Reciprocating blade screen for improved chip-thickness screening

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ABSTRACT: Further advancement has been made in the technology to screen overthick chips. A design using thin blades held under tension implements the oscillating-bar screen concept in an improved manner and yields very good performance with high capacity.

KEYWORDS: Blades, chip dimensions, prototypes, reciprocating equipment, screening, screens, thickness, yield.

During the last half of the 1980s, a large number of kraft pulp mills installed chip-thickness screening systems to take advantage of the well-documented process improvements arising from the reduced levels of overthick chips sent to the digesters. The great majority of these systems utilized a disk screen of some type as the principal device for screening out the overthick chips that needed to be resliced. After several years of operation, problems became apparent at many mills.

Several complicated and expensive fabrication procedures were developed to achieve the desired accuracy of the interface openings. Despite these efforts, the precision levels achieved at startup were reduced significantly after a relatively short period of operation. The difficulty of holding the numerous disks spaced precisely on each shaft, as well as the difficulty of holding adjacent shafts in alignment with each other, contributed to the observed declines in precision. These declines, along with the wear of individual disk teeth from the aggressive disk action, led directly to significant reductions in the performance of the disk screens. Systems that had started out in the 80–90% efficiency range for removal of overthick chips had declined to 40–50% or less. For example, **Fig. 1** shows the performance decline at one Weyerhaeuser mill over the first three years of operation.

Operational and maintenance problems were also encountered. At some locations, there were serious mechanical problems, such as disk shaft breakage. Many installations experienced shaft bearing failures and high maintenance for drive chains in oil baths. These leaked oil out and let chip fines in, contaminating the oil and frequently leading to bearing failure.

These performance and maintenance problems led to a growing dissatisfaction with disk screens, prompting several manufacturers to develop more suitable chip-thickness screening devices that could avoid these shortcomings. Many of these efforts were based on the idea that a set of parallel bars would create uniform, near-perfect slots that should be easier to construct and maintain than disk screens. Some of these efforts have been made public via attempts at commercialization (*1–3*), while others were only tested in manufacturers' shops and never released on the market.

Each of these efforts was plagued by one principal difficulty—that of chips plugging the slots and rapidly reducing the screening capacity to unacceptable levels. While a number of these screen designs used some relative motion between adjacent bars to help minimize plugging, each had essentially only a linear relative motion, which proved to be inadequate.

After some study at Weyerhaeuser, we became convinced that plugging could be avoided if the motion between each adjacent bar had both vertical and horizontal components. The simplest implementation of this was considered to be for each adjacent bar to be driven in a circular, rotational, reciprocating path, as illustrated in **Fig. 2.** It was discovered that this was not a new concept, having been disclosed in Sweden earlier in this century (*4*) but, to our knowledge, never commercially implemented until recently (*5*).

*For overthick screening, performance can be described as the maximization of the difference between high overthick removal efficiency and low accept-chip carryover. This is referred to as the screen-performance index value (*7*).

