Slotted headbox screening for fine, publication, and newsprint grades

Oliver Heise

In a paper mill not using secondary fiber and experiencing in-house or virgin pulp contamination, managers can analyze their headbox screening systems before considering a broke or thick-stock screening system.

A papermaker is concerned with three main issues with respect to a headbox screen. In order of importance, they are:

1. Pulsation amplitude
2. Deflocculation
3. Screening.

Screening efficiency has become as important as pulsation amplitude in relieving fine contamination. Fine contaminants are any small plastic particles that impair any paper machine, calendering, or coating operation.

Let's review the traditional headbox screening concept and how it works. A typical system is diagrammed in **Fig. 1**.

Traditional headbox screens have baskets with conically drilled holes. In the final screening stage, vibration screens are used. These vibration screens often have plates with holes that do not match the holes in previous stages.

Fine plastic contaminants can pass through these holes. **Figure 2** shows typical contaminants screened out by a traditional headbox screening system, while **Fig. 3** shows small contaminants screened out by a low-pulse, slotted headbox screening system.

Typical sources of contamination

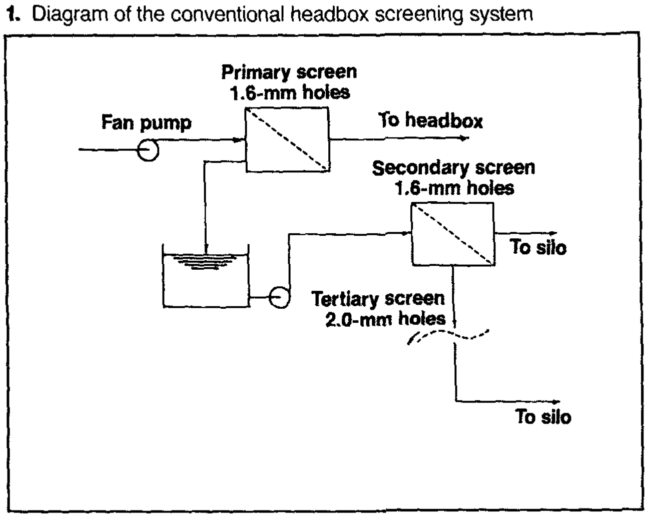
Virgin pulp contamination

During shipping and trucking of market pulp, there is always the danger of virgin pulp contamination. Shipping instructions and cellophane windows from envelopes can get into the furnish pulper.

Virgin pulp contamination can start from chip piles exposed to airborne plastic contamination. This contamination can get past the kraft pulping processes. As market pulp is shipped all over the world this plastic contamination travels from North American chip piles to European coater blades.

Heise is a product specialist with Voith, Inc. in Appleton, Wis. 54915.

1. Diagram of the conventional headbox screening system



In-house contamination

In-house contaminants are defined as those which reach the paper machine through the broke system. In-house contamination occurs because, as **Fig. 4** shows, the broke system in effect connects the converting or finishing room to the pulper. Consequently, the hot melts and stretch wrap used in the finishing and converting operation are part of any broke.

Humans can also add such contaminants as work gloves, ear plugs, candy wrappers, and coffee stirrers. These are usually found after paper machine shutdown.

Another contaminant is duct tape that is used prior to splicing on the paper machine carry-through rope. This tape can fall onto conveyors or into pulpers under the machine. A major source of contamination comes from customer's rejected paper rolls, comprised of virgin pulp. Not all customers use repulpable tape.

Operational problem areas

Coating and pigmenting

The most sensitive area where contaminants can cause operational problems is the coating operation. Whether

2. Typical contaminants screened out by a traditional headbox screening system

3. Small contaminants screened out by a low-pulse, slotted headbox screening system

running an on-machine or off-machine coater, streaks and breaks can occur if the coater blade is not absolutely clean. Any contaminant in the basesheet ends up at the coater blade.

To understand the high standards of cleanliness which are applied to a blade, one should note that coater manufacturers have a sophisticated filter system for the coater return lines. These systems are fine-tuned to even pick up loose fibers.

Though pigmenting with a size press is less sensitive toward contamination, an embedded contaminant can cause streaks if off-machine coating takes place. If the sheet in a size press is exposed to hydraulic forces, it can be torn apart if wet holes exist. Wet holes are caused by contaminants sticking to dryer cans and felts.

Calendering

Supercalendering and soft-nip calendering

Contaminants in the sheet can dent the synthetic roll covers of supercalenders and soft-nip calenders as much as 5/1000 of an inch. A dented roll cover can cause ringers in the finished sheet, which results in the synthetic cover needing to be reground.

Newsprint mills report that contaminants can also cause "calendering-cutting," breaks caused by shives.

