Screening of recovered paper stock for the production of graphic papers

The author:
Reimund Rienecker
Stock Preparation

Since graphic papers are bulk grades produced on high-speed machines, operating economics have a high priority. For the higher quality grades, however, additional aspects must be considered. Although primary fibres are still preferred here, a certain content of recovered paper is not a bad idea since it brings advantages on the paper machine. This presents no problems with today's advanced technology for processing recovered paper, but specific criteria must still be met. Only white paper grades should be used and they should have a sufficiently high quality potential, and be available in suitably large quantities. The only reliable source meeting these needs is household collection. Recovered paper is, however, very different from primary fibres. It contains contaminants virtually unknown in primary stock and these can decisively influence production, and the end product itself. The main problem is stickies, which occur wherever recovered paper is used. The following statement is therefore fundamental in the screening of recovered paper: Using recovered paper means having to solve the stickies problem!

Although screening stickies is no easy task due to their inherent characteristics, removal can be facilitated under certain conditions. These include the choice of suitable screens, screen baskets and rotor design (see twogether Journal No. 1 and 4.). However, no measures on their own can guarantee optimum screening, since acceptable stickies removal is not possible with single screening systems or machines. Recovered paper processing therefore consists of several subsystems, of which screening is by far the most important. *Fig. 1* shows a typical recovered paper processing line. **Hole screening** removes problematic contaminants to protect the downstream systems and to make the stock suitable for fine slot screening. Although every effort is made to exploit all potential for optimum stickies removal, stickies removal rates (by number) in hole screening are rather low. An efficiency as high as 50 % for the complete hole screening system would be

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	Pulping	Protector system	MC Screening ø	MC Screening //	Flotation I	HW Cleaning	LW Cleaning	LC Screening //	Disk filter	Press	Dispersion I	Bleaching I	Flotation II	Disk filter	Press	Dispersion II	Bleaching II	Press	Refining	HW Cleaning	LC Screening
Newsprint																					
standard	+	+	+		+	+		+	+	+	+	+	+	+						+	+
improved	+	+	+		+	+		+	+	+	+	+	+	+			+			+	+
SC papers																					
standard	+	+	+	+	+	+		+	+	+	+	+	+	+	+	+	+		+	+	+
improved	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
LWC papers																					
standard	+	+	+	+	+	+		+		+	+	+	+	+			+		+	+	+
improved	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+	+	+

Fig. 1: Schematic arrangement of recovered fibre stock preparation for various graphic paper grades.

Fig. 2: Hole pre-screening in DIP systems. Left: Normal stickies size distribution in the inlet Right: Stickies removal as a function of particle size.

Fig. 3: Comparison of stickies removal with various screening system concepts.

an extremely good result. Screening efficiency is critically dependent on various factors, above all on the stickies size distribution *(Fig. 2)*. On the left-hand side, a typical stickies distribution according to size shows that the stickies count increases asymptotically with reducing particle size, a trend which extends beyond the measurability limit. This indicates that many stickies pass through the relatively large screen holes, and also cannot be detected by conventional laboratory measuring methods. It is therefore difficult to make an objective assessment. The right-hand side of the graph summarizes the average stickies removal efficiencies of several screening systems (all with a hole diameter of 1.4 mm) as a function of stickies size. Removal efficiency falls off to a minimum of 10 to 30 % as particle size reduces to about 750 µm, and it remains constant until the measuring limit of 150 µm is reached. Efficiencies of over 70 % therefore cannot be expected, since most stickies are below 600 to 700 µm in size. It is therefore advisable not to demand too high a removal efficiency, since this just leads to reducing the stickies size below the measuring limit rather than removing them. This apparent good efficiency provides enviable removal rates but only makes things more difficult for the downstream systems. The next process stage is usually **slotted screening**.

Reducing slot size means more and more fine sand is retained. This is virtually impossible to remove in the MC range and leads to increased system wear. Stickies removal is also more difficult in the MC range (see twogether Journal No. 4). The usual practice in modern plants is to

