

Putting the Pressure on Tail Screening

Improving fiber recovery by using intermediate dilution in the screen basket.

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The tail screen function of a screening system, i.e. the final step in screening where good fibers are recovered and coarse material finally rejected, is a vastly discussed matter. The large holes of conventional non-pressurized tail screens recover good fibers but also let sand separated in the screen room back to the process. Another drawback is the risk of air entrainment since it is non-pressurized. A pressurized tail screen with the possibility to use slotted screen baskets is a most sought-after equipment. This paper describes the development of a new concept for a pressurized tail screen and the evaluation in mill scale. The concept involves utilizing the Metso invention of intermediate dilution (Swedish patent SE 524 527) in the screen basket that was developed to eliminate the reduction of capacity and screening efficiency that is caused by the pulp thickening across the screening surface.

In cooperation with Korsnäs AB pulp mill, Metso was allowed to rebuild the tertiary screen of Line 3. During a four-month trial period, the mass flow rate of reject from the tertiary screen was decreased from 0.39 to 0.25 bdt/h. With an increased shive content from 35% to 67%, the amount of good fibers rejected decreased from 0.26 to 0.08 bdt/h. This gives a total increase in yield by 4.3 metric tons per day. The shive content in the accept pulp from the primary screen did not increase during the trial period.

PRESSURE SCREENING

In today's pulp mills, pressure screening in multiple stages is the preferred method for removal of impurities such as sand and shives from the pulp. Multiple stages are needed since most pressure screens cannot sufficiently concentrate the impurities in only one screening stage due to thickening of

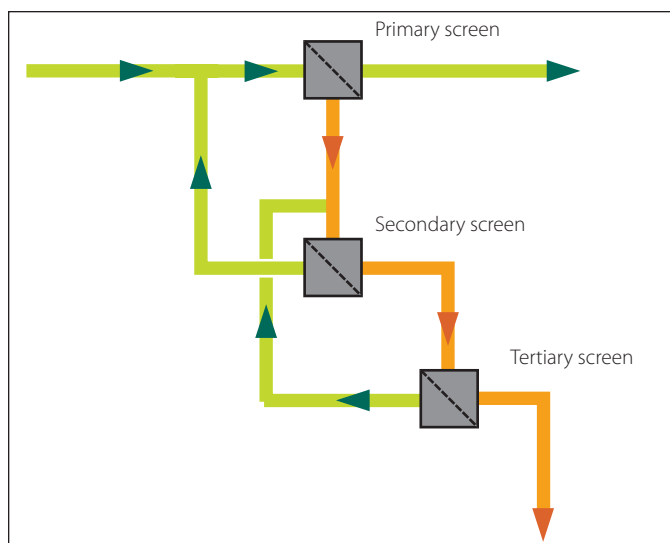


Fig. 1. Cascade coupled screening system.

the reject. Most commonly, a screen room consists of at least three stages. To effectively utilize the energy input and to minimize the amount of impurities in the accepted pulp, the most common way of connecting the screening systems is in a cascade arrangement. The high demands on yield make it necessary to use some kind of reject washing to minimize the amount of good fibers taken out from the system. Due to thickening and its consequences, pressure screens are not commonly used in this position. To maximize the amount of good fibers brought back to the process, reject washers, or tail screens, are equipped with large holes, often 4 – 6 mm in diameter. Drawbacks of this method are low selectivity due to the large holes, non-pressurized vessel and that large volumes of washing liquor are needed, making it impossible to maintain the cascade coupling.

To handle the high flow rate from reject washing, the accept from the tail screen usually cannot be connected in cascade to the preceding screen. Instead, it is put in a low consistency tank prior to the primary screens. This forced arrangement puts a higher load on the primary screen, both with respect to the cleanness of the inlet pulp and the reduced consistency caused by the dilution.

IMPROVING THE PROCESS

A development project was initiated to improve the selectivity of the tail screening function in a screen room and a concept evaluation was then undertaken to test the ideas of a rather tall screen basket, separated into two or more screening zones by using intermediate dilution to dilute the pulp between the zones. Metso decided that the best way to accomplish this was to work with a suitable customer and rebuild, for example, a tertiary screen because the composition of pulp at the very end of a screen room makes it very difficult, if not impossible, to perform the studies in a pilot plant.