Fine paper mills running on-line machine calenders also report breaks caused by contaminants. These mills also encounter sticky contaminants like duct tape particles on steel rolls, and these particles can pick up clay.

Winder slitters and printing presses

Papermakers at newsprint mills are mainly concerned about shives causing breaks at the winder slitters and, later, in the high-speed printing presses.

Solutions to virgin pulp and in-house contamination

Statistical screening efficiency

For many mills, a first, easy step to alleviate virgin and in-house contaminants is through improved housekeeping. But, if a converting or finishing operation is an integral part of the mill, this alone cannot solve the problem.

If broke contamination is identified as the main problem, the use of fine-slotted screens will minimize any contamination. However, such a screening system will not catch the whole stock flow to the paper machine[1]. A good example of a broke screening system is shown in **Fig. 5.**

A thick-stock screening system using fine-slotted screens between the blender and machine chest ensures that all the stock is screened. However, this approach requires a second screening system in addition to the one in the approach flow, as **Fig. 6** shows. Mill managers will have to consider the additional installation and operating costs.

Is it feasible to install a high-efficiency headbox screening system?

A headbox screening system is a cascade screening system. The accepts of secondary and tertiary stages go, via silo and fan pulp, through the primary screen again. For such a three-stage cascade screening system, the statistical screening efficiency E for the module is defined as:

$$E_M = (100 \times E_1E_2E_3)/(1 - E_1 + E_1E_2E_3) \quad (1)$$

Let's review how various systems are affected by contamination. We'll assume the following E numbers applied to four cases.

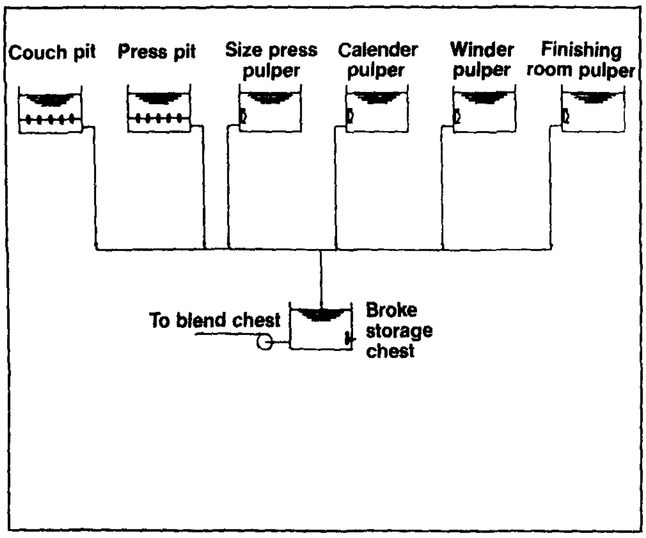
Case No. 1:

a typical headbox screening system with holes and tailing vibration screen.

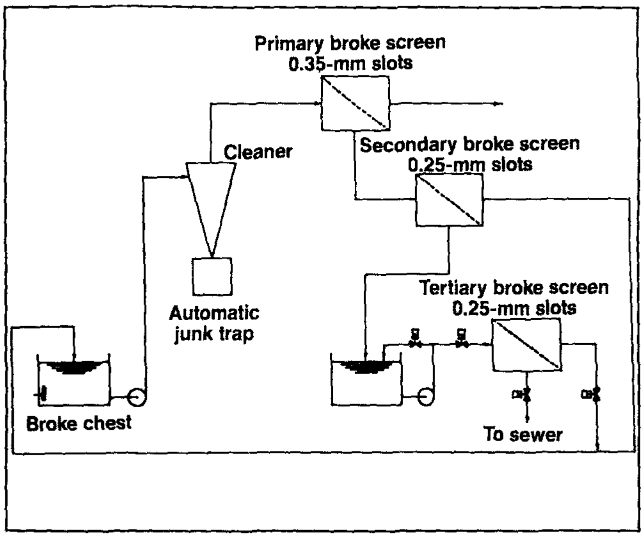
Let us assume that E_1 = 40% (1.6-2.0-mm holes, 5-8% by volume reject flow), E_2 = 40%, and E_3 = 25% (vibration screen, 2.4-mm-holes). Using our equation, the overall efficiency for the module would be 6%.

[1]Heise, O., Pulp and Paper, 62(2): 117(1989).

