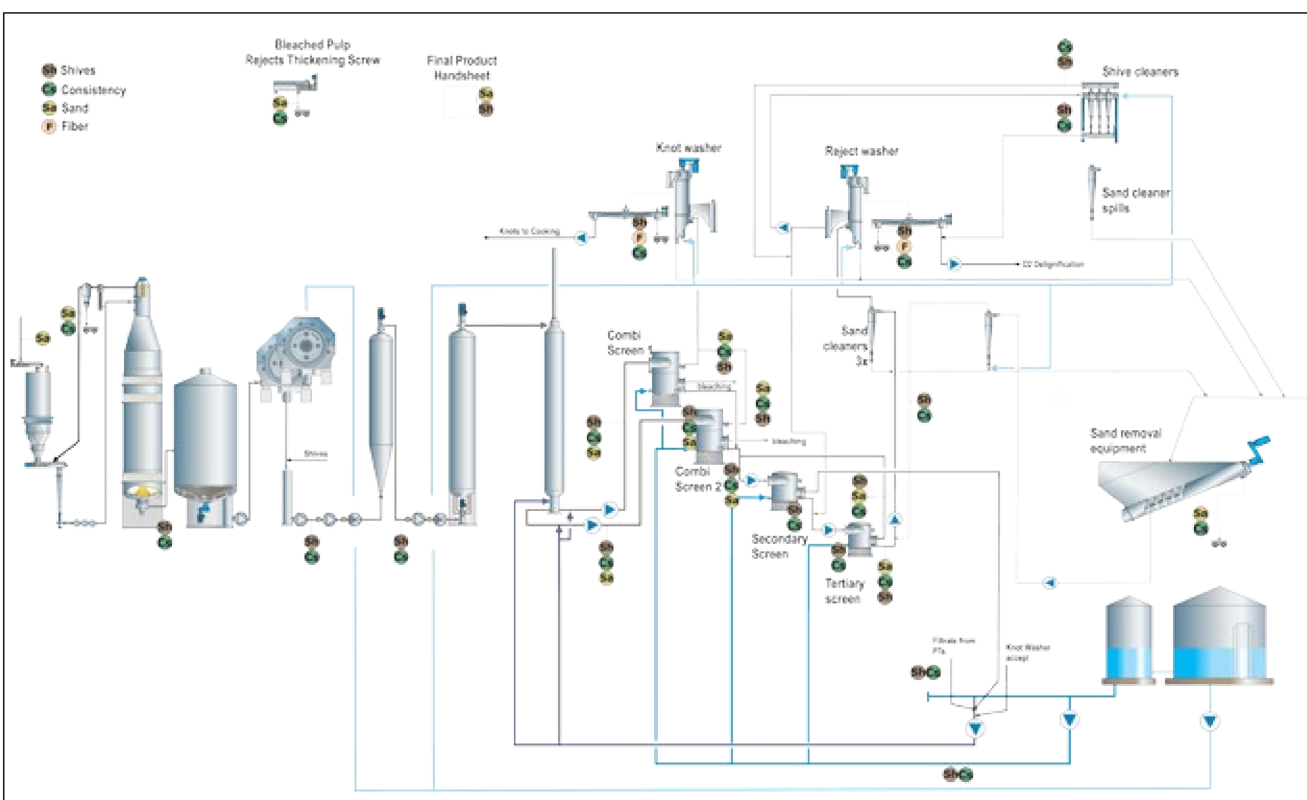

Figure 2. Sampling points [adapted 1]

For the shives profile, samples from two different periods were collected: November 2017 and February 2018. In November, 10 samples were collected for each sampling point and in February, 6 samples were collected. For the sand profile, 10 samples were collected in November 2017.

In November, sampling was done for 5 days, collecting individual samples with a 12h interval. In February, it was done for 3 days, with the same time interval.

METHODS

The samples were collected in adequate recipients and stored in laboratory at 20ºC. Consistency and Shives were measured according to SCANC17:64 and Somerville T275 sp-12, respectively. Fiber content in rejects was analyzed according to AHL4, using 0.15 mm slots.

Sand content was measured based on ISO776:2011 standards. This standard measures insoluble in HCl, thus, is measuring total ash content.

