Executive Summary

The introduction of the fine-slotted wedge wire screen basket has been a significant advance in machine screening technology. With conventional wedge wire designs, the very narrow slot size leads to a rapidly increasing pressure drop over the screen basket and a corresponding increase in pumping energy required to counteract the restriction in screening capacity. This paper describes a new laminar design wedge wire developed to reduce the pressure drop over the screen, providing high screening efficiency, reduced stringing and excellent runnability. Several examples will demonstrate savings from reduced energy.
Mill experience with an energy saving laminar design screen basket in the paper machine approach system

The introduction of the fine-slotted wedge wire screen basket has been a significant advance in machine screening technology. Wedge wire baskets doubled the open area compared to conventional milled screen baskets, increasing screening efficiency while enhancing screened pulp properties.

Depending on the amount of impurities and flocs in the paper machine approach flow, ultra narrow slots are needed to guarantee the accept pulp quality. But screening with narrow slots is a challenge. With conventional wedge wire designs, the very narrow slot size leads to a rapidly increasing pressure drop over the screen basket and a corresponding increase in pumping energy required to counteract the restriction in screening capacity.

A new laminar design wedge wire has been developed to reduce the pressure drop over the screen, providing high screening efficiency, reduced stringing and excellent runnability.

The remainder of this paper describes how Computational Fluid Dynamics (CFD) simulations have been used to optimize flow at the screen boundary layer and reduce flow resistance in the accept channel, lessening thickening and thereby the load on the screen. Several examples from machine screening are discussed, where considerable savings have been achieved from the reduced energy needed for the headbox feed pump to achieve the same headbox pressure compared to conventional screening technology.

Introduction

With advances in basket design improving rigidity, wire widths have been reduced and as the amount of impurities among the incoming stock has increased, ultra narrow slots are needed to guarantee the accept pulp quality. Screening with thin wires and narrow slots is a challenge. Especially in high consistency applications, conventional wire design with very narrow slot size leads to a rapidly increasing pressure drop over the screen basket and thus to considerable restrictions in the screening capacity.

Many mills around the world also suffer from stringing or spinning on the accept side of the screen when conventional wires combined with narrow slots are used (Figure 1).

Computational Fluid Dynamics (CFD) simulations with different wedge wire types have established that the wire shape and especially turbulence in the accept channel affect screening efficiency even more than understood earlier.

Valmet has determined that optimizing the flow at the screen boundary layer and reducing flow resistance through the slots and following the accept channel contribute to less thickening and the load on the screen. The resultant decrease in pressure drop across the screen reduces the energy needed for the headbox feed pump to achieve the same headbox pressure compared to conventional screening technology.

Figure 1. Stringing or spinning can be a common problem with conventional wire screens.
Initial Studies
The starting point for this project was to collect information from existing screen basket wires which are used worldwide and, with CFD technology, determine the effects of accept channel turbulence on screening efficiency. By using CFD simulations we were able to simulate the flow on the surface of the screen basket wire and understand how the flow behaves at the accept channel (Figure 2).

We will be using the word 'turbulence', but in reality the flow is not turbulent, it is laminar - a flow condition in which local speed and pressure change unpredictably as an average flow is maintained. With many wire shapes, high turbulence in the accept channel after narrow slots lowers capacity due to increased pressure drop over the basket and also tends to create strings.

As a result of the CFD simulations with different wedge wire types, we experimented with different wire shapes and dimensions to gain a smooth, non-turbulent and streamlined flow through the accept channel between adjacent wires. The main idea of the new wire shape is to remarkably reduce the unfavorable backflow vorticity at the accept channel side right after the narrow slot. The smooth, backward-opening shape of the accept channel with gradually changing opening angle (patented) has minimized backflow vorticity even at higher slot velocities (Figure 3).

Decreasing accept channel backflow leads to decreasing pressure drop over the screen basket and reduced stringing, especially at higher slot velocities (Figure 4). Backflow is 0% when pulp is flowing directly from the slot to the exit of the accept channel, 100% when the pulp / flow makes one round in the accept channel before exiting and 200% when the pulp / flow makes two rounds in the accept channel before exiting. The thickening factor is less and thereby the load exerted on the screen is reduced. The laminar flow also contributes to a longer basket life.

The laminar flow pattern in the accept channel after the slot ensures outstanding runnability without fiber blockage or stringing. Compare the improvement in

![Rotation direction of foils](Figure 2. Using CFD simulations, high turbulence is seen in the accept channel with various wire shapes.)

![Rotation direction of foils](Figure 3. The new laminar design wire minimizes backflow vorticity.)

![Pressure Drop vs. Passing Speed Through Slots](Figure 4. The laminar design decreases the pressure drop over the screen basket, even at higher slot velocities. Mill-scale pilot trials showed a possible 35% energy saving with higher slot speeds, i.e. higher production speed.)
accept channel shown in Figure 3 with conventional wire examples shown in Figure 2.

In addition to the streamlined flow through the backward-opening accept channel, extra attention is paid to the feed side profile of the new wire. With the same profile height and foil speed (i.e. energy), a thicker strain layer with more efficient micro turbulence and fluidization of the pulp on the basket surface is obtained by using the new laminar design wire (Figure 5).

