Advantages of Shoe Presses V/s. Roll Presses

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Press is the last point in the paper machine where water is removed by means of mechanical load/energy. Basic of the press is passing the paper through 2 solid rolls. Gradually the modifications were done just by increasing the load using different type & size of press rolls. After reaching a limit in the loading, scientists started to experiment with bigger diameter rolls in order to increase the nip width. They are called long nip or wide nip presses. Other methods using suction rolls and blind-drilled rolls also very common but as it is economical to remove water by mechanical loading than by vacuum, scientists did not stop at long nip. The ultimate aim was to squeeze out maximum amount of water from the paper. At one stage, situation reached when it was not possible to increase the load because the paper properties started to deteriorate. This was the time when machine designers were forced to re-evaluate how presses are designed, the birth of the new technology called SHOE PRESS.

A Shoe Press (Above figure) is essentially a deflection roll with a flexible shell and a concave loading shoe. The flexible shell is a thin polyurethane membrane, called blanket. This blanket forms a circular loop, much like a roll cover, unit it passes through the nip. Here it is forced to bend in the opposite direction between the loading shoe and the mating roll.

INTRODUCTION

The main objectives of a Press in the paper machine are maximum water removal, high Levels of efficiency and runnability and maximize sheet quality. There are various things which effect the removal of water in a press. These include:

- Pressing process variables.
- Stock refining - Refining level (SR°) influences water removal.
- Stock / Sheet temperature - Sheet temperature increase, helps water removal.
- Felt design.
- Felt conditioning.

Pressing Process was what that needed to be studied because it was the most important and most influential parameter for the efficiency of a press section.

SHOE PRESS INTRODUCTION

The first shoe press, the ENP, was introduced to the industry by Beloit in

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The figure on the right shows the fundamental of a shoe press in a simpler way. It is pressing the paper web between a hydraulically loaded shoe and a moving solid roll.

Increased Dryness

The primary function of any press is to remove water. And the more water that can be removed by the press, the less work the dryer section will have to do. A drier sheet out the press also means a stronger sheet, which results in enhanced paper quality and improved runnability.

The two major factors which influence water removal in the press nip are pressure and time (Fig's.1&2). Increasing either the average pressure in the nip or the nip residence time will result in a drier sheet out of the press. To maximize water removal, both the pressure and the time in the nip should be increased. Unfortunately, in a conventional roll press, these variables have to be limited to avoid problems with sheet crushing and to stay within mechanical limits of rolls, roll cover and clothing. The shoe press manages to avoid these limitations. The easiest way to understand the operation and the benefits of the shoe press is by using the Press Impulse Theory. This widely accepted theory was developed to explain the relationship between pressure and time in the nip and their effect on governing press exit dryness. Press Impulse is defined as the product of the average pressure in the nip and the nip residence time.

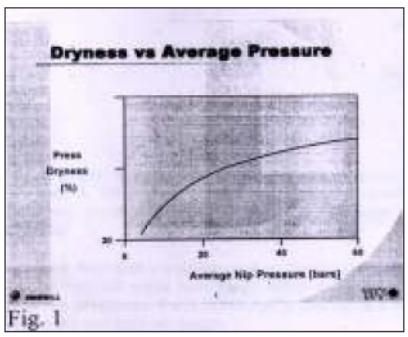

Fig. 1

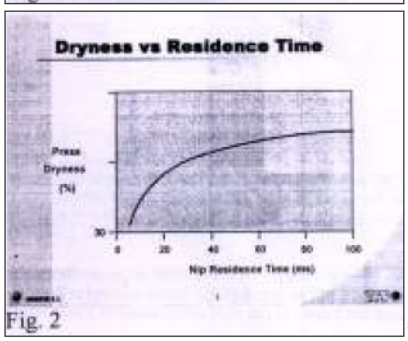

Fig. 2

Press Impulse, measured in (kPa*sec) equals the loading divided by the machine speed divided by a conversion

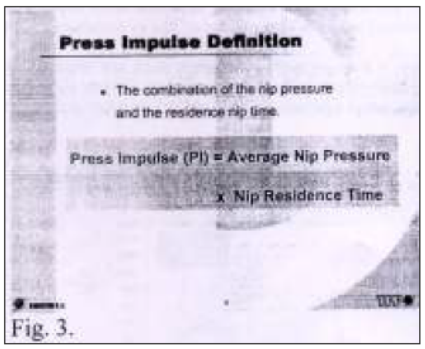

Fig. 3.

