Advances in hot pressing technology

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New technology has produced hot presses which can lower energy costs while achieving press drynesses previously thought unobtainable.

Reduced drying costs and better production through improvements in wet pressing have been the subject of research for many years. Hot pressing has formed a significant part of such work. In recent years, the technique has been refined to give press drynesses previously thought unobtainable.

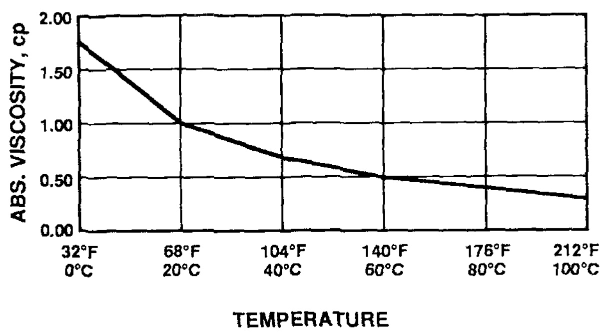
Theory

Research has shown that for constant operating conditions such as felt type, furnish, sheet basis weight, machine speed, etc., the water that is removed is a function of:

- Applied pressure
- Nip width
- Water viscosity.

The degree of water removal is proportional to the applied pressure and width and inversely proportional to the viscosity of the water in the nip, as illustrated in **Fig. 1.**

1. Water viscosity/temperature



Application of theory

Although dewatering increases directly with pressure applied, after a certain point the relationship is not linear. Further increases in pressure result in only minimal increases in water removal, and effects on the sheet and felts can become detrimental.

Increasing dwell time under pressure improves dewatering, and the relationship between nip width and machine speed becomes an important factor in press nip design.[1] Increases in nip width allow larger increases in applied pressure without affecting felt porosity due to greater surface pressure distribution. However, once again, after a certain point the relationship is not linear, and only moderate increases in water removal are achieved.

These data suggest that investigations be directed toward water viscosity. At a temperature of 20°C, water viscosity is approximately 1.00 cp and at 60°C about 0.5 cp. Therefore, according to theory, the dewatering rate should double in any case where flow is controlling. See Fig. 1.

The lower viscosity permits:

- Reduced resistance to water flow in the sheet, thus increasing sheet compression and yielding higher drynesses
- Increased water flow through the felt, as the felt will be able to handle higher water loads.

However, significant decreases in water viscosity become minimal as temperatures rise beyond approximately 80°C, and heating the sheet beyond this point produces minimal gains in water removal.

Design

The aforementioned criteria produced the basis for the design of the TEM-SEC Press.[2] The TEM-SEC Press consists basically of a large diameter (1.5 to 3.0 meters) center roll which is internally heated by steam injection (up to 3 bar).

The operating temperature for the roll is usually between 80°C and 100°C, and the roll is coated with a special alloy non-stick surface. Acting on this center roll are press rolls [rubber covered 10-15 measurement of cover hardness (P&J)], which can be blind drilled or grooved.

Nip loadings of 80-280 kN/m are applied to the center roll through two or more nips around the roll. Typical press layouts are shown in **Figs. 2-5.**

[1]Busker, L. H., Tappi 54(3): 373(1971).

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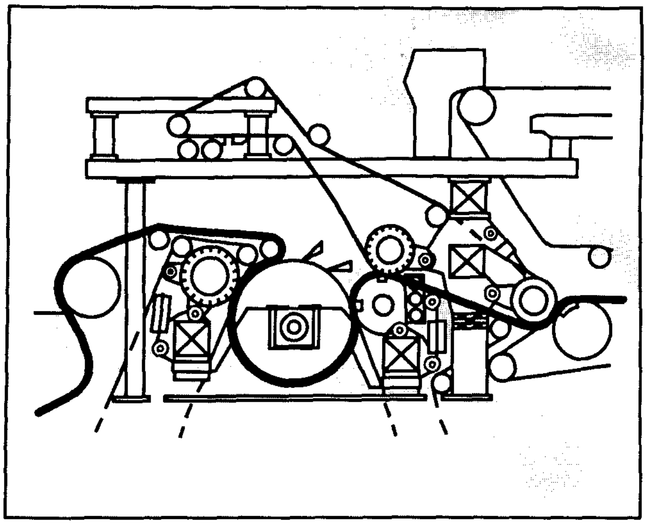
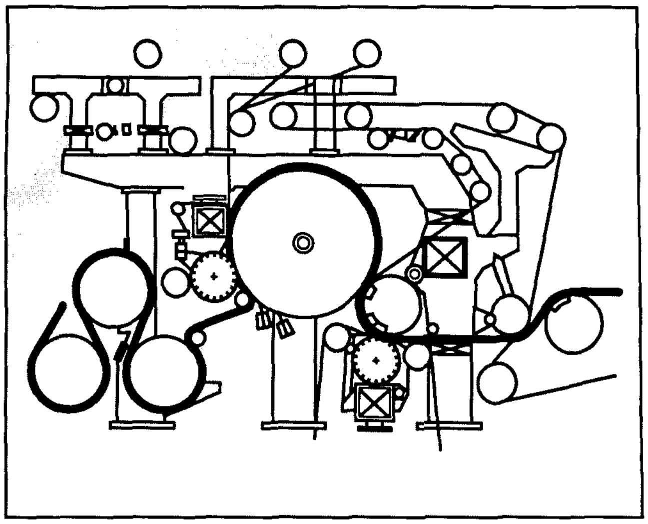
[2]Fall, Y. S., The TEM-SEC Press—A Hot Pressing Concept, World Pulp & Paper Technology 1989, p. 191.

