

Modern Closed-Draw Press Sections

Ever-growing quality and production efficiency requirements have once again refocused papermaking development efforts on efficient wet pressing.

By Timo Pirinen
and Roland Banecki

The limitations of the conventional center roll based press concept at high speeds have been understood for years now. These limitations mainly stem from the increased draw required to release the sheet from the center roll (Fig. 1). The speed barrier has been pushed up through various component solutions, but the speed of center roll based press concepts is still moving along a flattening curve approaching 2,000 m/min. No speed limit is in sight for the so-called closed-draw press sections addressed in this article as all open draws from the press to the dryer section have been eliminated.

Metso Paper decided to build a new pilot machine for its Jyväskylä research facility slightly over ten years ago. Development work also began at this time on a new generation of writing and printing paper machine press sections. Press technology was quite conservative until then, with the exception of some long-nip technology applications.

The world's first production-scale closed-draw press for writing and printing papers was purchased by Willamette Industries for its Hawesville, Kentucky mill. Both nips of this

press were long ones and all press fabrics were felts. This machine started up successfully in 1998.

(Editor's note: In 2002, Weyerhaeuser acquired Willamette Industries. In March 2007, Domtar acquired Weyerhaeuser's Fine Paper business, including the Hawesville mill.)

Metso also started up its new pilot machine in that same year. Extensive test runs pointed out two significant areas for development: the underlying concept for press 1, and the bottom fabric of press 2.

Both a suction roll nip and grooved roll nip were tested as alternative concepts for the 1st press in addition to a long nip (Fig. 2). A transfer belt was selected as the bottom fabric of the 2nd press based on the groundbreaking joint development efforts of Metso and Albany International.

This development work resulted in the following concepts coming online:

- Willamette Hawesville PM 2, fine paper, USA, long nip, started 1998.
- Nordland Papier PM 4, fine paper, Germany, suction roll nip and transfer belt, started 1999.
- Augsburg PM 3, LWC, Germany, grooved roll nip and transfer belt, started 2000.

Metso was also the first to bring to market a single-nip closed-draw press designed particularly for uncoated fine paper grades. Fewer than ten of these types of presses are currently in operation around the world. The press is very compact and easy to use, but its operating window is narrower than that of a two-nip press. The primary advantages of the single-nip concept are its lower operating and investment costs.

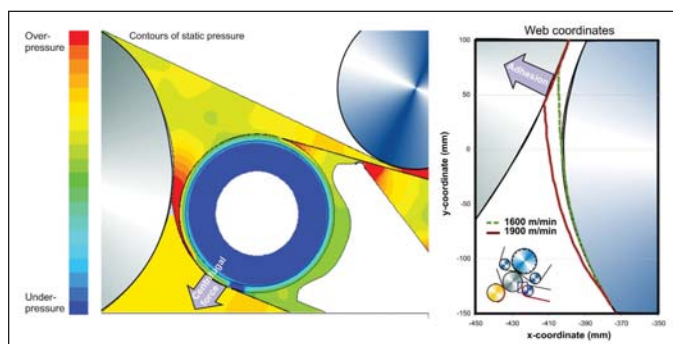


Figure 1. Machine speed is limited by the draw required for sheet release from the center roll.

The relative benefits of the two-nip concept become clear at high speeds, however, and its greater production capacity quickly covers its incremental investment and operating costs compared to a single-nip press. A two-nip press concept also provides better quality potential with current fabrics, especially in terms of CD stiffness.

Single-nip presses nevertheless have their own clearly defined applications and their construction will continue in the future as well.

FIRST PRESS DEVELOPMENT IN HISTORY

The first alternative press concept investigated along with a long nip was a grooved roll nip. Metso has supplied a total of 11 grooved roll nips, which are all working very well from a process standpoint. Grooved roll nip applications were limited to wood-containing grades. It soon turned out that a grooved roll nip provided good dryness after the 1st nip, quick felt startup at high linear loads, symmetrical dewatering, and a reliable and durable nip.