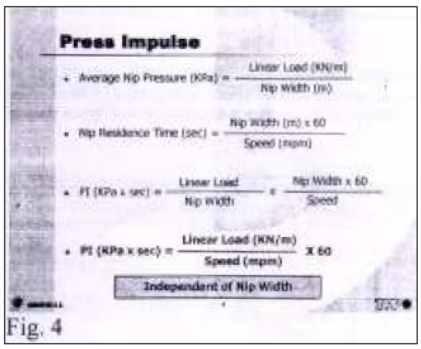

Fig. 4

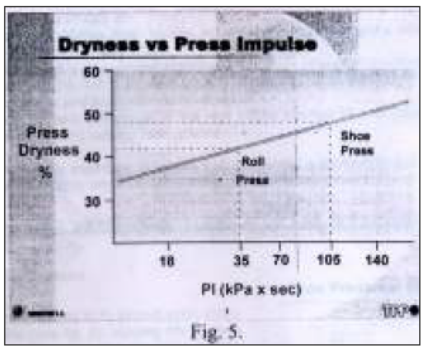

Fig. 5.

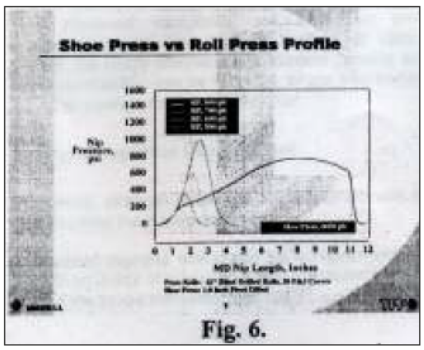

Fig. 6.

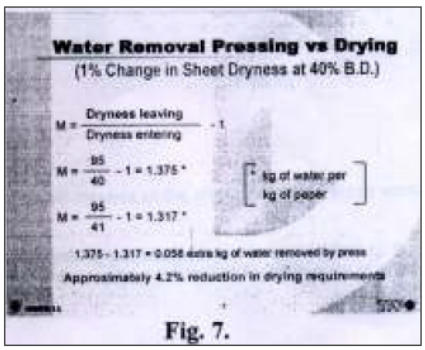

Fig. 7.

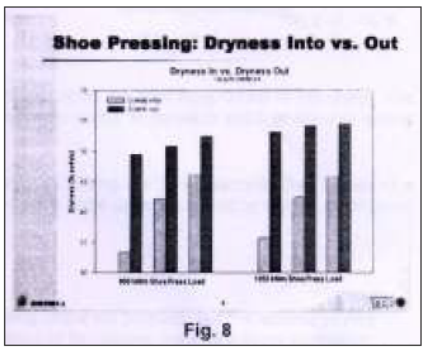

Fig. 8

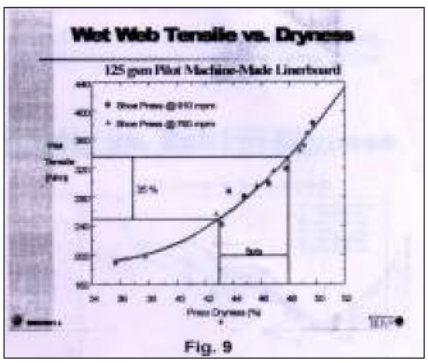

Fig. 9

factor of 60. Press Impulse is independent of nip width (see Fig's. 3 &4).