RESULTS AND DISCUSSION

Shives profile overview

Figure 3 shows the shives profile in the fiberline for 3 different periods (P1, P2 and P3). The period of June 2017, P1, was published in [3]. The digester discharge total shive content increased for P2 and P3, the average remained below 0.515 ± 0.269%. There was an increase in mill final pulp production of 4-4.5% when comparing P1 and P2 or P3. The production for P2 and P3 was similar. The Kappa was similar for all the periods and the average was 15.4 ± 0.2. The increase in production and variation in chips properties might influence the amount of rejects in the digester blowline, which increased when comparing the periods. Differences in digester operation were not seen in the periods, so cooking plant itself is not related to higher rejects in blowline at P3. When comparing dryness and chips classification for the three periods, P3 presented lower average dryness, lower average of accept chips size and lower average of overall

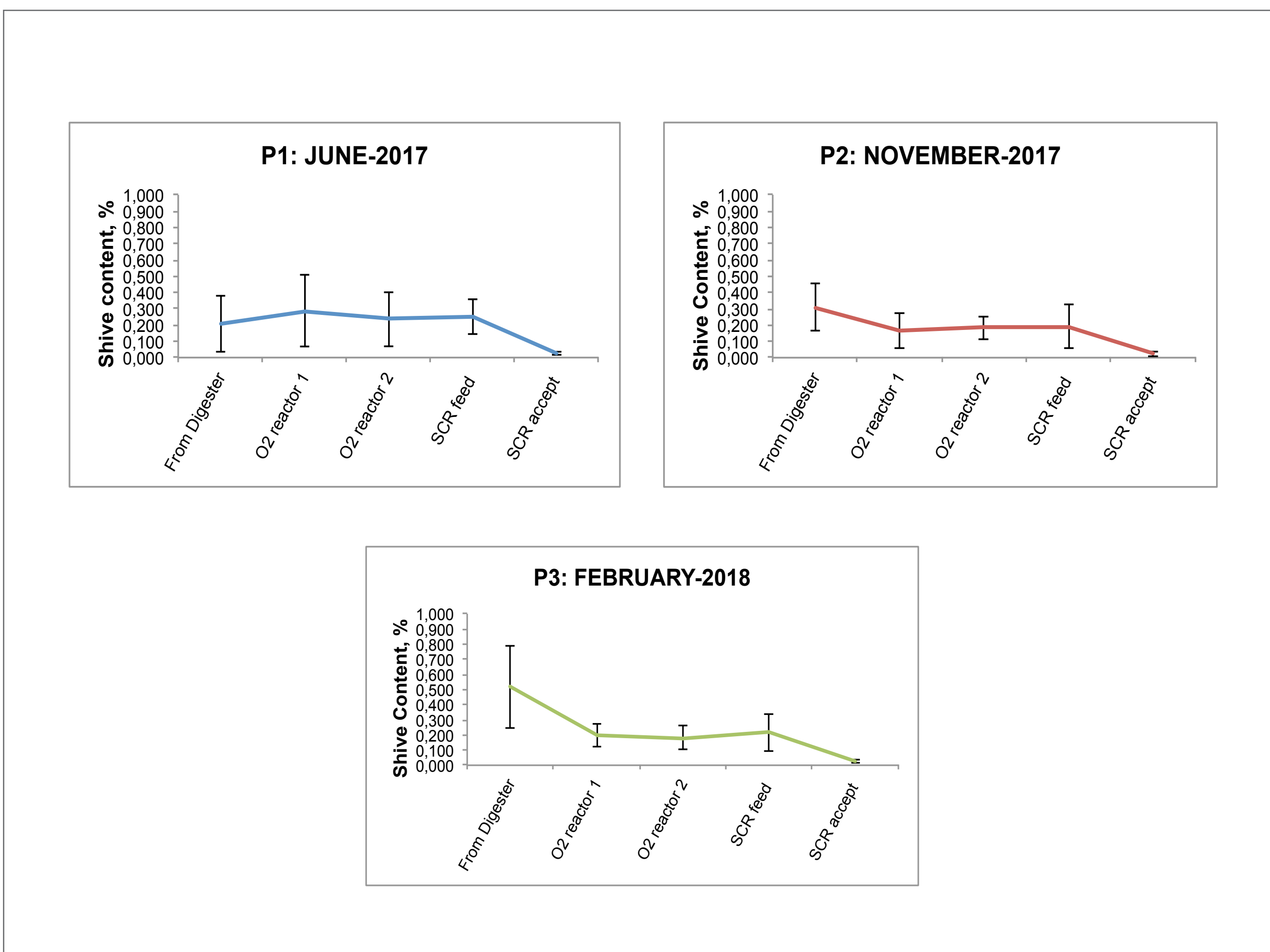

Figure 3. Shive Profiles in Fiberline

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thickness amount, being the opposite result than expected, as these characteristics would imply in lower rejects content. Besides, for P3, wood from a specific source, which is known for its higher biological knots content than others, was used. Other wood chips properties were also evaluated for the three periods, and P3 showed higher average nominal length and thickness than previous ones. The effectiveness of removing air from chips during steaming (before actual cooking) is determined by chip length, as well as the effectiveness of cooking liquor penetration into the chip particle [4]. Chip thickness is related to the cooking liquor impregnation inside the chip particle, thinner chips are better [4]. Another interesting evaluation was the shives properties that are measured along the fiberline. The mill installed a specific shives module at the kappa and brightness analyzer, as such, the shives properties are measured online at the same points that kappa and brightness are analyzed. The same increase trend was observed when comparing P3 and P2, for P1 data was not available. Shives length, width and amount were slightly higher for P3 at the blowline, delignification feed, screening outlet and DA stage feed. These facts might be related to higher reject content at the blowline for P3. Further investigations and new tests are advisable to re-evaluate this result.