The project involved Metso's Nimax-db screen basket concept, which was developed to eliminate the reduction of capacity and screening efficiency that is caused by the pulp thickening across the screening surface. The concept is based on the idea of splitting the screen basket in two or more screening zones with intermediate dilution. With this technique it is possible to optimize the process of screening by providing control of the reject thickening in the lower part of the screen. This also provides a more effective utilization of the screening surface.

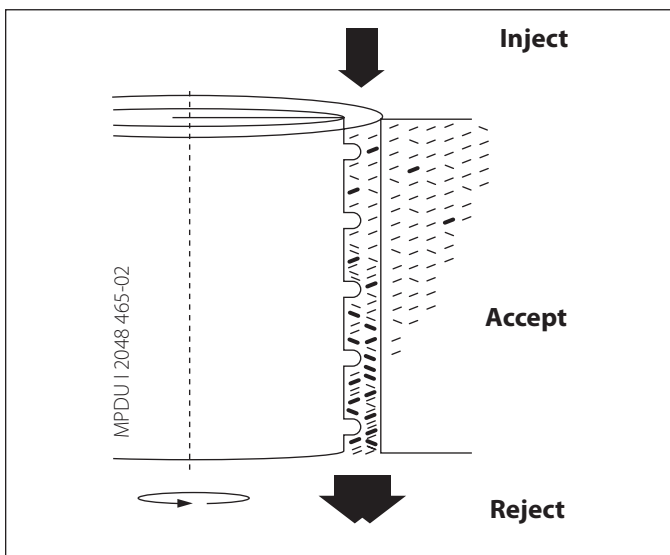


Fig. 2. Schematic figure of the thickening in a typical pressure screen.



Fig. 3. Illustration of how two dilution belts were fitted to the screen.

The mill allowed Metso to map the brown stock screen room of Line 3 and then propose a plan and target for a rebuilding of the tertiary D4 screen according to the new technology of intermediate dilution.

INTERMEDIATE DILUTION

It is obvious that the size of the screen, and especially the height of the screen basket, is an important factor for the phenomenon of thickening and variations in screening efficiency. Since it is less expensive to achieve a certain screen plate area with a high and narrow screen in comparison to a low screen with a large diameter, many screens have too high and too narrow baskets to achieve an optimal screening result. One way to compensate for the thickening is to dilute the pulp in the screening zone. Many different dilution concepts have been developed with varying success.

Dilution liquid can, for example, be fed through the rotor and from there be distributed to the pulp. The required amount of dilution is often not determined according to a measured need. It is adjusted arbitrarily and in many cases the flow of dilution liquid is not measured at all.

The newly developed screen with intermediate dilution reduces the limitations to operate a pressure screen at low reject rates. With dilution added in two or more places directly in the screening zone, thickening still takes place, but under controlled circumstances. The new screen can

conveniently be described as a multi-stage feed forward screening system, where the available screen plate area is better utilized. Due to the increased content of impurities in the latter stages it is often advantageous to use a narrower slot width as the pulp gets closer to the reject outlet. Since it isn't possible to measure the flows within the screen, a control algorithm has been developed to calculate the required amount of dilution in each stage without knowledge of the accept and reject flow from the preceding stage. Only the flow rates and consistencies of the initial feed and the final reject are required. For a screen with multiple intermediate dilution, the control algorithm for the first dilution stage can generally be written as:

$$Qd_1 = \sqrt[n]{Qf^{n-1} * Qr} (\sqrt[n]{T} - \sqrt[n]{T^{1-n}}) ;$$

Where (n) is the number of screening stages.

KORSNÄS PULP MILL

The Korsnas pulp mill has three production lines for sulphate kraft pulp. Line 3 produces bleached pulp, while Lines 1 and 2 produce unbleached pulp for sack kraft paper and packaging board. Rejects from Line 3 are taken through a separate system for reject handling and then distributed to production Lines 1 and 2. With a substantial difference in price between bleached and unbleached kraft pulp, there is an incentive for an improvement in yield in production in Line 3 by reducing the amount of good fibers displaced to fiber Lines 1 and 2. Production capacity of Line 3 is about 1,300 adt/d of both hardwood and softwood pulp.

