# Energy Efficient Recycled Fiber Screening


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### ABSTRACT

In today's papermaking process energy consumption plays a key role in the total manufacturing costs. Recycled paper collection increases continuously and the recycled paper also includes bigger variety of contaminants in both quality and quantity. The overall portion of the recycled fiber in the end product is also increasing due to raw material costs and availability. Efficient screening is a must to reach the desired pulp quality. In recycled fiber preparation line the screening will be usually done in various sub-processes. Each screening process is designed to remove different types of contaminants. Coarse screening removes large and heavy impurities whereas fine screening concentrates to remove sticky and dirt specs. In all screening processes the importance is to reach maximum contaminant reduction with gentle screening action so that the contaminant particle size is not reduced.

Energy efficiency in screening can be achieved by optimizing the screen operation or sizing of the equipment. Optimizing the shape of the rotor can lead to higher slot velocities and thus to higher production without the problems of screening surface blockage. With higher capacities per screening area we can reach smaller equipment sizes thus reducing the energy consumption. The co-rotational effect of the stock with the rotor uses significantly high share of energy and the co-rotation of the stock itself doesn't affect the screening efficiency. Optimized flow properties inside the screen can reduce the co-rotation and flow resistance affecting to the rotor and therefore reducing the energy consumption.

In this paper the new innovations in recycled fiber screening will be reviewed. Metso Paper has renewed the design of the screening equipment to reach needed production level with smaller equipment sizing and with lower energy consumption per produced ton of pulp. New innovations in screen basket technology are also introduced highlighting the screening efficiency improvement and longer lifetime of baskets.


## INTRODUCTION

Today's fast printing presses and papermaking machines place strict demands on fiber quality and on purity of the stock. Optimal screening performance is essential for achieving the desired pulp quality with the highest possible production efficiency and lowest energy consumption. Each screening process is designed to remove different types of contaminants. Coarse screening removes large and heavy impurities whereas fine screening concentrates to remove sticky and dirt specs. In all screening processes the importance is to reach maximum contaminant reduction with gentle screening action so that the contaminant particle size is not reduced.

### Low-energy coarse screening

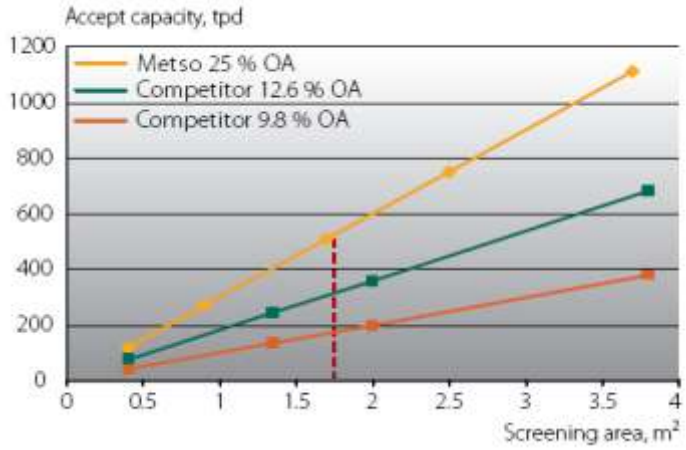
Coarse screening continues the process that begins in the pulping station, i.e. the gentle removal of large impurities in such a way as not to further reduce them in size. If any impurities are broken up in the first stage, it will require a great deal of effort to screen out these smaller impurities in the following stages, and this can have a negative effect on overall screening efficiency. Machine downtime must also be considered, as large abrasive contraries, such as stones, glass or tramp metal, can reduce the life of slotted baskets.

The pulping station and coarse screening act as the "buffer" part of the DIP and OCC line. Their purpose is to produce pulp with a sufficiently high level of cleanliness to ensure the runnability of the fractionation and fine screening stages. These latter stages complete the process by producing uniform pulp cleanliness.

In 2006, the coarse screening technology was further improved in order to further improve reject removal in recycled fiber processes. The new coarse screen product family studied in this article provides even higher screening efficiency at lower operating cost (Figures 1+ 2) than conventional technology.

