

## Hot pressing of paper web

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**Abstract:** *Hot pressing of paper web.* Pressing and drying of paper web are basic steps in the overall paper production process. The purpose of pressing is to remove water from paper web by the action of mechanical pressure while during drying the remaining water is removed by evaporation. Since the 80s of the last century, there are studies on the combination of these two processes, namely compression of paper web with simultaneous evaporation of water. In recent years, the Institute of Papermaking and Printing Technical University a prototype device for simulating process of hot pressing was constructed. The article presents influence of basic technological parameters (temperature and pressure) on tensile properties of paper which underwent hot pressing and compared these results with data obtained for paper prepared in conventional way in Rapid-Koethen apparatus.

*Keywords:* pressing, drying, tensile properties,

### INTRODUCTION

Mechanical dewatering of paper web is much cheaper than drying. For this reason, the aim of this process is to achieve as high as possible dryness of paper webs after press section of paper machine.

For many decades, it was done by improving shaft presses, press felts and auxiliary devices for cleaning and conditioning of felts. Despite of the fact that these improvements that were introduced, conventional shaft press could work efficiently only at maximal speed of 4 m/s (240 m/min.).

The rapid growth in demand for paper that occurred after World War II tended to build more and more efficient and therefore wider and faster paper machines. When in the fifties of the last century speed of paper machines reached level of 500 m/min., the use of conventional shaft presses was an important factor limiting further growth of paper machine speed.

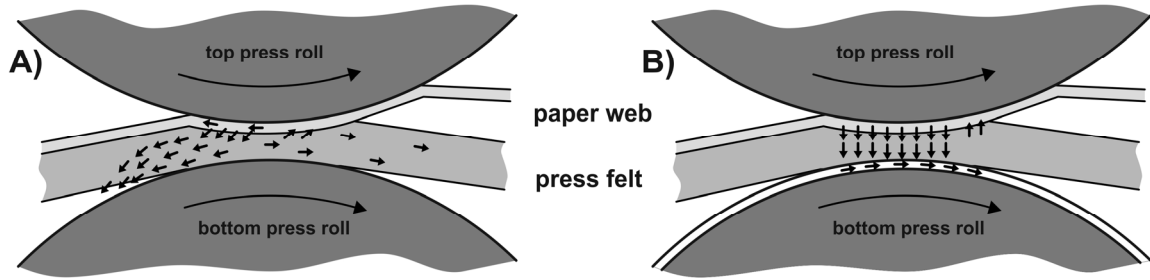
### THE DEVELOPMENT OF CLASSICAL METHODS OF PAPER WEB DRYING

After the depletion of simple ways to intensify process of pressing, in the middle of last century, the first systematic study of this process were started. The first researcher who has contributed significantly to the scientific description of dewatering of paper web in press was Campbell.

This researcher has formulated statements indicating that:

- it is necessary to divide total pressure into hydraulic pressure and structural pressure,
- there is dependence of intensity of the removal of water from paper web on compression time and applied pressure.

These tests were further developed by Bergstrom [1], Wahlstrom [2] and have enabled development of presses with lateral movement of water in the compression zone (Fig. 1).

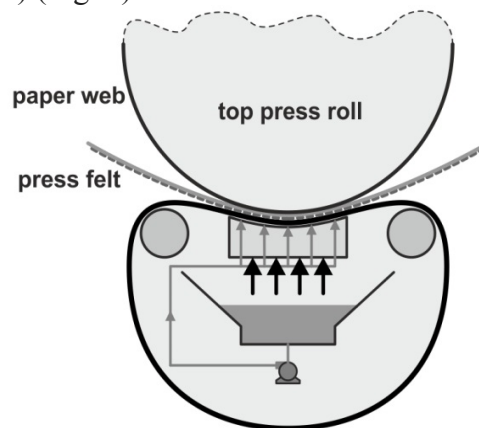


**Fig. 1** Flow of water in the compression zone  
*A) in conventional shaft press, B) in cross-flow press*

Later research done by Wirst [3] Askolf [4] Nilsson and Larsson [5] and many other researchers have enabled to elaborate in the late sixties of the twentieth century detailed description of pressing mechanism by Wahlstrom [6]. Introduction of the concept of pressing pulse (I) as the product of pressure (P) and pressing time (t) by Schiele [7] was of great importance for further development of this research.