Despite the higher capacity, an advanced strain rate level optimization right above the slot helps to keep unwanted impurities out of the accept flow.

**True slot width**

Over time, abrasive wear gradually increases slot size and leads to poor screening, while wearing of the wire contour results in reduced capacity. The profiles of conventional wires prevent the accurate measurement of slot width just by their shape, making it impossible to be sure of the slot size (Figure 6). This can be even worse if the basket is re-chromed and too little or too much coating is applied to the trailing edge of the profile. In this case, actual slot size can vary tremendously and screening results will suffer. With the new laminar wires, the basket can be re-chromed with the assurance of maintaining the desired slot size and screening performance. The cost of recoating is typically a third the price of a new basket and, depending on condition, the basket can usually be recoated at least three times.

**Results from a Finnish board machine**

In a recent replacement of a conventional machine screen basket on a 300,000 tpy board machine in Finland, the old basket with a 0.40 mm slot and open area of 11.8% was replaced with an exactly dimensioned laminar design basket. The results are shown in Figure 7. The pressure drop across the new basket reduced by 1 psi (7 kPa), to 4.6 accept channel shown in Figure 3 with conventional wire examples shown in Figure 2.

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psi (32 kPa), resulting in 20 kW savings in headbox feed pump energy. This equates to annual energy savings of 168 MWh.

The results were very good even though the flow is very low, only 3.3 f/s (1 m/s) through the machine screen basket whereas the designed maximum flow is 9.8 f/s (3 m/s). As a result of the lower pressure drop and shape of the laminar design wire, rotor pulsation to the headbox was also reduced, providing an added bonus of improved sheet quality (Figure 8).

Results from a North American tissue machine
The machine screen basket on a tissue machine was changed to the new laminar design due to wear of the old conventional wire screen. The new basket was dimensioned exactly the same with 0.35mm slots and 9.1% open area. The pressure drop across the basket dropped from 4.5 psi (31 kPa) to 3.5 psi (24 kPa) (Figure 9), resulting in a 10 kW reduction at the headbox feed pump.

Additional savings were achievable through reduced fiber loss from the two stage screening system. Operating with a reject thickening factor of RTF 1.3 compared to an RTF of 2.7 for the conventional screen, the laminar design wire reduced fiber loss by one ton per day.

Nimax LD screen basket
The new laminar design wire profiles are the result of dozens of simulations aimed at optimizing the flow at the screen boundary layer and reducing flow resistance through the slots. The new wire design, called Nimax LD (Figure 10, next page), optimizes flow at the screen boundary layer and reduces flow resistance through the slots, lessening thickening and thereby the load exerted on the screen.
The wire shape is designed to give a laminar, non-turbulent and streamlined flow through the accept channel between adjacent wires. The result is a low pressure drop and thus good capacity with energy savings. The laminar flow pattern after the slot not only ensures outstanding runnability, without fiber blockage or stringing problems, it also contributes to a longer basket life.

**NimCat basket**

High consistency screening applications can dictate frequent basket replacement with screen life measured only in a few months. The innovative design of the NimCat basket (Figure 11) reuses the screen support cage by changing only the wear component, the screening panel. By reusing the more expensive support cage, screen basket replacement costs are significantly reduced, especially in high-wear applications.

With no special wear rate inspections needed, the NimCat basket can remain in operation until the panel profile is completely worn down and the screen is no longer performing. After the panel change at the nearest Valmet workshop, a newly rebuilt NimCat screen basket performs again just as good as new. With panel replacement, it is also easy to change the basket specifications by switching to another type of screening panel profile or to a different slot width. Adjusting to new process requirements can be carried out efficiently for much less cost than a completely new basket. A selection of application-specific Nimax wire types is available to provide the best possible combination of capacity, separation efficiency and energy consumption in addition to increased basket life.

**NimLuc basket**

Valmet’s NimLuc baskets comprise a preformed basket with integral single piece mounting and stiffening ring that provides robust performance for low consistency screening of recycled fiber. Advanced laser cutting capabilities with new manufacturing techniques make NimLuc basket performance and lifetime comparable to baskets costing significantly more.

The high open area of NimLuc, combined with the low flow resistance over the screen basket, provides high screening capacity. Controlled thickening and low reject rate provides savings in the form of lower fiber loss. The basket’s durable construction (Figure 12), with
its robust wedge wires and the accuracy of new manufacturing technology offers an alternative for a cost effective screen basket solution.

**Summary**

Nimax LD laminar design screen baskets outperform conventional wedge wire designs, by reducing the pressure drop over the screen, thereby improving screening efficiency while reducing stringing and optimizing runnability. Considerable savings are achievable by reducing the headbox feed pump energy consumption when compared with conventional screening technology. NimCat and NimLuc screen baskets also provide cost effective screening capabilities.

*This white paper combines technical information obtained from Valmet personnel and published Valmet articles and papers.*

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*We are committed to moving our customers' performance forward.*