Press section performance

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ABSTRACT

Factors affecting press section performance include press loading, nip width, machine speed, sheet temperature, grade and furnish, and felting arrangement. This paper reviews these factors, provides practical information on judging their effect on press dryness, and gives typical press performance standards.

Application:

To optimize press performance, one must consider many factors. Discussion of each factor shows ideal running conditions.

PRESSING WATER FROM A SHEET OF paper involves squeezing the sheet using mechanical compression to express the water. The degree of water removal is proportional to the applied pressure and pressing time. It is inversely proportional to the water viscosity.

The actual dryness in a given press arrangement will also depend on the water retention value of the fibers and the basis weight. Typical press performance figures allow judgment of the effectiveness of a press on a particular grade. If the press performance is inadequate, then one must evaluate all the variables to determine the most cost-effective approach to optimization. The following comments will serve as a general guide to these variables. While the emphasis is on press dryness, the reader must remember that the press can have a major impact on sheet strength properties. Most conditions that maximize sheet dryness also maximize wet sheet consolidation. They will therefore improve sheet strength as well.

PRESS LOADING

Increasing the press loading is most effective in pressure limited nips. Modern felts and roll covers can tolerate very high nip pressures. Linerboard and corrugating medium grades commonly run big roll or jumbo presses with nip pressures of 330 kN/m (2000 pli). Shoe presses on linerboard typically run 1000 kN/m (6000 pli) over a long nip. Either press arrangement can achieve 46–50% press dryness. On kraft containing grades, they can give strength improvements of 10–30%. Since both presses are usually double felted, the high nip pressure gives a strong felt mark in the sheet. For some paper grades, however, these very high nip pressures may not be practical. Table I shows typical sheet dryness improvements for every 52 kN/m (300 pli) increase in nip pressure for any press arrangement.

Approximately 40% of press dryness gain will continue in subsequent press nips. For example, if a 1.5% gain occurs at the first press nip and the second nip is unchanged, the dryness out of the second nip would increase by 0.6%. If the third nip is also unchanged, then dryness from the third nip would increase by only 0.24%.

DWELL TIME

Dwell time in the nip is particularly important in flow controlled nips. Often, however, increased dwell time will only be effective when maintaining the nip pressure per unit area. Figure 1 shows the effect of roll cover hardness on nip pressure and nip width for a loading of 120 kN/m *(1)*. Changing cover hardness from 6 to 20 Pussey and Jones (P & J) in this example increased nip width from 19 to 24.5 mm (0.75 in. to 1 in.) but reduced nip pressure from 8 to 3.5 MPa (1150 to 500 psi). One would have to increase the nip loading to increase the nip pressure.

Jumbo presses can have nip widths of 75–100 mm (3–4 in.). Shoe presses have 230–250-mm (9–10-in.) nip width. The very high loadings of these presses mean that nip pressure is still high. It is the combination of high pressure and long dwell time that gives such good press dryness results on board grades.

Increasing machine speed will obviously affect dwell time negatively. Increasing machine speed by 100 m/min will typically reduce press consistency approximately 1.5%. Heavy weight board grades usually show more loss than lightweight sheets.

PRESS NIP FORMULAS

The relationship between press load and nip residence time sometimes causes confusion. The formulas in Table II can be useful.

FURNISH

The freeness and water retention value of the furnish have big impacts on press performance. Figure 2 shows a typical chart of dryness vs. press load for three degrees of freeness. Increasing freeness by 40 mL CSF will increase sheet dryness by approximately 1%.