According to the researcher, there are correlational relationship between size of the pressing pulse and achieved dryness of paper web after pressing process. Taking into consideration technological limitations of pressure that can be applied in pressing zone, this correlation indicated that the only factor in intensification of dewatering of web is pressing time.

However, as a result of increase in speed of the paper machine pressing time underwent systematic reduction. For example, in the press of a paper machine at speed of 1200 m/min. (pressing zone width of 30 mm) compression time is just 0,15ms. In order to increase pressing time many attempts were made to extend compression zone. A breakthrough in this field was made by development of press with extended pressing zone (ENP-Extended Nip Press) (Fig. 2).



**Fig. 2** Schematic press with extended pressing zone

In the extended nip press (ENP) compression zone was increased from about 30 mm to about 300 mm so about 10-times. This solution provided proper dewatering of paper web and is a standard one in modern paper machines.

## HOT PRESSING SYSTEMS

The study on compression mechanism has shown that next to pressure and pressing time an important factor in pressing process is temperature in pressing zone. This is due to the fact that temperature influences viscosity of water contained in pressed paper web.

One of the important factors in process of hot pressing is the fact that higher temperature induce higher flexibility of fibers and lead to lower porosity of pressed paper web. Studies have shown that the most effective way to increase pressing temperature is to heat press rolls.

The first generation of hot pressure presses is TEM-SEC press in which paper web is heated by hot press rolls up to approximately 100°C. In this press relatively low pressure is applied (~150kN/m) and dryness of paper web after press section is 55÷57%.

Promising results obtained in hot pressing has led researchers to increase temperature in compression zone above 100°C, forming a so-called class of superhot presses. In this process, due to increased pressure in nip, despite temperature exceeding 100°C water is still in liquid state. Also, the removal of water from paper web is done exactly the same as in conventional presses. Further increase in temperature in press nip over 100°C can cause delamination of paper web leaving pressing zone, as a result of rapid evaporation of superheated water. The development of such presses leads to merging pressing and drying. This process is referred to as hot pressing or may be also called pressure drying.

## EXPERIMENTAL

In order to investigate effect of pressure drying on properties of paper products, an experimental test site was constructed in Institute of Papermaking and Printing at Technical University of Lodz.

This test site allows simultaneously pressing and drying of paper web. Operation parameters are: pressure ranging of 0 to 10 bar and temperature up to 150°C.

Studies carried out so far have shown that paper obtained by pressure drying has significantly different properties than paper produced in classical way. In the study bleached kraft pulp from softwood (mainly pine) refined to about 30°SR was used. Increase in the density of 0.125g/cm<sup>3</sup> paper (about 15%), breaking length of about 1200 m (about 15%), resistance to bursting of about 50 kPa (about 10%) could be observed for paper produced by pressure drying.

Collected research data on pressure drying have shown that this method can greatly intensify the process of drying a paper web. For several years, advanced attempts to implement this method in industrial practice have been conducted. Experimental industrial scale device is called "Condebelt". It is expected that after finding solution to a number of technical problems in materials, design and technology, these installations will revolutionize press and drying sections of paper machine. Nowadays, drying sections are most expensive and place consuming section of any paper machines. For example, modern drying sections of paper machines installed recently in Poland (Mondi-Świecie, Ostroleka) have length of about 200 m.

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**Streszczenie:** *Gorące prasowanie wstęgi papierniczej.* Prasowanie i suszenie wstęgi papierniczej są podstawowymi etapami w ogólnym procesie wytwarzania papieru. Celem procesu prasowania jest usunięcie wody ze wstęgi papierniczej poprzez działanie ciśnienia natomiast podczas suszenia pozostałe po prasowaniu woda usuwana jest poprzez odparowanie. Od lat 80 ubiegłego stulecia istnieją badania nad połączeniem tych dwóch procesów a mianowicie nad prasowaniem wstęgi papieru z równoczesnym odparowaniem wody. W ostatnich latach w Instytucie Papiernictwa i Poligrafii Politechniki Łódzkiej skonstruowano prototypowe urządzenie umożliwiające zasymulowanie procesu gorącego prasowania. Artykuł przedstawia wpływ podstawowych parametrów technologicznych (temperatury i ciśnienia) na właściwości wytrzymałościowe papieru poddanego gorącemu prasowaniu i otrzymanego drogą tradycyjnego formowania w aparacie Rapid-Koethen.

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