It can be observed that not only the shives content, but also the variability of shives content to the O2 reactor 1 was lower for P2 (0.163 ± 0.106 %) and P3 (0.196 ± 0.074 %) when compared to P1 (0.286 ± 0.223 %). This fact may be related to the recirculation of rejects to the process. The rejects from the reject washer were opened more often to the container for P2 and P3 periods, meaning that these rejects were not often recirculated back to O2 delignification feed. This was also due to the mill's operation strategy. During P1, the rejects from reject washer were sent 68% of the time to the container, 78% for P2 and 76% for P3. But it is important to notice that the rejects from the shives cleaners are normally returned to O2 delignification feed.

The shives content and its variability in the screening feed and accept remained similar for all the periods. The screening feed can be affected because of the cascade mode configuration of the screenroom. It varies depending on shives content in the accept of secondary screen, knot washer accept and pressure thickeners filtrate, which are flows that return to dilute the screenroom feed.

Shives and fiber losses

Tables 1 and 2 show the fiber and total shives purged from process from the knot and reject washers for the 3 different periods.

Fiber purges from knot washer were 0.40-1.93 adt/d (0.01-0.04%) and shives purges were 1.50-8.58 adt/d (0.03-0.17%), as demonstrated in Table 1. For the reject washer, fibers purges were 2.07-3.08 adt/d (0.04-0.06%), and shives purges 3.94-6.28 adt/d (0.08-0.13%), as shown in Table 2.

Based on the Table 1, the fiber and shives out of the process for P3 in the knot washer were higher than the previous periods P1 and P2. The increase in rejects in the digester blowline for P3, as demonstrated in Figure 3, justifies an increase of discarded rejects from the knot washer. Additionally, the knots from knot washer were sent 30% of the time to the container for P1 and P2, but 73% for P3. As mentioned in section 3.1, the increase in knots discharge from the process occurred for P3 due to the wood source, which is known for its higher knots content. In addition, for the reject washer, no significant variation is seen among the three periods, as shown in Table 2.

Table 1. Fiber and shives purges from Knot Washer

	P1		P2		P3	
	adt/d	%	adt/d	%	adt/d	%
Fiber Losses Amount	0.62-2.13	0.01-0.04	0.40-1.35	0.01-0.03	1.42-1.93	0.03-0.04
Shives Losses Amount	2.21-7.58	0.05-0.15	1.50-4.99	0.03-0.10	6.30-8.58	0.12-0.17

Table 2. Fiber and shives losses from Reject Washer

	P1		P2		P3	
	adt/d	%	adt/d	%	adt/d	%
Fiber Losses Amount	2.09-3.08	0.04-0.06	2.28-2.92	0.04-0.06	2.07-2.73	0.04-0.05
Shives Losses Amount	4.26-6.28	0.09-0.13	3.94-5.06	0.08-0.10	4.57-6.01	0.09-0.12