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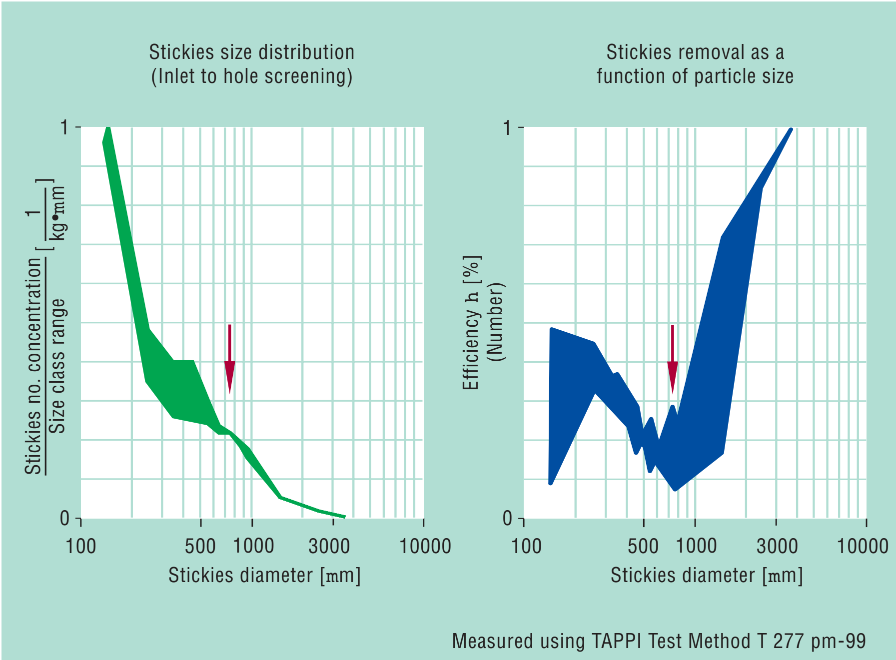

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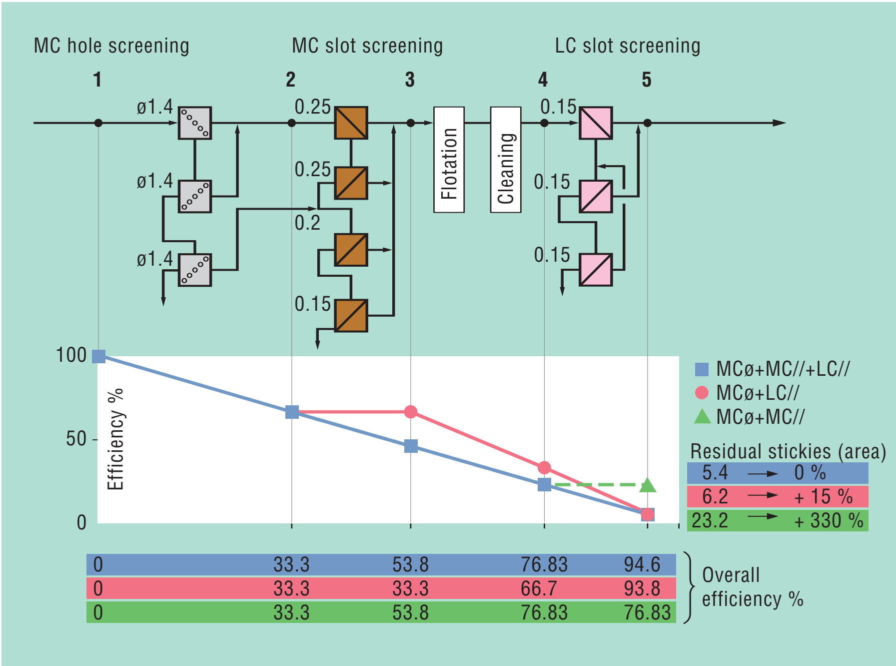

Fig. 4: Scale size comparison of fibres and shives from wood-containing DIP stock with the cross-section of a 0.1 mm C-bar® slotted screen basket.

Fig. 5: Effect of slot width changes on system operating reliability in a DIP fine screening system.