The products of the coarse screen family operate in the consistency range of 3-5 % and utilize rotating basket

**Figure 1.**
**Accept capacity in primary coarse screening stage, OA = open area of screen basket**





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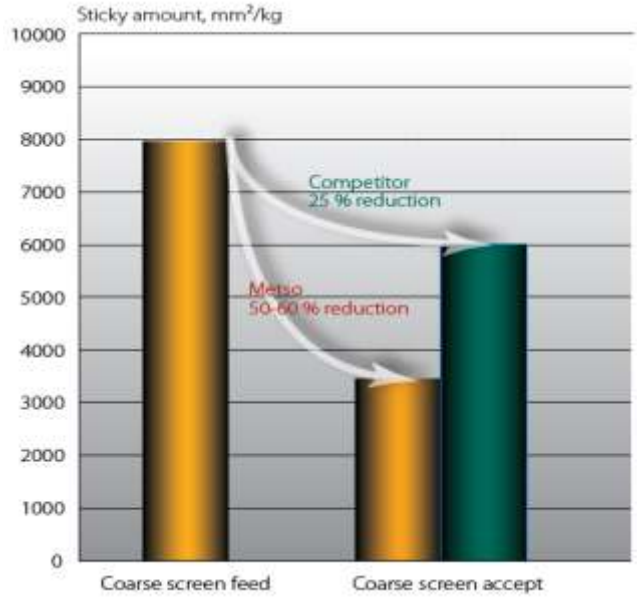


**Figure 2.**
**Sticky removal efficiency, mill results**

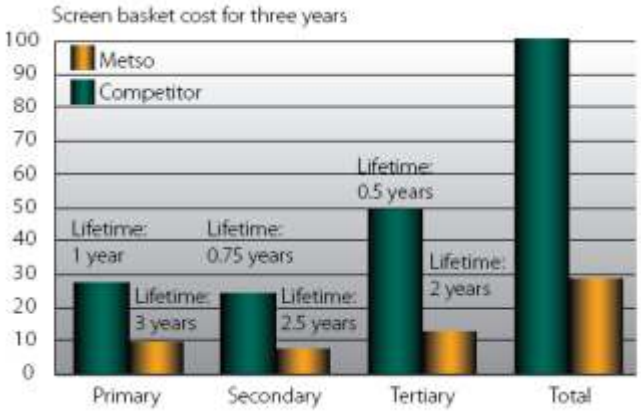


**Figure 3.**
**Expected screen basket costs for three years**

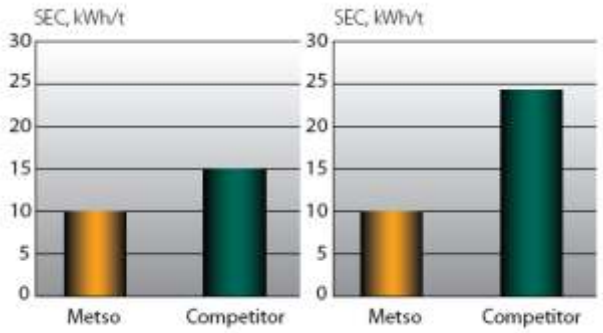


**Figure 4.**
**Energy consumption in DIP and OCC coarse screening, comparison**

**Figure 5.**
**Three sizes of coarse screens, one with light reject removal unit**

**Figure 6.**
**Sectional drawing of a coarse screen**

technology, which features continuous reject removal. The rotating basket minimizes wear, because its centrifugal force minimizes contact between harmful particles and the screen basket (Fig. 3). This way of operating also reduces energy consumption (Fig. 4).

The operation of the buffer part must be robust; i.e. it must disintegrate the pulp without excess disintegration of impurities, and it must tolerate varying amounts and types of "soft" impurities (e.g. plastic) and "hard" impurities (e.g. metal, glass, wood and sand) while avoiding excess wear problems and removing these impurities "without" fiber losses.

The products of the coarse screen family (Figures 5 + 6) fulfill all the requirements listed above. The accepted pulp passes through the basket into an inner chamber, where a stator with foils is located. The foil generates the appropriate pulp fluidization on the surface of the rotating basket, which guarantees excellent screening performance. Due to the design of the screen, the process is gentle, ensuring that contaminants and heavy impurities are rejected effectively without touching the basket. The screens can also be equipped with light reject removal units which effectively removes lightweight contaminants.