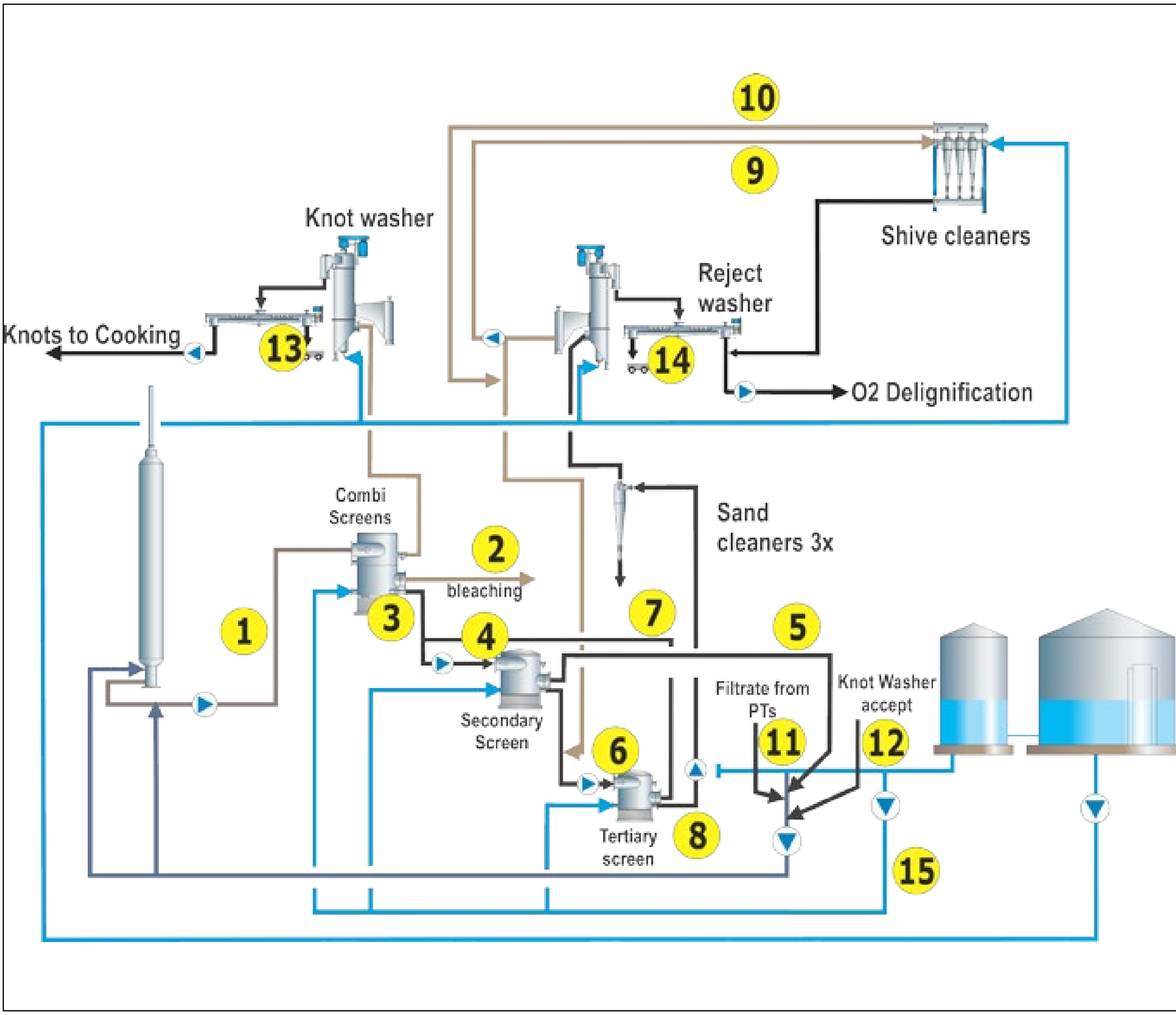

Figure 4. Shive Balance in Screenroom.

	Shives, P1 %	Shives, P2 %	Shives, P3 %
1	0.254%	0.191%	0.216%
2	0.026%	0.021%	0.024%
3	1.221%	0.870%	0.921%
4	1.087%	0.765%	0.805%
5	0.054%	0.038%	0.040%
6	5.393%	3.322%	3.655%
7	0.276%	0.228%	0.167%
8	16.855%	11.213%	12.185%
9	2.815%	1.783%	1.487%
10	0.799%	0.277%	0.299%
11	0.000%	0.176%	0.090%
12	0.907%	0.134%	0.016%
13	78.460%	78.591%	81.523%
14	67.218%	63.419%	68.770%
15	0.092%	1.330%	0.641%

Shives balance

Figure 4 shows the shives balance for the screenroom considering three different periods P1, P2 and P3. Screening accepts production and consistency were, respectively, 5020 adt/d and 4.5% for P1 and 5250 adt/d and 4.9% for P2 and P3.