The screen room is equipped with four primary D8 screens, one secondary D8 screen, one tertiary D4 screen and a screw press to dewater the reject from the tertiary screen. All screens were delivered by Metso during the construction of the fiber line in 1987 as M-models utilizing the centrisorter-concept, but were retrofitted in 1996 to the D-model equipped with a foil-rotor. All screens are equipped with slotted screen baskets with a slot width of 0.25 mm.

MAPPING – REFERENCE PERIOD

Prior to rebuilding the tertiary screen, a mapping of the screen room was conducted. All samples were analyzed in the laboratory at the pulp mill. Analysis for shive and fiber content was done with a Somerville screen according to TAPPI method T275 sp-987. According to the samples analyzed, a screen room balance was established. All balances presented were prepared using the software WScreen 4.28.

Reject shive content from the tertiary screen was measured to 35% at a total mass flow rate of 0.39 bdt/h. Volumetric flow rate of the reject was 25 m³/h, and thus the mass flow rate of rejected fiber was 0.26 bdt/h.

REBUILDING – TEST PERIOD

By fitting the new screen basket with two dilution belts the tertiary screen was rebuilt into a feed-forward, three-stage screen (see Figure 3). The three screening stages were equipped with a slot width of 0.25 mm in the two upper stages and 0.22 mm in the lower. After rebuilding, a test period of four months took place to adjust flow rates and evaluate the impact of different settings. Hardwood and softwood pulps were sampled and the Kappa number in the blowline varied between 17 and 36.

At start-up, the reject flow rate was set at 15 m³/h. Upper and lower dilution was 30 and 15 m³/h respectively according to the control algorithm based on mass flow of pulp within the screen. The objective of minimizing the reject flow was tested by lowering the flow with 1 m³/h each week. Mill operators concluded that 11 m³/h was not comfortable. Several pluggings of the reject valve occurred and the operators decided to increase the reject flow back to 15 m³/h. Despite these pluggings the screen never shut down—neither due to high load nor due to high differential pressure.

Figure 4 shows the shive contents in the three pulp streams during the test period. The average shive content in the reject from the tertiary screen was 67% during the test period. The shive content of the accept stream was 6.5%. At an average reject consistency of 1.65%, the mass flow rate was calculated to 0.25 bdt/h of which the mass flow of fiber then was 0.08 bdt/h.

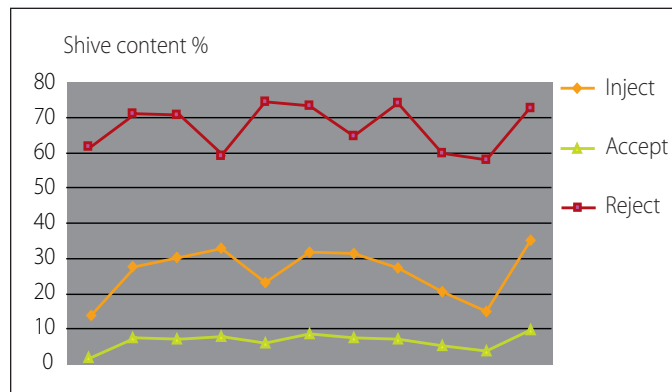


Fig. 4. Shive content in inkjet, accept and reject streams during the test period.

MILL RESULTS

The results attained during the screen room mapping and testing periods clearly showed that the yield was improved in Line 3 by increasing the reject content of the reject flow with intermediate dilution. Even though the tertiary screen was operating at a shive removal efficiency of more than 90% during the mapping period, there was a large amount of good fiber going as reject. By rebuilding the tertiary screen to a three stage feed-forward screen with intermediate dilution, it was possible to reduce the reject flow from 25 m³/h to below 15 m³/h. After the test period, a dilution was added to the reject to keep the control valve more open and counteract the tendencies to plug. With a reject dilution of 8 m³/h and the flow rate set at 20 m³/h, the actual flow of pulp from the screen is only 12 m³/h.