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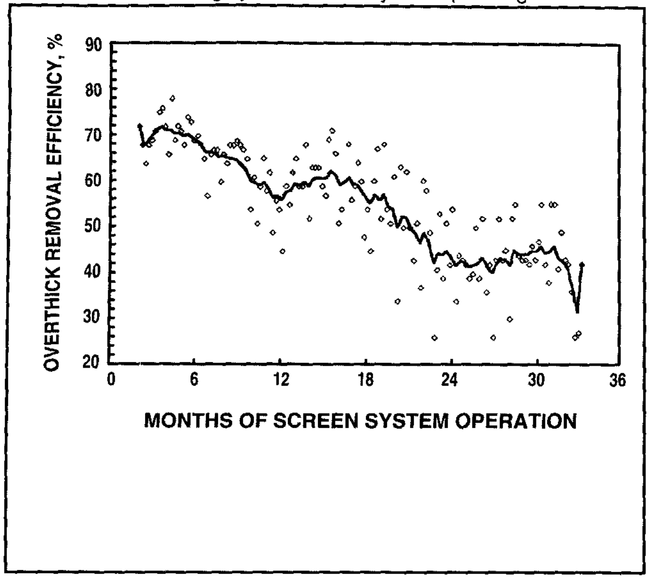
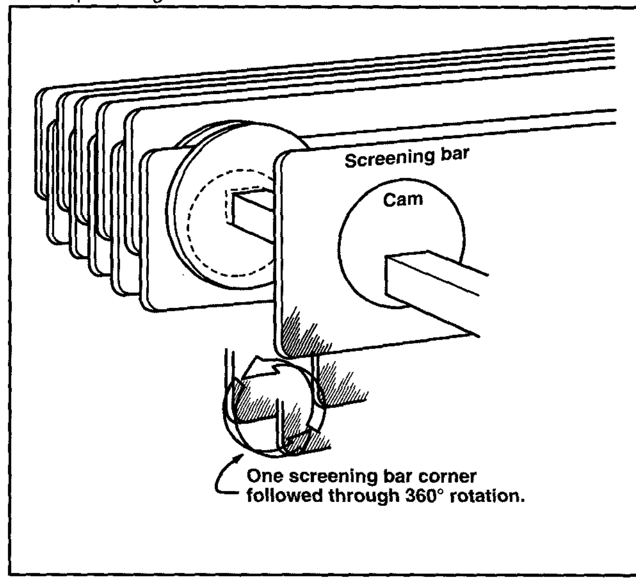
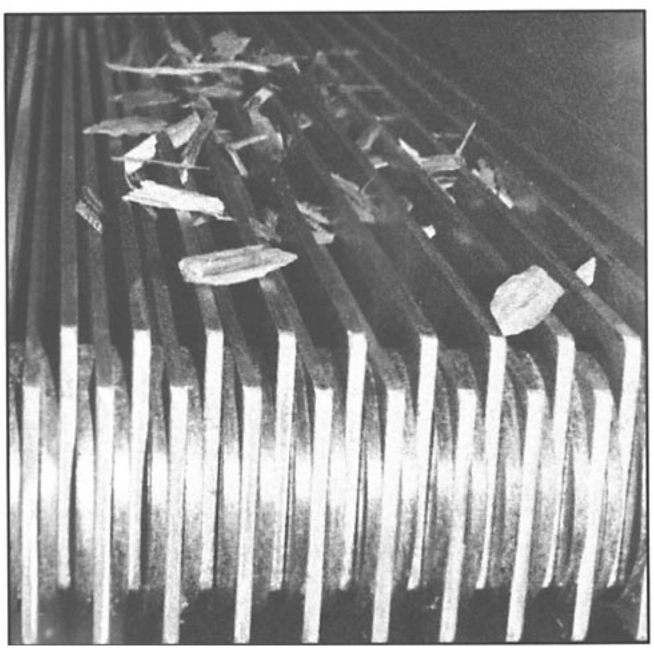
1. Decline in screening system efficiency with operating time