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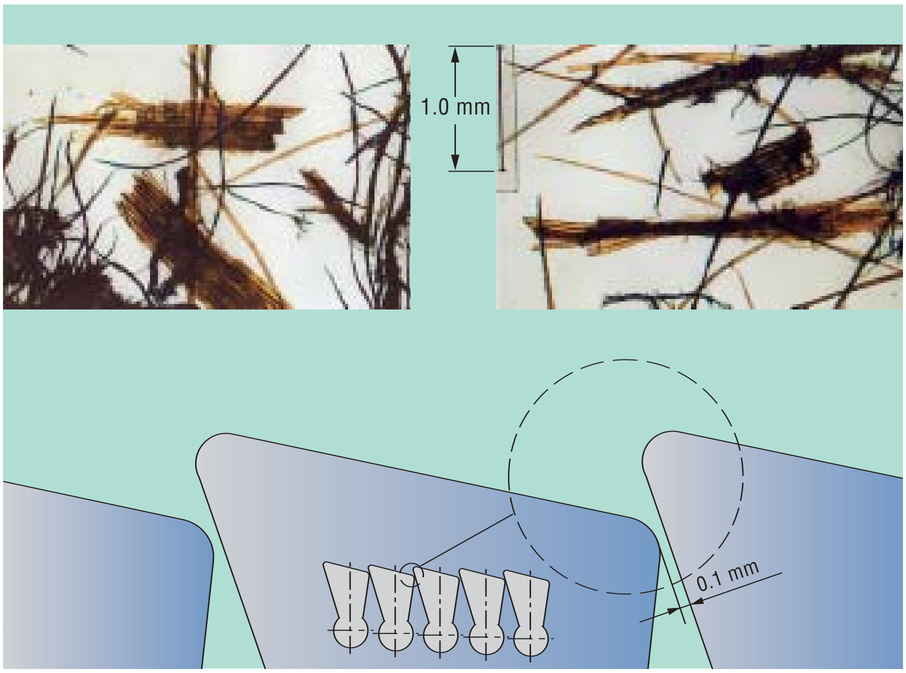

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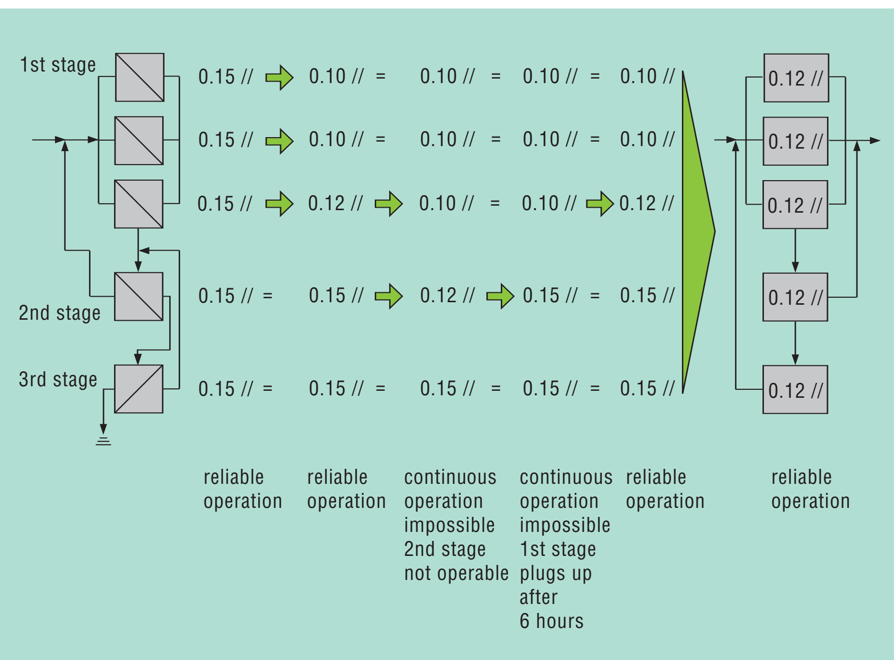

install LC cleaning after deinking and this is then followed by fine slot screening with today's standard slot width of 0.15 mm, although the trend is towards even finer slot widths.

Voith Sulzer had the rare chance of examining various screening systems in a DIP line (schematic arrangement shown in *Fig. 3*) for graphic papers made from 100 % recovered paper. Their direct influence on paper machine runnability was assessed. The system was originally operated exclusively with MC hole and slotted screening. An LC slotted screening stage was added at a later date. Stickies removal then improved from 76.8 % to an overall system screening efficiency of 94.6 %, and sheet breaks on the paper machine were reduced from about three per day to only about one in six weeks. This drastic improvement underlines the need for a well-designed and sensibly operated LC slotted screening stage.

How far can slot widths be reduced?

Today, slot widths of 0.15 mm are standard practice, but particularly for improved qualities, requirements are much more demanding and the trend is therefore towards even finer slots. Here there are limits. *Fig. 4* shows a cross-section through a C-bar® basket with a slot width of 0.1 mm, and on the same scale, fibres and shives from a deinking line for processing wood-containing recovered paper grades. Clearly, even normal TMP fibres or fibre bundles can only pass through such fine slots when they are forced through. This means accepting either large rejects quantities and/or a reduction

Fig. 6: Scale size comparison of scanning electron microscope photographs of calendered paper made from various furnishes with the cross-section of a 0.1 mm C-bar® slotted screen basket.