The mass flow rate of reject from the tertiary screen was decreased from 0.39 to 0.25 bdt/h (see Table 1). The increase in shive content from 35% to 67% resulted in a decrease in the amount of good fiber rejected from Line 3 from 0.26 to 0.08 bdt/h. Thus, almost 4.3 metric tons of good fiber could be saved in every day of production.

A question came up prior to rebuilding the screen and trying to decrease the reject mass flow as to whether or not the shive content of the accept pulp from the primary screens would increase? With several months of mill data regarding the shive content in accept pulp (Fig. 4), the answer is no, it does not increase. Even though the shive content in the accept from the tertiary screen increased from below 1% to over 6%, the cascade coupling of the tertiary stage seems to fulfill the total shive reduction of the screen room.

EVALUATION OF TERTIARY SCREEN			
Kappa production	On-line bdt/h	Tert. screen mapping	Test period (Avg)
		24	25
		1.64	1.44
C _{IN}	%	0.90	0.84
C _{ACC}	%	0.75	0.56
C _{REJ}	%	1.55	1.65
Q _{IN}	m ³ /h	182	172
Q _{ACC}	m ³ /h	157	211
Q _{REJ}	m ³ /h	25	16
Dil. Upper	m ³ /h	-	34
Dil. Lower	m ³ /h	-	20
Dil. Reject	m ³ /h		
dp	kPa	13	20
Shive _{IN}	%	10.3	26.3
Shive _{ACC}	%	0.4	6.6
Shive _{REJ}	%	34.7	67.2
Reduction	%	96.1	75.5
Fiber in reject	bdt/h	0.26	0.08
Reject mass flow	bdt/h	0.39	0.25

Table 1. Data from mapping and test period.

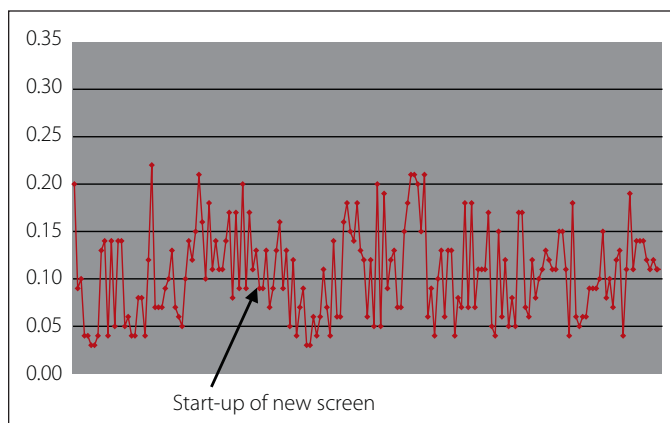


Fig. 5. Shive contents in accept pulp from the primary screens before and after rebuilding of the tertiary screen.

The fact that the screen did not stop due to high motor load or high differential pressure when the reject valve plugged is normally not possible. We came around to testing this phenomenon by actually closing the reject valve by hand and measuring the shives in the accept stream using a PQM-1000 fiber analyzer. After about 30 minutes the shive content in the accept stabilized on a level that was about twice the normal level, but the screen kept running with a slightly increased load and differential pressure. This would not have been possible in a conventional pressurized screen without plugging. By continuously adding dilution to the screening area the thickening is prevented and the free movement of individual particles is maintained. This also shows in that the new screen basket lasted 12 months in a position where the average basket lifetime previously was 6 to 7 months. It should be mentioned that the test with the reject valve closed was aborted after 40 minutes.

CONCLUSION

The findings during this development project show the possibility to replace a common tail screen with a pressure screen utilizing the concept of intermediate dilution. Apart from saving good fiber back to the process in the same way as a tail screen, a pressure screen can be operated with a slotted screen basket that maintains the selectivity of separating sand and other impurities. The decreased flow rate from this position will also render the possibility to maintain the cascade coupling of the screen room. ■

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