For a given paperboard furnish at a given temperature, the dryness out of a press is not a function of nip width or whether it is a roll or a shoe type press, but strictly a function of press impulse (Fig. 5). And at a given speed, the only way to increase the press impulse, and thus the press dryness, is to increase the loading in the nip.

For example, a 350 kN/m jumbo roll press operating at 600 mpm will produce a press impulse of 35 kPa·sec. A 1050 kN/m loaded shoe press operating at 600 mpm will produce a press impulse of 105 kN/m·sec. So depending on furnish, this difference will result in 4-6 percentage point BD increase in sheet dryness.

It is clear then that the ability of shoe press to provide nip loadings up to 1050 kN/m and higher is what sets it apart from roll press technology, which is limited to ax. 350 kN/m maximum loading due to the excessive peak nip pressures. Peak pressures in the nip of a two roll press become quite high at increased nip loads due to the reduced nip length.

These peak pressures are affected not only by the load, but also by roll diameters and roll cover hardness. This causes dilemma when trying to design roll presses for high nip loads. A two roll press operating at 350 kN/m with large diameter rolls and medium-hard cover would generate a peak pressure in the nip on the order of 10 MPa. Peak pressures of this magnitude can lead to sheet crushing and reduced felt life. In an attempt to lower the peak pressures in the nip, the roll cover will have to be softened. However, increased heat generation in soft cover can lead to cover bonding problems and premature failures.

By contrast, the peak pressure in shoe presses is controlled by shoe size and position rather than by cover hardness and roll diameter. The shoe is designed to keep the peak pressure in the nip below 6 MPa. Below this pressure level, the chances for damage to the felt, sheet or roll covers are greatly diminished (fig. 6).

A improvement of 4 to 6 points can be expected when a shoe press is incorporated into the press section. The advantages of this dryness benefit are:

- For a new machine, a shorter dryer section would be required, ultimately saving steam, hardware and building costs.
- In a rebuild situation for a drier-limited machine, installation of a shoe press could allow a machine speed increase of roughly 4-5 % for each point of dryness improvement, (fig. 7), which means 16 to 30% increase in speed and production in most cases.
- Another option is to take advantage of the real estate savings of a shortened dryer section for sizing the sheet for making value-added grades.

The exit of the shoe is also very important. Gorostidi's shoe features a sharp radiused nose designed to the pressure in the nip drop off sharply eliminating reweting and optimizing sheet dryness.

RESULTS BASED ON VARIOUS EXPERIMENTS DONE IN THE LAB AND LATERON IMPLIMEN--TED IN THE PAPER MILLS

Improved Uniformity of Dryness

Another benefit of Shoe Pressing is its impact upon cross-machine moisture profile (see fig. 8). Varying the dryness into an Extended Nip by 10 points or more has very little effect upon the dryness out of the shoe press. This suggests that having a shoe press in the final press position should virtually eliminate any concerns about dryness profile variations that may occur ahead of the shoe press.

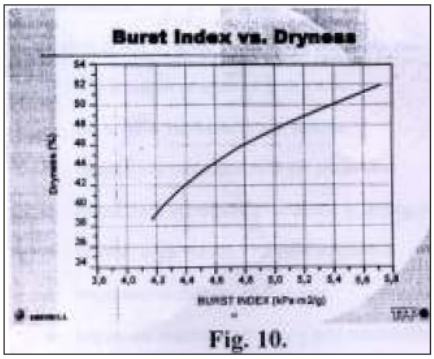

Fig. 10.