The shives removal efficiency remained similar for the periods. Combi-screens efficiency was 89-90%, secondary screens achieved 95% efficiency and tertiary, 93-95%. For the shive cleaners, the efficiency varied from 72-84%. It was possible to notice that after P1, which was a period before annual shut down, the shive cleaners' efficiency increased up to 12%.

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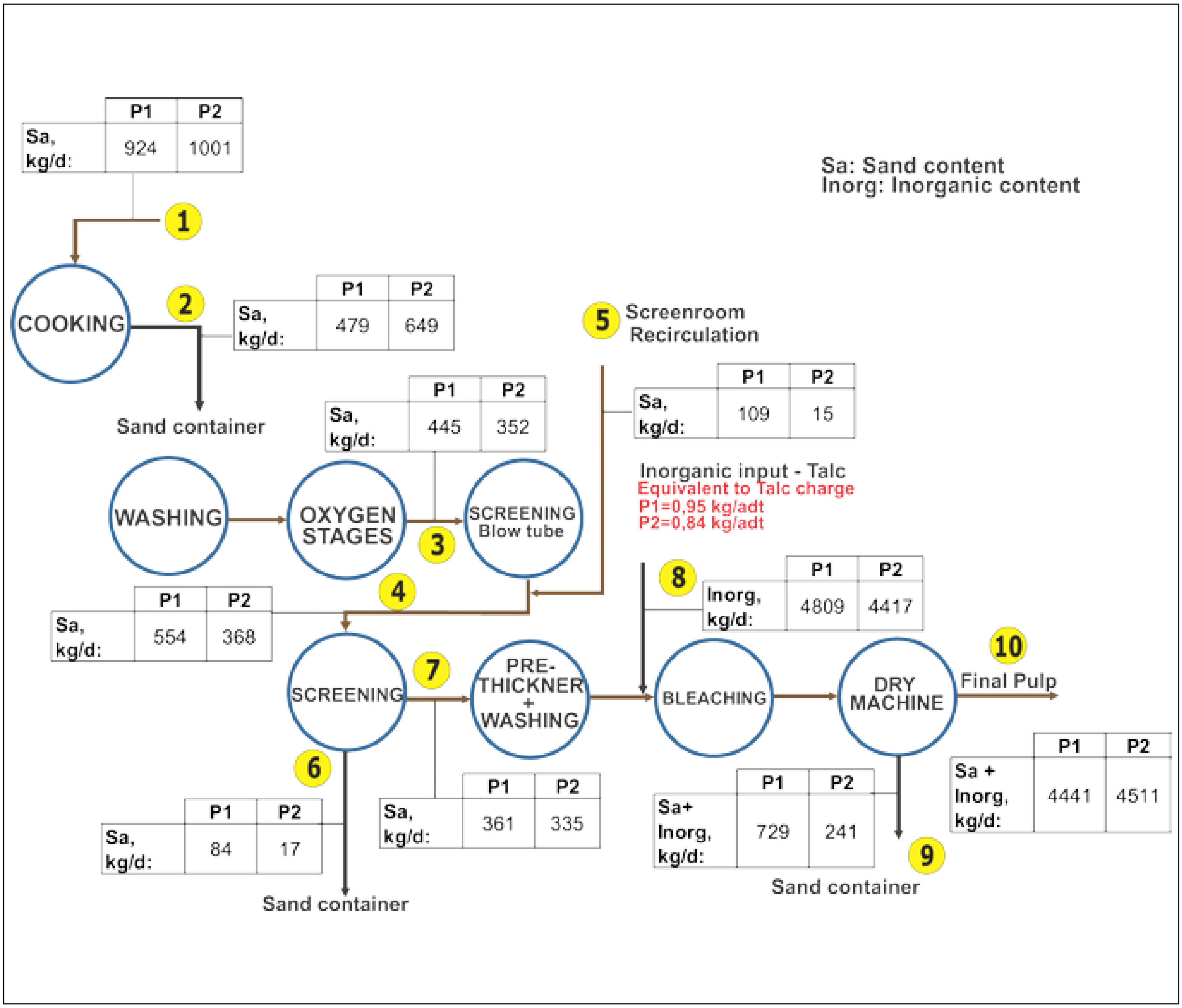

Figure 5. Sand Balance in Fiberline.