Finding the right felt combination for a grooved roll nip posed a challenge to felt suppliers and papermakers due to the limited range of available felt types. Systematic development efforts have since brought gradual improvements to the situation. However, long nips have lately been replacing grooved roll nips also in the case of wood-containing grades, primarily due to more advanced long-nip rolls and press shoe construction. These new shoe designs combine the favorable characteristics of long nips and grooved roll nips. A long nip is also easier to use from a felt standpoint.

The development of suction roll nips was originally driven by existing press section suction rolls that were incorporated in rebuilds. It soon turned out, however, that a suction roll nip produced a good bulk/smoothness ratio, and a very reliable sheet transfer to the bottom felt.

This translated into a dependable concept for woodfree grades. A total of 10 two-nip closed-draw presses are currently in use worldwide for uncoated woodfree grades, 8 of which were supplied by Metso. Five of these are based on suction roll nips and three on two long nips.

Long nip development work has involved constant testing of various press shoe designs, fabrics, etc. Two grade-based distinct shoe types have emerged from these development efforts.

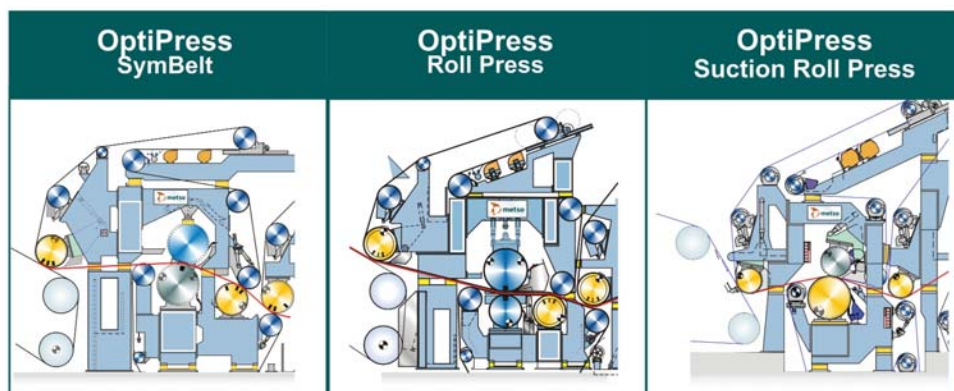


Figure 2. Alternative 1st nip concepts.

A. Lower load and shorter shoe for bulk grades.

- Saves bulk.
- Produces limited roughness.
- Provides good dryness.
- Slowly climbing pressure profile provides high water handling capacity.

B. Higher load and longer shoe for wood-containing grades.

- Pressure profile close to that of a grooved roll nip.
- Very high mechanical pressure.
- Very good dryness.
- Symmetrical dewatering.
- Good runnability at high speeds.

The primary function of the 1st nip is qualitative (Fig. 3), while the 2nd nip is expected to boost sheet dryness for good dryer section runnability. A single nip cannot deliver this combination at high speeds.

As proof of the effectiveness of the foregoing development efforts, Changshu PM 1 was the first fine paper machine to set a 1,700 m/min 24-hour speed record, and Shandong Chenming PM 4, a DIP-based newsprint machine, was running at roughly 1,700 m/min within one week after

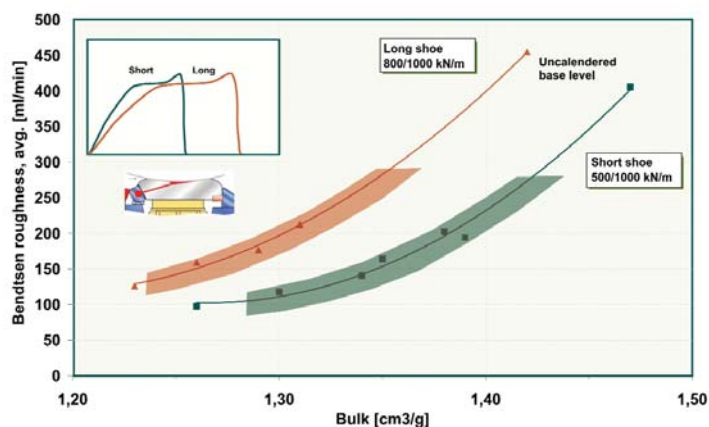


Figure 3. Effect of shoe length on bulk.