In packaging paper lines, the secondary or tertiary stage consists of a hole plate-type of screen that minimizes the fiber losses caused by possible wet-strength material that is included in the raw material. Fiber losses are minimized by introducing a controlled amount of disintegration energy with a special deflaking type of rotor. These coarse screen concepts yield minimum impurities breakdown and high stickies removal efficiency (> 50%) with low fiber losses (< 0.5%).

## Features

- energy savings, with rotating basket technology
- high screening performance, due to gentle operation
- high capacity, through large open area
- low operating costs, due to long basket and stator life
- broad process knowledge and support

## Excellent fine screening results, with correct combination of foil and screen basket

The main focus of fine screening is to reduce the amount of stickies and dirt

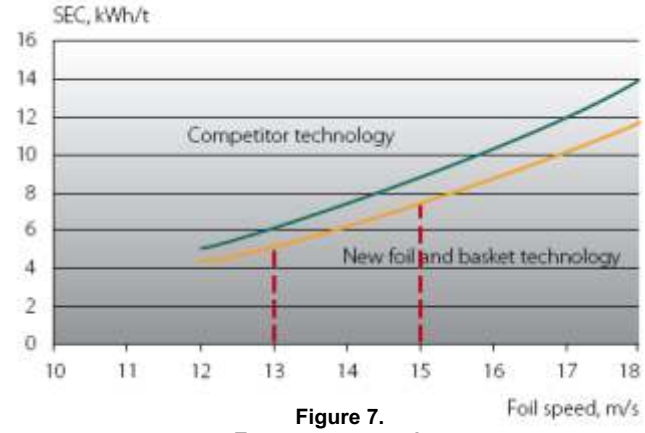


**Figure 7.**
**Energy consumption**

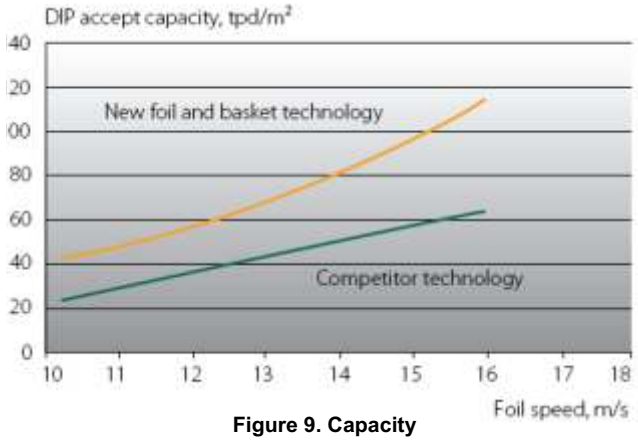


**Figure 9. Capacity**

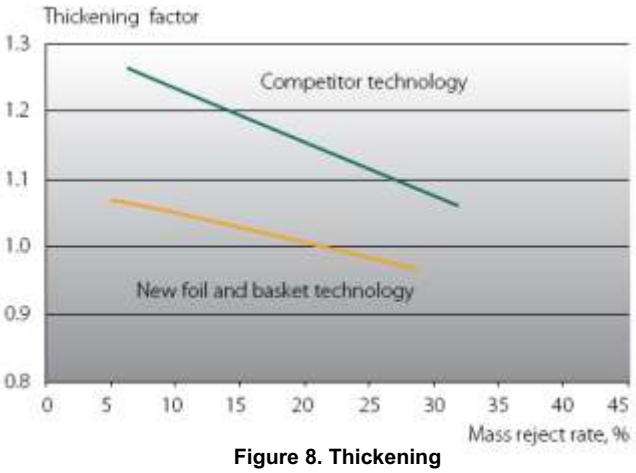


**Figure 8. Thickening**

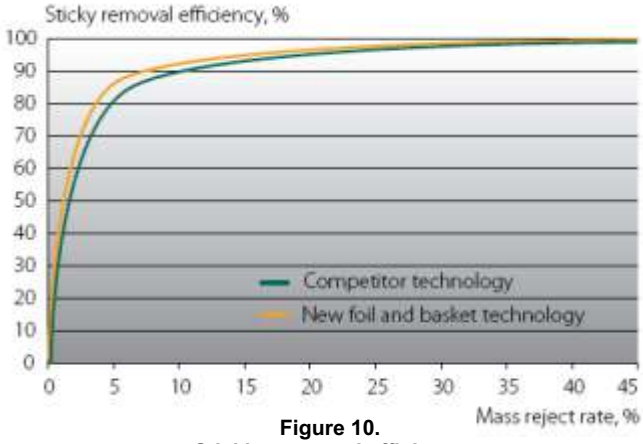


**Figure 10.**
**Stickies removal efficiency**

specks by gentle screening and minimum long fiber loss. The fine screen product family studied in this article combines comprehensive screening experience and state-of-the-art screen basket technology. The fine screens deliver high screening efficiency and excellent pulp quality. The correct combination of rotor and optimal screen basket ensures uniform consistency and pulp flow through the screening area in the consistency range 0.5 - 4.5%. The fine screens feature a new foil. This new foil technology delivers an optimum, process-adjusted relationship between high capacity, high quality and low energy consumption.

The new foil shape and a new screen basket wire type were created based on the results noticed in extensive rotor foil and screen basket studies, done between 2004 and 2006. These studies involved flow simulations, laboratory studies and pilot and mill-scale trials, and were carried out to find new ways of controlling the pressure screen throughput conditions, in order to find out better ways to meet the requirements of different screening applications.

As a basis for the foil study, the pressure pulses created by different low-consistency foil shapes were compared, in order to determine the influence on screening performance of the pulse shape created by the foil. The basket study investigated how screening capacity and quality could be influenced by the flow resistance of the screen basket panel during the production flow and suction pulse modes.

The work commenced with flow simulations using a commercial CFD (computational fluid dynamics) code to gain a deeper understanding of the basic flow patterns and particle separation phenomena inside the screen. The simulation results were then verified by trials carried out with an industrial-scale screen with a 0.9 m² screening area.