Fig. 7: Comparison of standard and A/B screening concept (single stage).

Fig. 8: Comparison of 3-stage forward-flow concepts with different stickies size distributions. System A: Standard arrangement with simple screening in all three stages. System B: First stage with simple screening, second and third stages with A/B arrangement.

in stickies size. The tolerance between required efficiency and operating reliability is very narrow with fine slots, particularly on wood-containing grades, as shown in the following mill example.

A fine screening system *(Fig. 5)* consisting of five machines in three stages, originally with 0.15 mm slot widths (system on the left), was systematically converted to finer slots. One can easily see how even the slightest modifications can heavily influence operating reliability of the overall screening system. In the meantime, this plant has now been completely fitted with 0.12 mm slotted baskets and some changes have also been made in the loop layout as well. This arrangement also operates completely trouble-free like the arrangement before it. Although these measures increased slot velocity, the measurable number of stickies has been reduced by 32 %, and the stickies area by 51 %. With wood-free furnishes, the use of ultra-fine slots is less critical. This is illustrated in a DIP line for wood-free copy paper production, where a complete fine screening system has been installed. All screen baskets have 0.10 mm slots. This four-stage system with the first two stages arranged for forward flow is extremely effective and has been in trouble-free operation for several years.

SC and LWC papers

SC papers require the highest possible surface quality, in particular smoothness. Prerequisite for high surface quality is a fine-grade stock, free of shives and fibre bundles. If recovered fibres are used,

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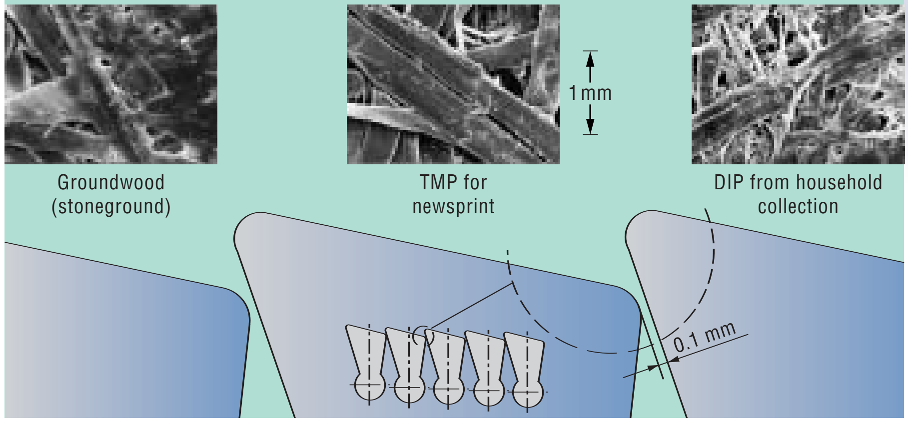

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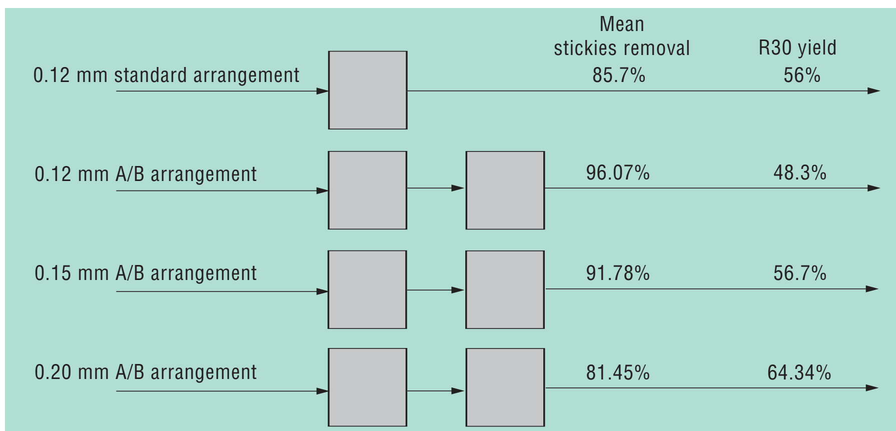