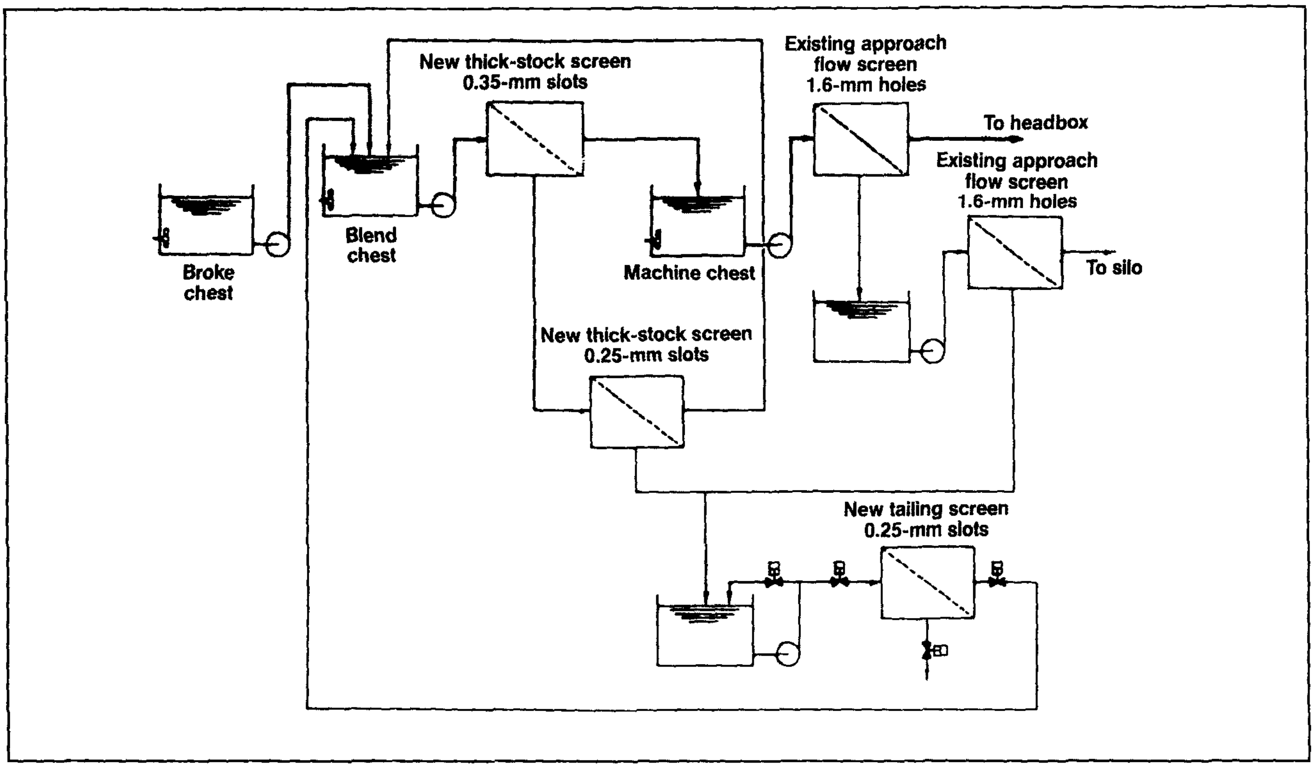
4. Sources of broke contamination



5. Fine slotted broke screening system



6. Thick-stock screening system



Case No. 2:
a secondary and tertiary screen with fine slots.

Let us assume that E_1 = 40%, E_2 = 80% (0.25-0.4-mm slots), and E_3 = 80% (0.25-0.4-mm slots). In this case, the statistical efficiency would be E_M = 30%.

Case No. 3:
an increase in rejects flow from the primary screen.

Let us assume that E_1 = 50% (10-15% rejects flow), E_2 = 80%, and E_3 = 80%. The module's efficiency E_M = 39%

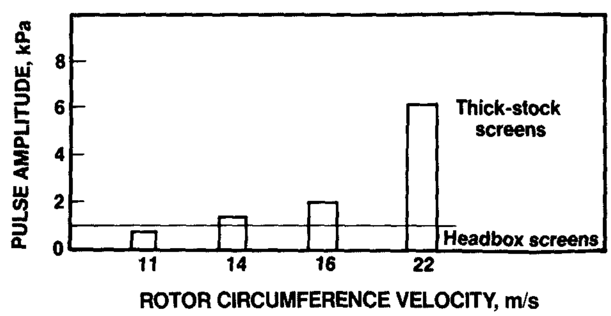
Case No. 4:
fine slots (0.25-0.4 mm in all three stages).

Let us assume that E_1 = 80%, E_2 = 80%, and E_3 = 80%. The overall efficiency would be 72%.