Sand balance

Figure 5 shows sand balance in the Fiberline, where sand content in final product and sand discard in the Dry Machine area were also considered. It is important to mention that the method utilized to identify sand was ISO776:2011 and this method takes into account not only sand, but also some of the inorganic matter in the sample, which has no solubility in hydrochloric acid, considering that, when evaluating sand with this method, it is measuring total ash content. As a result, the talc input in the bleaching feed is presented as an input source. Talc is an inorganic material which is accounted when evaluating sand content by the referred methodology [3]. It is important to mention that other inorganic materials may affect the sand indication. Especially for wood, there is the impact of ions, like calcium and magnesium, which content can reach 600 ppm, as referenced in other wood materials analyses.

As described in [3] and looking at Figure 5, the samples were collected and analyzed for streams 2, 4, 6, 7, 9 and 10 and the values for streams 1, 3, 5 and 8 were calculated.

Comparing two different periods, the calculated sand content in incoming wood is similar. The total sand removal in fiberline increased from 61.0% to 66.5% and the most part was removed in the Cooking plant. The portion of Cooking plant sand removal increased from 85% to 97%. For P2, the amount of sand removed in Cooking increased (649 kg/d) and in Screenroom decreased (17 kg/d). For both periods P1 and P2, the amount of sand going to the fine screen is low and because of that the amount of sand removed in screenroom is also low. Comparing the sand content in the reject line from the tertiary screen, it was observed that for P1, it was 1.3 kg/d and for P2, 2.0 kg/d. Although there was a small increase in sand content in the tertiary screen rejects, the amount is still low. The sand preferably goes with the pulp and this behavior can be related with the type of sand which is fine. Information about the sand particle size can be found in [3].

Also, the amount of sand returning to the screenroom feed dilution reduced comparing P1 and P2. This can be explained due to the change in the pressure thickener condition. For period P1, there was a restriction in the pressure thickeners screens. As such, for P1 more sand tended to go with the filtrate and return with the dilution flow. See stream number 11 in Figure 4. The filtrate from pressure thickeners enters the suction of the dilution pump.

For P2, the sand and inorganic content in the final pulp was expected to be lower than P1 because the sand removal efficiency in fiberline was higher for a similar sand content in the incoming wood and also because the inorganic content coming with talc was lower for P2. However, as shown in Figure 5, the sand and inorganic efficiency removal in dry machine area reduced for P2 period from 14.1% to 5.1%, resulting in a pulp with slightly higher content of sand and inorganic.

As seen in [3], the sand particle size evaluation was done in P1, which shows the sand particle size distribution for the wood chips, discharged sand from the cooking plant and screenroom. It was noticed that the general size of the sand particles is small, mostly being lower than 0,500 mm. This fine sand quality is attributed to the soil characteristics of Mato Grosso do Sul [3]. Further evaluation will be done for period P2.

CONCLUSIONS

This goal was to continue the investigation of the screenroom process, which started some years ago, and to compare results between each study. The shives profile showed that the total shives from digester discharge average is still low 0.515 ± 0.269%, even having increased for P2 and P3, what could also be the reason of having more fiber and total shives losses for P3 in the knot washer than the previous periods. In addition, the mill's final pulp production increased 4-4.5% when comparing P1 and P2 or P3. The production increase and chips properties might affect the amount of rejects in the digester blowline. Additionally, the rejects circuit closure was different for P1, P2 and P3, meaning that the recirculation of rejects to the process changed, which also changes the cascade mode configuration of the screenroom. The rejects from the reject washer were more often opened to the container for P2 and P3 periods, as such, these rejects were not often recirculated back to O2 delignification feed. For P1, the rejects from reject washer were sent 68% of the time to the container, 78% for P2 and 76% for P3. It is important to point out that the rejects from the shives cleaners normally return to O2 delignification feed. Regarding the shives balance, the total shives removal efficiency remained similar for the periods. The sand profile demonstrated that the sand (total ash) efficiency removal in fiberline increased from 61.0% to 66.5%, being the most part removed at the cooking plant, and the minor part, in the screenroom. As the amount of sand feeding the fine screen is low, the amount of sand (total ash) removed in screenroom is also low. For P2, the sand and inorganic content in the final pulp was slightly higher as the sand and inorganic efficiency removal in dry machine area reduced for the P2 period from 14.1% to 5.1%. It is important to reinforce that the method to identify sand also takes into account the inorganic matter in the sample that is not acid soluble, as some talc constituents and other inorganics may affect the sand indication, as the method is measuring total ash content.

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