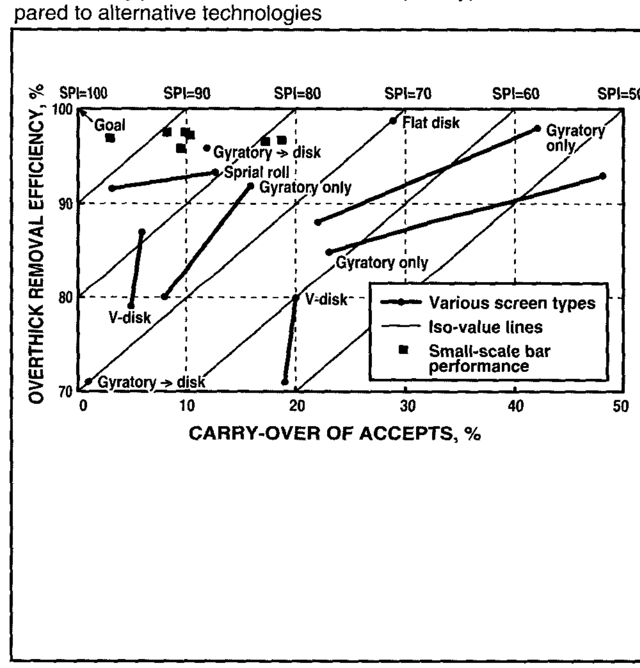
2. Reciprocating bar screen motion



3. Weyerhaeuser small-scale prototype bar screen



4. Screening performance of small-scale prototype bar screen compared to alternative technologies

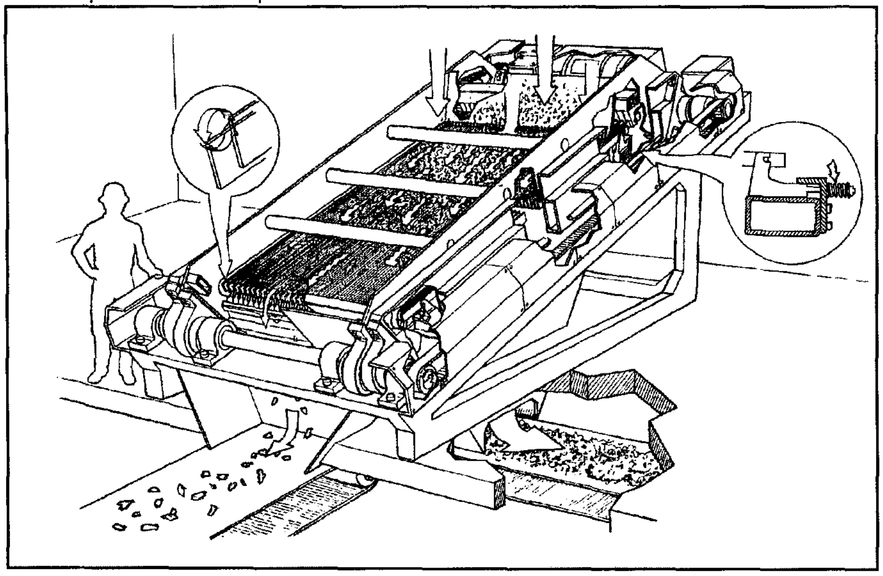


Development of small-scale prototype screen

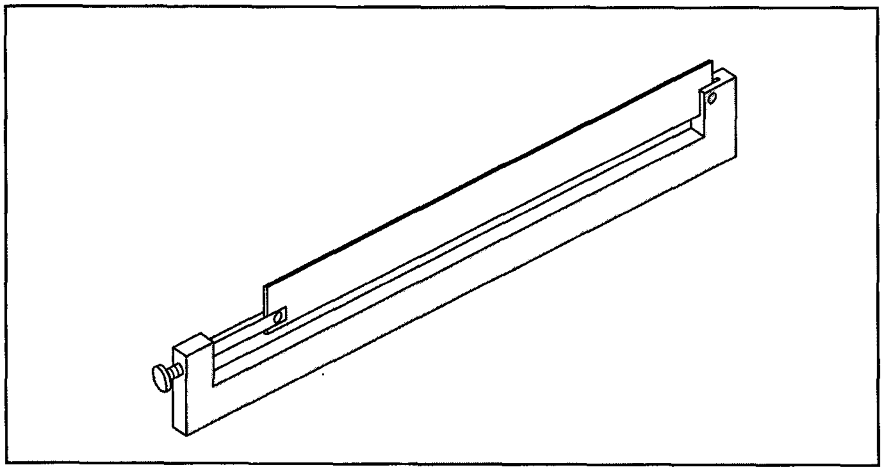
In the late 1980s, we decided to investigate the concept of a reciprocating bar screen. A small-scale prototype bar screen, approximately 1.5-ft wide and 4-ft long, was constructed. The prototype is illustrated in **Fig. 3**. Extensive testing was performed (*6*), and the initial results were very encouraging. The results demonstrated that it was relatively easy, compared with disk screens, to obtain very high slot-opening precision levels, leading to very high screening performance.*

The prototype bar screen had a high screen-performance index compared with other available thickness-screening technology (**Fig. 4**), achieving both high overthick removal efficiency and, simultaneously, low accept-chip carryover. In addition, the highly precise slot openings allowed the slot opening to be sized much closer to the desired chip-thickness cut point, so that a screen to remove 8-mm overthick chips could be built with slot openings of 8 mm, rather than the reduced opening (e.g., 6.5 mm) that is commonly

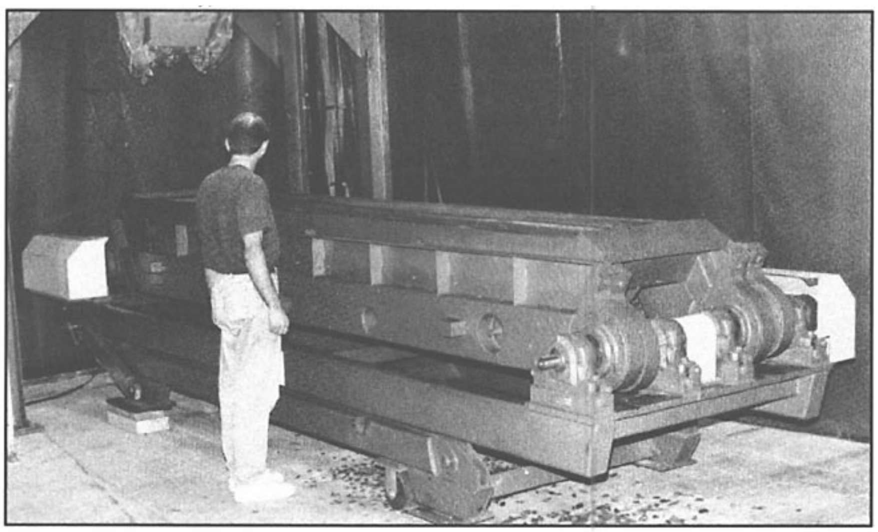
5. Conceptual mill-scale implementation of bar screen



6. Tensioning concept for thin blade-type bar screen



7. Pilot-scale blade-type bar screen



used on disk screens to keep the removal efficiency high. The larger slots give the bar screen greater capacity per unit of screen area, since more of the accept chips, which constitute the bulk of the feed, pass through the screen more quickly.