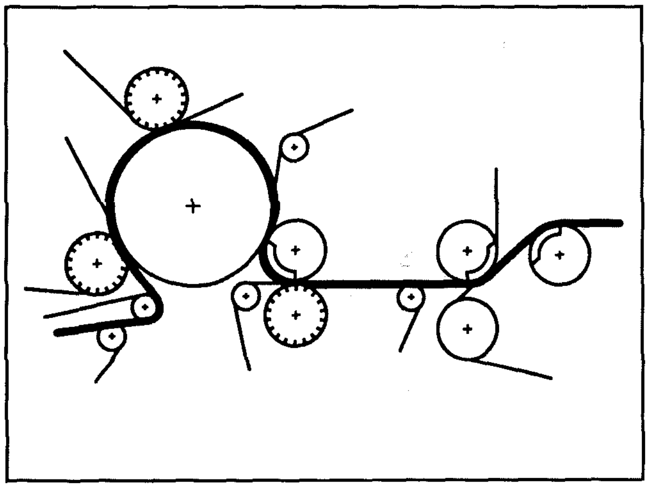
2. Triple nip (under TEM-SEC)



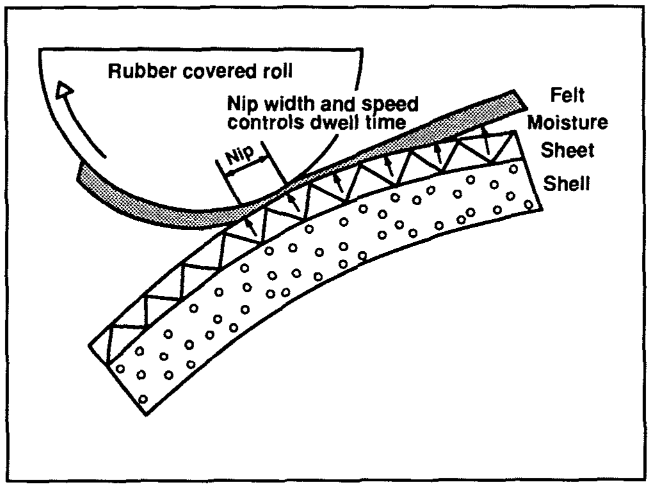
3. Triple nip (over TEM-SEC)



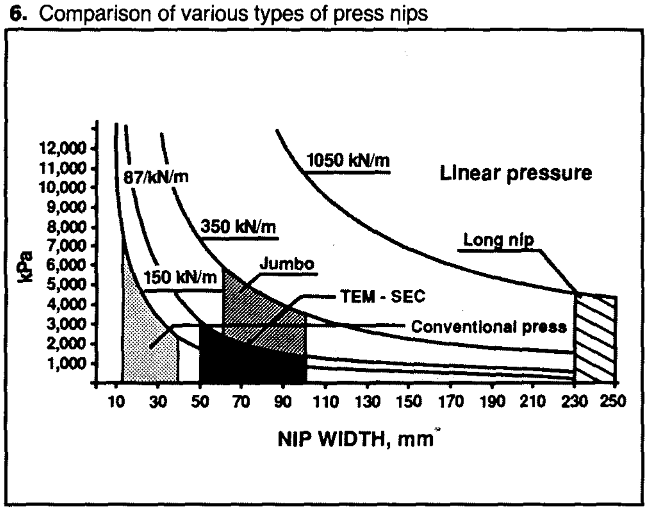
4. Four nip (over TEM-SEC)



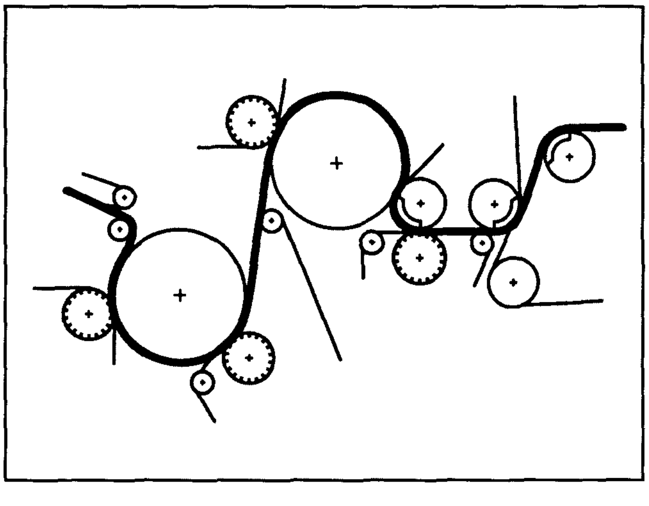
5. Typical nip detail; water is transferred through heated nip from the sheet to the felt.