The water retention value (WRV) is a measure of the water retained by a 1400-g/m^2 pulp pad after centrifuging for 30 min at 900 g. The WRV number is the water to fiber ratio of the pad after centrifuging from

Grade	Approx. increase in sheet cons. for every 52 kN/m
Linerboard	+1.0%
Corrugating	+1.2%
Newsprint	+1.5%
Bond	+1.5%

I. Press loading vs. consistency

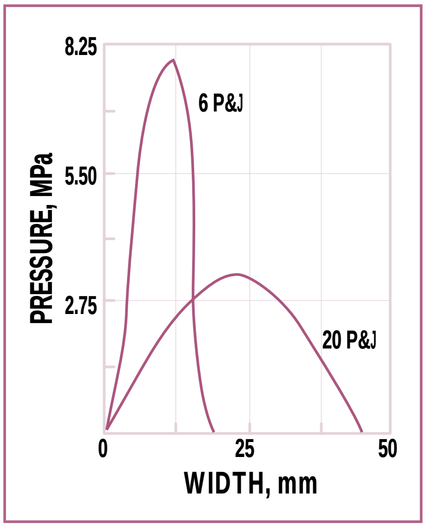
Average nip pressure in MPa (psi) = Nip load in kN/m (pli)/Nip width in mm (in.) (1)

Maximum nip pressure = Average nip pressure x 1.33 (2)

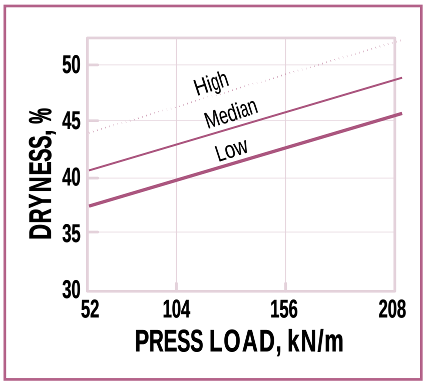
Dwell time in milliseconds = Nip width in mm/Machine speed in m/s (3)

Press impulse = Average nip pressure x Dwell time (4)

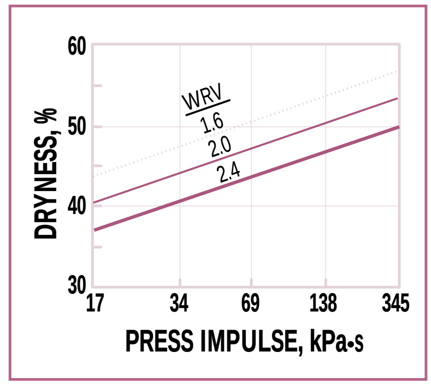
II. Press nip formulas



1. Effect of roll cover hardness



2. Machine furnish vs. sheet consistency for pulp of various freeness



3. Water retention value

TAPPI Useful Method 256. WRV is a more accurate predictor of press performance than freeness. Figure 3 shows typical effects of WRV on press dryness *(2)*.

SHEET TEMPERATURE

Installing steam boxes or using a heated press roll can raise the temperature of the web in the press. These procedures can increase the web temperature to 70°C (160°F). This reduces the viscosity of the water, softens the fiber, and increases water removal. The temperature increase also produces a denser sheet with improved strength properties.

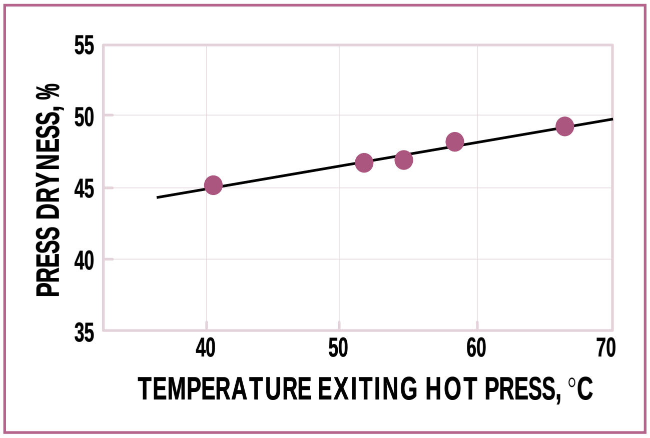
A hot press can obtain dryness levels of 45–50% depending on furnish. Recycled furnishes containing a significant quantity of stickies may require very careful doctoring arrangements and a hot water felt shower. This would allow the full use of high temperatures while avoiding the deposition of the stickies. Typical applications are corrugating medium, boxboard, and recycled linerboard.