The experiences with the small-scale prototype also led us to believe that, in addition to performance and capacity advantages, there could be significant fabrication and operational advantages. The bars were easier to manufacture than the disk-screen structures that had become necessary to achieve the desired levels of accuracy. In addition, there were a number of simple methods available for invoking the desired screening motion, and the bars were relatively inexpensive and easily replaceable.

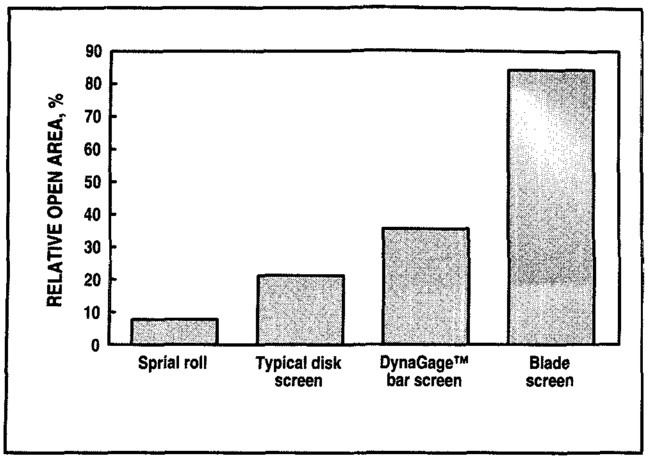
Tensioned-blade concept

Once we demonstrated that the basic concept of bar screening had significant promise, we began the process of up-scaling to a mill-scale design. A significant obstacle was the difficulty of maintaining slot accuracy over the entire span of the long bars required in a mill-scale screen (**Fig. 5**). Increasing the bar thickness to obtain the needed rigidity over longer spans meant there was more bar material. With constant-width slot openings, this meant that the relative percentage of the total screen area available for accept-chip passage was diminished. It also increased the total mass of the screen and the power needed to drive it.

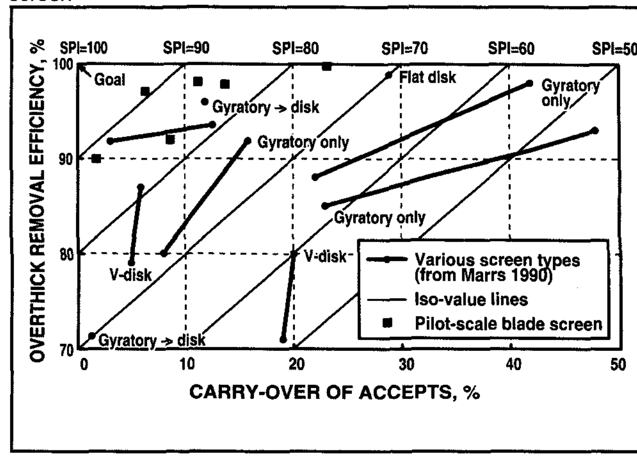
To solve these problems, a breakthrough concept was derived from another process where very straight, accurate elements of minimum width are required—the sawing of wood. It is very common to achieve a straight, thin element by using a thin, flexible blade held in the desired path by tension, as in a hacksaw (**Fig. 6**).

A joint development program was undertaken with a screening equipment manufacturer, and this concept led to the design and construction of a pilot-scale thickness screen that utilizes thin bars, or blades, spring-loaded

8. Relative percentage open area for different screen types



9. Screening performance comparison of pilot-scale tensioned blade screen



with just sufficient tension to keep them in the desired accurate, straight position during the screening operation.

Using this configuration it has been possible to construct a blade screen in which the blades span 10 ft, yet are only about 1.5-mm thick (**Fig. 7**). This leads to greatly reduced mass of material in the screening blades compared with the thick bars, and additionally gives a very dramatic increase in the percentage of the screen surface that is open to accept-chip passage.

Figure 8 shows that the disk screens used for separation of overthick chips typically have less than 25% of their screen surface area open for the passage of chips. The other commercially available bar screens have less than 35% open area. In contrast, the tensioned thin-blade screen has as much as 85% open area. Since typically 80–90% of the feed chips are acceptable in size and *should* pass through the screen, this huge increase in the percentage of open area significantly increases the capacity of the blade screen.

This design also has a construction that allows very simple maintenance, since all components are easily accessible and simple to replace. This should lead to substantially reduced operation and maintenance costs.

Summary

After extensive testing on a pilot-scale screen, we have refined the operational conditions to provide high screening performance (**Fig. 9**) and capacity, all in a simple, reliable, low-maintenance design. After considering all currently available chip-thickness screening alternatives, one of our mills has selected this design for implementation. The screen will start production in mid-1993.

Literature cited

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