6. Comparison of various types of press nips



7. Double TEM-SEC



Heating the sheet as it is placed under pressure in the nip gives a nearly instantaneous heat transfer, which is very efficient and differentiates this type of press from all other forms of pressing.

The configuration of the press, i.e., the large center roll relative to the press rolls, permits wider nips at relatively

I. kg H_2O/kg fiber

% moisture-free	kg_{H_2O} / kg_{fiber}
41	1.44
44	1.27
46	1.17
48	1.08
50	1.00
52	0.92
54	0.85

II. TEM-SEC production data

	Before	*After*
Tensile MD/CD, kN/m	8.0/6.2	8.3/6.55
Burst, kPa	379	552
Tear MD/CD, mN	2354/2982	3335/3845
Stiffness MD/CD, mN•m	18.9/11.4	16.8/12.8
Press dryness, %	41	54

Grade: Packaging, 335 g/m² (69 lb. / 1000 ft²)
Speed: 245 m/min (800 ft/min)
Production increased 15%; steam consumption reduced 25%

low applied pressures and is a very effective press nip even without the utilization of heat.

From **Fig. 6** we can see that nip widths up to those obtainable using a high intensity (Jumbo) press can be achieved with the TEM-SEC at much lower specific pressures. These lower specific pressures in the nip result in less demand on felts and roll covers. Thus they contribute to higher operating efficiency and lower running costs of the TEM-SEC Press.

The diameter of the center roll is determined by the grade, basis weight of the paper or board, and the speed. Although the basic configuration of the press is maintained, its geometry is very flexible; every TEM-SEC is tailor-made for each machine. The press is very compact, and the elimination of open press draws is a high priority.

To date, all the TEM-SEC Presses running have attained press drynesses between 50% and 56% at speeds up to 550 m/min at the present time. This has resulted in dramatic reductions in steam consumption.

For example, if we increase the dryness of the web entering the dryers from 44% to 54%, the amount of water in the sheet is reduced by 33%. See **Table I** for other comparisons. For example:

kg_{H_2O} / kg_{fiber} = 100 - consistency (% solids) / consistency (% solids)

% water reduction = $kg_{H_2O\,(old)} - kg_{H_2O\,(new)}$ / $kg_{H_2O\,(old)}$

At 44% consistency, water load is 1.27 kg/kg_{fiber}

At 54% consistency, water load is 0.85 kg/kg_{fiber}

% reduction = (1.27 - 0.85) / 1.27
= 33%

This increase in dryness results in large savings in steam or considerable increases in production. The steam consumption of the TEM-SEC is low—between 0.1 kg and 0.25 kg of steam/kg paper. In addition, the sheet enters the dryer section at a much higher temperature than normal. The first section of dryers, whose function was to heat the sheet to vaporization temperature, can now be run at higher temperatures, thereby increasing the efficiency of the first section. This again gives rise to increased production.

Additionally, a dryer sheet is stronger. This, coupled with an absence of open draws in the press, will produce a significant reduction in the number of sheet breaks.

Effects on sheet properties

Essentially the TEM-SEC is a high-tech dewatering device whose function is the extraction of water from the sheet of paper or board. The traditional press phenomena remain relevant, even though differences in sheet quality can be observed.

Observations regarding mechanical sheet properties from installations in the field include:

- Increased bulk, resistance to delamination, burst
- Maintenance of porosity, rigidity, tear, and permeability
- Increased smoothness (less calendering required).

Less calendering to achieve the same smoothness contributes to the preservation of bulk. It is clear that if you eliminate more water from the sheet, the apparent specific volume decreases. This curve is not linear, and bulk reductions level off as dryness is increased.

In general terms, sheet properties have improved from 5% to 15% on almost all installations which cover a wide range of products. Examples of this are shown in **Table II.**

Summary

The TEM-SEC Press has established itself as a press capable of reducing energy costs or increasing production by achieving press drynesses from 50% to 56%, based on the following design principles:

- Moderate increases in nip width
- Pressures and temperatures compatible with standard felt and roll cover design
- Heating the sheet to reduce water viscosity.

Further development of these principles in the laboratory has resulted in drynesses in excess of 60%, and work is in progress to attain even higher values. Different configurations are being tried, including placing TEM-SEC Presses in series to obtain even higher drynesses, as shown in **Fig. 7.** This and other work within the dryer section forms much of the basis for future research.□

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