Figure 4 shows the effect of raising the temperature of corrugating medium sheet from 40°C to 70°C with a sheet temperatur entering the hot press at 40°C. The data is for a 125 g/m^2 corrugating medium of OCC furnish running at 610 m/min. Sheet dryness increased from 45% to 49%. Here a hot roll supplied the heat directly in the nip. Temperature measurement was on the opposite side of the sheet on the exit side of the nip. This ensured heating of the entire thickness of the web. Measuring entering temperature rather than exit temperature gives a lower dryness increase for a given temperature increase because the sheet inevitably cools slightly before and in the nip. It is a general rule that each 10°C increase in entering sheet temperature gives a 1% increase in consistency.

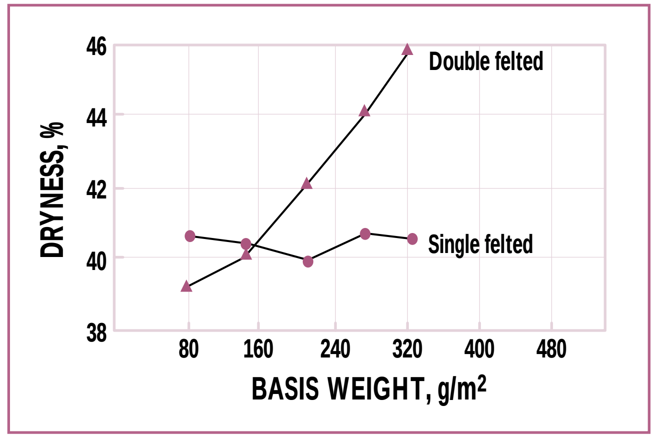
FELT ARRANGEMENT

Double felting a nip allows water removal in both directions and can greatly increase its capacity. The greatest advantage is for heavier weight sheets and higher nip pressures. For lower basis weights and lower freeness furnishes, double felting the first nip can give some improvement in press performance and make for a forgiving nip. Subsequent nips may not benefit from double felting, however. Figure 5 shows a typical response to double vs. single felting for a range of basis weights.

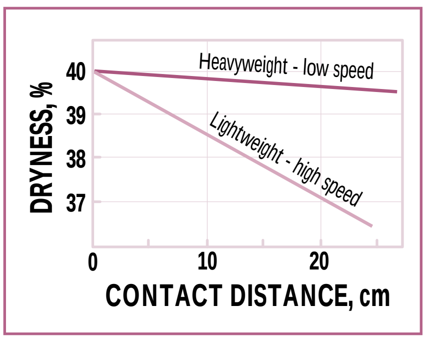
Felting a lumpbreaker on a board machine can improve dryness by 3% after the nip. If the sheet stays in con-



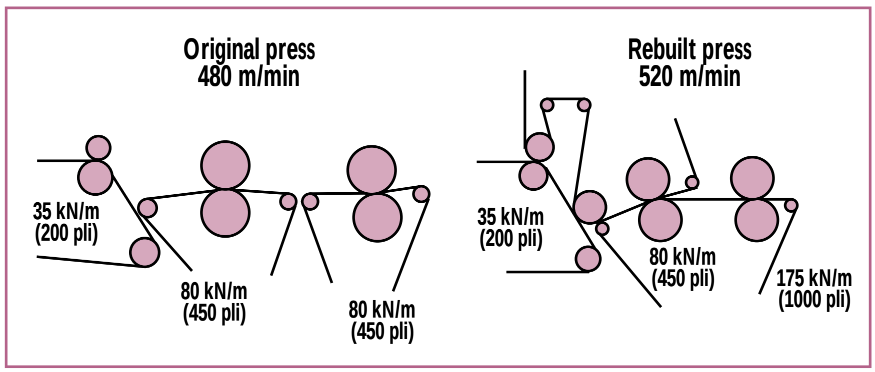
4. Sheet consistency vs. sheet temperature