Conventional foils react weakly to foil speed or gap changes. In adjustable screening, a stronger response to the changing control parameters is needed to find the optimal operation point with respect to capacity and quality. In screening, a relatively low level of pulp co-rotation can be utilized, resulting in reduced energy consumption (even by 10-30%), and increased runnability of the screen with the same quality standard. There are no blockage problems, even at low rotation speeds, which allows excellent runnability in a wide operating window. Because it is possible to use higher slot velocities without blockage, higher capacity can be reached, or a smaller screen size can be chosen, for a given capacity.

Mill-scale results prove that a foil shape with a gentle pressure gradient, combined with sufficiently strong pulsation and a screen basket wire shape with optimized flow conditions, deliver high separation efficiency, improved capacity, reduced energy consumption and less fiber loss.

As a result of all the research work, the optimized geometries of the further developed screen baskets provide the best possible combination of capacity, screening efficiency, and energy consumption for each application, in addition to increased basket life. The new application-specific screen baskets can be used in all types of screens and in a broad range of applications, including mechanical, chemical and recycled

fiber pulping and the approach system.

The requirements for separation processes in recycled fiber lines have intensified significantly in recent years. The raw material contains more than double the amount of macro-stickies that was commonly present ten years ago. Even though the amount of impurities in pulp is constantly increasing, the targeted accept quality needs to be maintained in order to ensure good runnability of the paper or board machine. In addition, cost and energy efficiency aspects are increasingly important.

In deinked pulp screening, strong reject thickening that causes increased fiber loss or adds more screening stages is undesirable. When considering the new screen basket design for DIP applications, the primary target was to achieve controlled thickening inside the screen. The new screen baskets specifically designed for DIP or OCC technologies allow a low level of thickening and thus minor fiber losses. A further advantage of the high-capacity screen basket wire design is the possibility to use narrow screen basket slots, which results in excellent pulp quality. Higher slot velocities can be used without blockage, which means that higher capacity can be reached without adding another screen, or that even a smaller screen can be used.

The optimal screening results obtained by combining the new screen basket wire and new foil design can be summed up as follows, as proven in industrial-scale experiments and mill runs (Figures 7-10):

- 10-30% energy saving
- 10-20% less thickening
- 20-30% more capacity
- excellent pulp quality
- longer life of basket
- excellent runnability

As the optimized flow pattern inside the screen not only ensures outstanding runnability, it also lessens thickening and thus reduces the load exerted on the screen basket. This leads to a longer basket life. The durable basket design, robust screen wires, and optional coating additionally improve basket life span, providing savings in screening and maintenance costs.

## REFERENCES

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