startup with very high dryness after the 1st nip. Dewatering at the 1st nip has been as high as 94%.

TRANSFER BELT AND OTHER PRESS FABRICS

Fabrics have represented one significant development area for modern closed-draws. This work has been carried out together with fabric suppliers and other development partners.

Challenges associated with the 1st nip have included: effective dewatering with fast startups, sandwich zone control, rewetting, and stable sheet edge control.

Metso has been testing various geometries in this area. Testing has also been supplemented with theoretical flow analyses. Research has revealed the significance of negative pressure in opening press nips and nip geometry has been optimized for sheet control (Fig. 4). Studies on felt/sheet geometry have shown that sheet tension control at the felt plays a critical role. The tension profile needs to be uniform and sheet tension must be sufficiently high. Sheet tension profile control after the nip is particularly important in the case of woodfree grades where the stock used is intrinsically less capable of sustaining steady sheet tension. In summary we can conclude that a closed-draw concept can be every bit as reliable in terms of runnability as a conventional press. Felt development work has taken some time but has also clearly proven its potential with respect to runnability.

The smooth surface of the impermeable transfer belt supports the sheet well between the press and dryer sections. The use of a transfer belt eliminates rewetting after the second long nip, thereby improving the sheet's moisture

profile. The runnability of transfer belts has been one of the main development themes from the start. Will belt operation be stable throughout the life of the belt and can the useful life of belts be brought to a satisfactory level? Related development efforts have been driven by these questions.

Stable belt operation includes sustained cleanliness, which has been studied through:

- production machine doctoring/shower solutions
- a pilot-scale recirculation flow simulator
- pilot machine doctoring tests
- static adhesion tests

The cleanliness of today's transfer belts is based on:

- an optimized transfer belt loop without any external rolls
- mechanical doctoring solutions
- shower arrangements
- high-pressure (100 bar) washing system
- final cleaning with a wiping doctor blade

Through these solutions Metso has been able to show that ASA adhesives can be used on fine paper machines instead of AKD adhesives without belt cleanliness problems, which may at their worst make the belt altogether unusable. Cleaning system payback periods are typically very short given the significant adhesive cost savings. Cleaning solutions meanwhile facilitate good press section runnability with DIP-based grades by controlling stickies. The cleanliness of the transfer belt typically also gains additional importance whenever a steambox is used at the press section.

RUNNABILITY AND PRODUCTIVITY

Closed-draw presses have now been built for nearly ten years and their performance can be evaluated with respect to both production efficiency and quality. Tangible results have been longer in the making than was originally thought for either fabric or concept development. However, we can currently conclude that break-free operation is perfectly realistic at speeds in excess of 2,000 m/min. Significantly higher speeds have been tested on Metso's pilot machine and the press section is clearly no longer a runnability bottleneck.

Effective dryer section runnability components also help to ensure the good runnability of fast paper machines. New horizontal and vertical impingement drying solutions have been developed for the start of the dryer section that move the first open draw further down the dryer section. This provides higher sheet temperature and dryness before critical contact with the first dryer cylinder.

The startup curves of today's closed-draw paper machines are in a class of their own, attesting to the concept's robustness and ease of use.