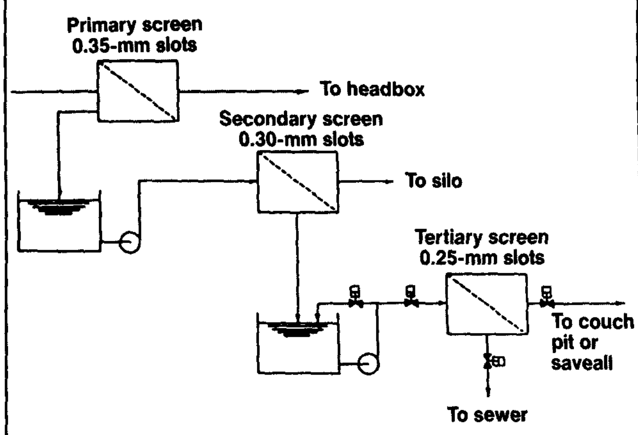
Case No. 1 is not the worst one ever encountered. Headbox screens with the reject valve closed or rejecting back into the approach flow system are not uncommon. Despite significant contamination, there are mills that still run their headbox screens inefficiently.

Case No. 2 and Case No. 3 reveal that improving the

7. Thick-stock screen pulse amplitudes, with pulses measured in the accepts pipe from the screen



8. Fine-slotted, low-pulse headbox screening system



second and tertiary stages increases system efficiency by a factor of 5-6. Although these numbers are relatively low, fine and newsprint mills can help reduce quality problems and breaks by improving their reject screens.

Case No. 4 has to be considered for a coated paper machine.

Utilizing low-pulse design

The screening efficiency of a pressure screen is not only a function of the slot or hole size in the basket. The rotor design and its circumference velocity have a direct impact on the screening efficiency.

In headbox screen systems, the low-pulse rotor design is based on an increased foil frequency. To further minimize the pulse amplitude, relatively low velocities at the rotor circumference are required.

Thick-stock screens use extremely high-pulse rotors with rotor velocities in excess of any headbox screen to fluidize the stock, as shown in **Fig. 7**. To optimize screening efficiency numbers, the low-pulse design has a definite advantage over high pulse design (**Fig. 8**).

Mill experience

Let's review some hypothetical scenarios for contaminant problems and examine the probable solutions. (These scenarios are based on actual experiences.)

Newsprint machine

A newsprint mill experiences "calender-cutting" and breaks at the winder slitter. The printer complains about excessive breaks in the printing press. After analyzing the problem, the mill manager concludes that shives from the TMP fiber content are causing all three problems.

To find a solution that would fit the budget, the manager decides to install a pressure screen with fine slots in the quaternary position of the existing approach flow. This screen is used to screen not only the tertiary screen accepts but also the last-stage cleaner rejects, which were sewered before. With this installation, the printing press breaks are reduced by 30%, and the mill saves 1 lb of fiber per 30-lb sheet. This savings represents a fiber savings of 3% of total production.

I. The impact of using a fine-slotted, low-pulse headbox screening system.

	Base case	*After improved house-keeping*	*After installation of pressure screens*
Breaks per week	100%	75%	45%
Cleanup time	100%	80%	15%
Wet-end breaks	100%	90%	50%

Using a bill blade on a coated paper machine.

Coated paper machine

Suppose a coated paper machine has bill blade streaks and breaks caused by a high level of in-house contamination. A contaminant awareness program is started to improve housekeeping. In addition, the second-stage headbox screen rejects are sewered. These actions reduce the breaks by 25%, as shown in **Table I**.

However, this reduction is still 35% higher than what is accepted with bill blade breaks. The mill then rejects the installation of a thick-stock screening or broke system because of the additional installation and operation costs.

So, the holed pressure screen baskets in the primary and secondary screens are replaced by fine-slotted ones. The existing tertiary vibration screen is also replaced by a fine-slotted pressure screen. Bill blade breaks drop an additional 30%. This improvement is significant because the mill reports that 90% of all current bill blade breaks are not related to contaminants.

The bill blade wash-up time per week is reduced by 75% after the successful startup of the slotted headbox screens. The wash-up time falls to below the typical cleanup times for the bill blade.

The wet-end breaks are reduced by 50%. With the pressure screen in the tertiary position and running through a wash cycle, fiber loss is reduced to zero.

Conclusions

In a paper mill not using secondary fiber and experiencing in-house or virgin pulp contamination, managers can analyze their headbox screening systems before considering a broke or thick-stock screening system.

In fine and newsprint mills, papermakers can sufficiently improve their screening needs by modifying the second and tertiary screen positions. In a mill manufacturing coated paper, the manager can seriously consider a fine-slotted headbox screening system that saves operational and installation costs of an additional screening system. A thick-stock or broke system is technically appropriate only if the headbox screening system cannot be modified.

The day will come when secondary fiber can be used in a coated paper basesheet. This innovation will require the design of the next generation of headbox screening systems. These systems will have extremely low pulsation amplitudes and will be even more efficient in removing debris.□

Received for review Jan. 9, 1990.

Accepted Jan. 11, 1990.

Presented at the TAPPI 1990 Papermakers Conference.