5. Double felting vs. sheet consistency



6. Sheet rewet from the felt as a function of contact distance



7. Original and rebuilt press

Felt lumpbreaker	Improvement 3%, Continuation from first press 40% Continuation from second press 40% 3% x 40% x 40% = 0.48% gain
Double felt first press	Improvement 2% Continuation from second press 40% 2% x 40% = 0.80% gain
Increased second press loading	1.2% gain per 52 kN/meter (175 - 80) x 1.2/52 = 2.20% gain
Increase in speed	1.5% Loss per 100 meters/min increase in speed (520 - 480) x 1.5/100 = 0.60% loss
Sheet rewet from tandem felt = 0.30% Loss Net rebuild dryness gain = 2.58%	

III. Effect of rebuild

tact with the felt after the nip, the effect of rewet can be considerable. This is particularly true for lightweight sheets and high machine speeds. Figure 6 shows the decrease in press dryness with contact distance of the sheet on the felt.

EXAMPLES

As an example of the application of these guidelines, consider the rebuild of an actual corrugating medium machine press located in the Northeastern United States. This machine has a 35-kN/m (200 pli) unfelted lumpbreaker on the couch and two straight-through, single felted presses loaded at 80 kN/m (450 pli) each as Fig. 7 shows.

Temperature increase of 20°C in first press (10 x 2 x 1%) X 40% = 0.8% gain
Temperature Increase of 15°C in second press (10 x 1.5 x 1%) = 1.5% gain
Net rebuild dryness gain = 2.3%

IV. Steam box installation

KEYWORDS

Evaluation, force, furnish, loads, machine speed, nip, performance evaluation, press sections, process variables, reaction time, temperature, time, variables, velocity.

The rebuild for this press included felting the lumpbreaker, double felting the first press, increasing the second press load to 175 kN/m (1000 pli), and installing a tandem bottom felt to improve runnability. In this example, the machine speed increased from 480 m/min (1580 ft/min) to 520 m/min (1700 ft/min). Table III provides an approximate estimate of the effect of this rebuild. Actual press dryness before the rebuild was 40.5% and after the rebuild was 43%. This shows good correlation with the above calculation.

Another example would be the installation of a steam box ahead of the first press in a machine with two presses. Table IV shows the effect in this instance.

PERFORMANCE STANDARDS

Table V gives typical press dryness numbers for several different grades. One can use it as a guide in determining whether a press is performing to current standards.

	Load, kN/m	Load, pli	Exit sheet cons., %
Newsprint			
First press	60	300	33
Second press	80	450	38
Third press	95	550	43
Bond			
First press	60	350	37
Second press	80	450	41
Third press	95	550	43
Corrugating medium			
First press	70	400	37
Second press	105	600	41
Third press	315	1800	46
Linerboard single felted			
First press	70	400	35
Second press	105	600	39
Third press	175	1000	42
Linerboard double felted			
First press	105	600	38
Second press	210	1200	43
Third press	350	2000	46

V. Press dryness numbers

SUMMARY

There are many factors that influence the performance of a press section. It is not possible to optimize any press without careful consideration of all these variables. Following is a summary of the factors discussed above:

- Increase the press loading for an increase of 1–1.5% per 52 kN/m (300 pli).
- Increase the machine speed for a decrease of 1.5% per 100 m/min (300 ft/min) *(3)*.
- Increase furnish to 40mL CSF for an increase of 1%.
- Change to heavy weight sheets for the double felt at the same pli for an increase of 2–3%.
- Use top felt lumpbreaker for an increase of 3%.

Note also that there will be a continuation of 40% of the gain through each nip. TJ

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Received for review June 28, 1995.
Accepted April 15, 1996.

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