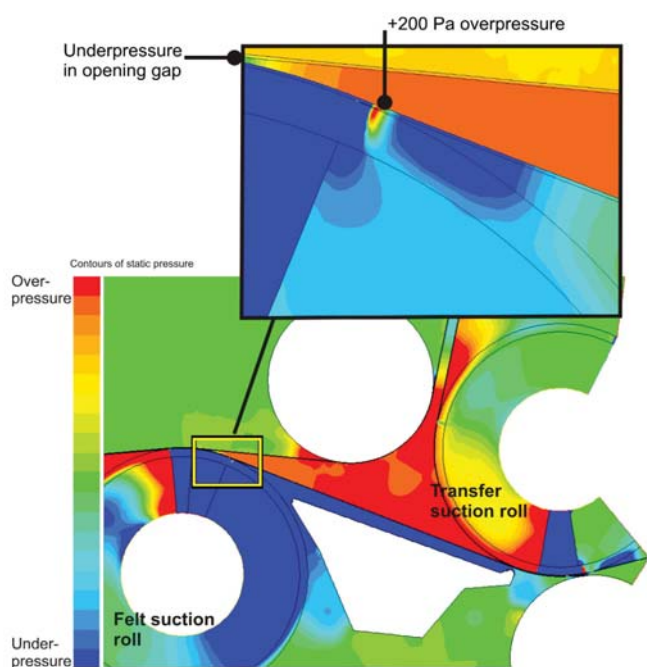
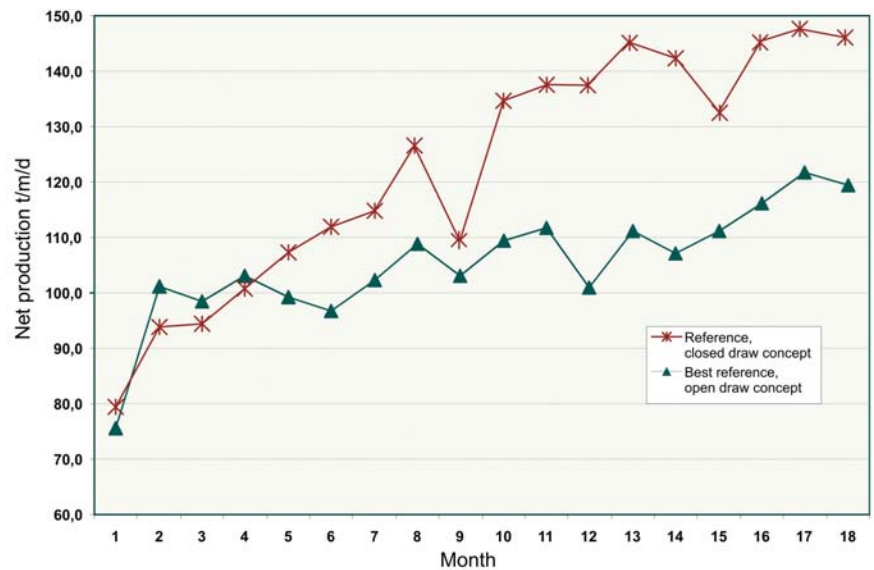


Figure 4. Negative pressure in an opening nip.

THE FUTURE

In 2006, ten years after commencing construction of the world's first closed-draw pilot machine, Metso made a further investment in the press section and early dryer section of the same pilot machine. Bringing paper quality to a whole new level is an important current development goal. Runnability has been proven and improved, and empirical data has been collected for further development work. The press section of the new pilot machine can be run with one, two or three nips, which facilitates the study of a number of new concepts. The new press concept employed also incorporates a lot of built-in detail for improved operability, maintenance and safety.

The pilot machine is viewed as a more general engineering tool beyond specific process, component and automation development work. New solutions include a revolutionary felt insertion unit that removes the need for cantilevering arrangements in structural design. New features also include improved utilization of space on the back side of the



Startup curve comparison between closed and open draw press concepts for the same paper grade.

machine, pre-tested modular components, such as an integrated automation tower, and many other solutions designed to bring down the total lifecycle cost of equipment. ■

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