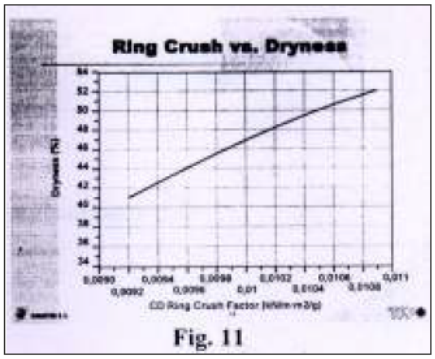

Fig. 11

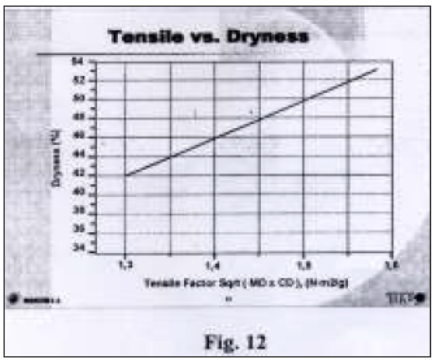

Fig. 12

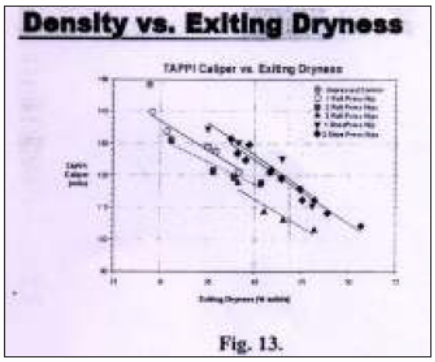

Fig. 13.

Runnability and Efficiency

A further benefit of increased dryness out of the press comes in wet web tensile strength, which is greatly improved by Shoe Press. Each added point of dryness yields an improvement of about 7% in wet web tensile strength (see figure 9). The typical shoe press dryness benefit of 4 to 6 points leads to a 28 to 42% increase in wet web tensile. This vastly improves machine efficiency by improving runnability and reducing the number of sheet breaks.

The benefit of a stronger sheet will be realized at all points between the shoe press and the reel; this can be most significant in applications where a shoe press replaces a roll press ahead an open draw.

This improved runnability will allow for production increases, or as an alternate method of utilizing the benefit, the costly chemical pulp content (usually added for better runnability) can be reduced, which also translates into cost savings for the papermaker.

Strength Properties Developm--ent

In general, strength properties are increased with increased dryness of the sheet exiting the press section and entering the drying section.

The added dryness which can be achieved with shoe pressing translates into improved Mullen or Burst. The Burst Index of a typical linerboard paper furnish will improve about 2.5 to 3 % for each point of dryness exiting the press increase (Fig. 10)

The dryness exiting the press section has a significant impact upon the final Ring Crush of the sheet. The Ring Crush of a typical linerboard paper furnish will improve up to 1.5 % for each point of dryness exiting the press increase (Fig. 11)

A well-defined relationship exists between tensile and dryness exiting the press section. The Tensile of a typical linerboard paper furnish will improve about 2% for each point of dryness exiting the press increase (Fig. 12)

Sheet density (Caliper)

Increased dryness can be obtained by increasing the loading of the roll presses, but the accompanying densification is not acceptable. Shoe Press provides a means of increasing dryness without excessive densification.
A Shoe Press will provide a sheet with higher caliper than a Roll Press used to press the same dryness.
A Shoe Press will provide a sheet with higher dryness than a Roll Press used to press the same caliper. (Fig 13)

REFERENCES

The very recent references includes
- Smurfit Limousin, France
- APP Gold Hua Sheng, China
- Dubois Veuze, France
- APP Jiwi Kimia, Indonesia

CONCLUSION

Depending on the specific application, a shoe press can provide:

- 4 to 6 points of additional dryness
- Up to 40% increase in wet tensile
- About 25% reduction in dryer steam/ton
- About 25% increased production in drying-limited machines
- Shorter dryer section for new machines
- Improved uniformity of dryness
- Improved machine efficiency and runnability
- Reduced chemical pulp content for same runnability
- Increase in strength properties
- Optimized caliper dryness relationship.

No Doubt, The Most Profitable Press Configuration Includes At Least One Shoe Press