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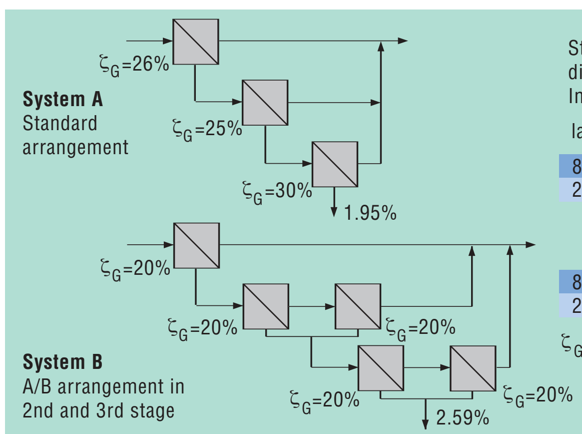

	Stickies distribution Inlet to 1st stage: large	small	Overall stickies removal	Overall rejects removal
System A	80%	20%	78%	1.95%
System A	20%	80%	70%	1.95%
System B	80%	20%	81%	2.59%
System B	20%	80%	80%	2.59%

ζ_G = reject rate by mass

problems may arise due to the contaminant content. For this reason, today's recycled fibre content hardly ever exceeds 30 % for top quality grades. With LWC grades, these requirements are not quite so extreme. On the one hand, the R14 fraction should not exceed certain limits due to the risk of fibre rising when the sheet is re-wetted during coating. On the other hand, R30 fibres are desirable for strength reasons. This situation is best illustrated by the comparison in *Fig. 6* which shows a cross-section through a 0.1 mm C-bar® screen basket and same scale microphotographs of calendered lab sheets made from various stocks. Clearly, the TMP fibre size in particular can greatly exceed the slot width. Such fibres have little chance of passing through such fine slots without considerable help.

Although such fine slots have a favourable influence on stickies removal – and manufacturing C-bar® baskets with slots under 0.1 mm is no problem today – slot widths do have their natural limit. This limit is determined by a practical compromise between throughput and acceptable conditions. Narrow slots alone are no general cure for stickies problems. Another possibility is the A/B arrangement.

A/B arrangement for improving efficiency

An A/B arrangement consists of two or more screens in series, where accepts from the first machine A are screened again in machine B. Stickies removal efficiencies and R30 yields with standard and A/B arrangements are compared in the following for various slot widths *(Fig. 7)*. Individual efficiency values for each size class are used instead of overall average efficiency values. An overall rejects rate of 25 % is assumed, i.e. 15 % in the A stage and 12 % in the B stage of an A/B arrangement.

For the single screen with 0.12 mm slot width, mill data reveals an average stickies removal efficiency of 85.7 % with an R30 yield of 56 %. In the second case, the A/B arrangement with 0.12 mm slot widths increases the stickies removal efficiency to 96 % and reduces R30 yield to 48 %. The third example shows a stickies removal efficiency of almost 92 % with the A/B arrangement and 0.15 mm slot widths. The R30 yield here is around 56 %. In other words, we have a significantly higher stickies removal efficiency than with the single machine, yet roughly the same R30 yield. If the A/B slot width is increased to 0.20 mm, the average stickies removal efficiency is 81.5 % with an R30 yield of 64 %. These examples show that even with a larger slot width of, for instance, 0,15 mm, the stickies removal efficiency can be significantly increased for the same long-fibre yield.

In another example the effect of the above arrangement variants when using several stages was investigated. Removal efficiency is based here on two stickies size classes. To calculate the overall stickies removal efficiency in each case, a higher efficiency is taken for the large particles and a lower efficiency for the smaller ones. This method was used for comparing two 3-stage screening systems *(Fig. 8)*. System "A" consists of "simple screening" with only an "A" machine in each stage, while system "B" has an A/B layout in the second and third stages. Both systems were computed twice, using different stickies size compositions each time: in the first case 80 % large and 20 % small stickies, and in the second case vice-versa. In system A, 26 % rejects were assumed in the first stage, 25 % in the second stage and 30 % in the third stage. This gives an overall substance loss of 1.95 %. In system B, 20 % rejects were assumed for all stages, the resultant substance loss being 2.59 %. With a stickies size distribution of 80 % large and 20 % small, system A has a stickies removal efficiency of 78 % compared with 81 % for system B. These examples show that with an above-average proportion of large stickies, the influence of system arrangement on stickies removal efficiency is only slight. But with a predominant proportion of small stickies, the picture is completely different. In this case removal efficiency in system A falls steeply from 78 to 70 %, while in system B it falls only by one percent from 81 to 80 %.

In other words, an A/B arrangement provides a high removal efficiency even if a large number of smaller particles are present, and, above all the arrangement ensures a high quality consistency. This is therefore a good way to attain optimum removal efficiencies.

For further details, please refer to Voith Sulzer Stock Preparation brochure st.SD.05.0004.GB.01