Annals of Warsaw University of Life Sciences - SGGW
Forestry and Wood Technology № 82, 2013: 231-234
(Ann. WULS - SGGW, For. and Wood Technol. 82, 2013)

# Influence of dielectrical constant of liquid on forming of paper

MARCIN DUBOWIK, PIOTR PRZYBYSZ, MARTA KUCNER, KAMILA BUZAŁA
Institute of Papermaking and Printing, Technical University of Lodz

**Abstract:** *Influence of dielectrical constant of liquid on forming of paper*. The main aim of this paper is to compare the impact of water and a few similar substances (alcohols) with different dielectric constant on process of forming of paper sheets. This article assesses properties of paper sheets obtained from pulp refined in water and further formed in several alcohols. Moreover, properties of obtained paper sheets are thoroughly investigated. The results show that water plays an important role in this process not only as transport medium but also as environment for creation of bonds between fibers during forming. All of results allowed to present significant impact of water in papermaking process.

*Keywords*: alcohols, dielectric constant, forming, properties of paper

## INTRODUCTION

Water is a substance necessary and taking an active part in refining and forming of paper [2,3]. Its unique properties have an effect on both properties of pulp, and finished product obtained from it[4,7]. Despite its special significance in many industrial processes, often its role is underestimated[1].

Forming of paper web in other liquids than water is relatively rare topic in the scientific literature. Consequently, questions have arisen: how properties of the finished product would be influenced, when paper was formed in other liquids, which have different value of the dipole moment.

This article describes the differences due to the structure of the paper and its selected properties that occur through formation of paper in liquids with different dipole momentum. The paper contains a brief description of the tests performed, the results obtained marks, and lessons learned on the basis of the figures and the observed changes in the finished product.

## MATERIALS

The research on which this article was written, there were model tests. Forming the web in liquids of different polarity, characterized by stock was used by similar parameters (obtained from the same feedstock, under the same conditions). Stock used for research did not contained any non-fibrous additives. Therefore, studies were simplified because the only variable that changed was environment of forming process. The rest of the parameters remained unchanged.

Pine bleached kraft pulp was used for the research. Before forming process the pulp was refined in the optimal refining time, which was determined in previously conducted research, carried out for this pulp. Stock used for research purposes was characterized by the following properties: Schopper-Riegler freeness 25°SR, WRV for pulp equal to 201%, WRV for fibers equal to 167% , fines content about 13%.

4 samples of refined stock were prepared to be formed in liquids of varying dipole momentum. Each sample consisted of two batches of PFI mill (45g of bone dry pulp). All the samples prepared by washing pulp in alcohols in which the pulp was formed. Rinsing was performed at least ten times so as to remove all the water in the paper pulp. Each washing was conducted in a volume of 2 liters of alcohol over 20 minutes.

The next step was forming of test sheets on Rapid - Koethen apparatus, in an selected alcohol environments. The formation was performed in accordance with PN-EN ISO 5269-

2:2001 standard. All obtained test sheets were characterized by basis weight of 75 g/m². Prior to performing all the tests samples were kept in a constant temperature and humidity room, under conditions of a temperature of 23°C and humidity of 50% RH, according to PN-EN ISO 187:1990.

Paper samples subjected to the process of conditioning, were used for testing properties such as volume and the breaking load.

The **volume** is the reciprocal of the weight by volume. It is defined as the ratio of the thickness of the paper to its weight[6]. Both the volume and the weight by volume characterize the structure of the paper product[8].

In order to determine the volume of the sheets obtained laboratory, the data obtained from the determinations weight and thickness of these sheets. It is calculated in accordance with PN-EN ISO 534:2012 E.

Paper subjected to tensile forces ruptures. The force required to rupture is defined as the **breaking load**[5]. Designation of the property has been done on the tensile testing machine INSTRON 5564. The device was automatically transferring any results to a PC using the software INSTRON Bluehill 2.5. For each measurement 12 strips with dimensions 15x150 mm were used. Samples were cut from previously air-conditioned laboratory webs. All the tests were made in accordance with the guidelines contained in the PN-EN ISO 1924-1:1998 P standard [1].

On the basis of tests made in accordance with the methodology outlined above, the following results were obtained:

Changing the polarity of the medium, which occurred in a forming process greatly affects the properties of the paper obtained in such conditions. Changing dipole momentum of the liquid used during forming has a significant impact on the vast majority of the properties of the finished products.

The **volume** of paper is a parameter describing structure of finished paper[9]. It is one of the most important structural and dimensional properties[10]. Papers, obtained by forming in liquids of varying dipole momentum, have the structure of different compactness. Analyzing *Figure 1*, you can describe and try to explain the occurrence of changes in the structure of the compactness of the paper, which was formed in different liquids.

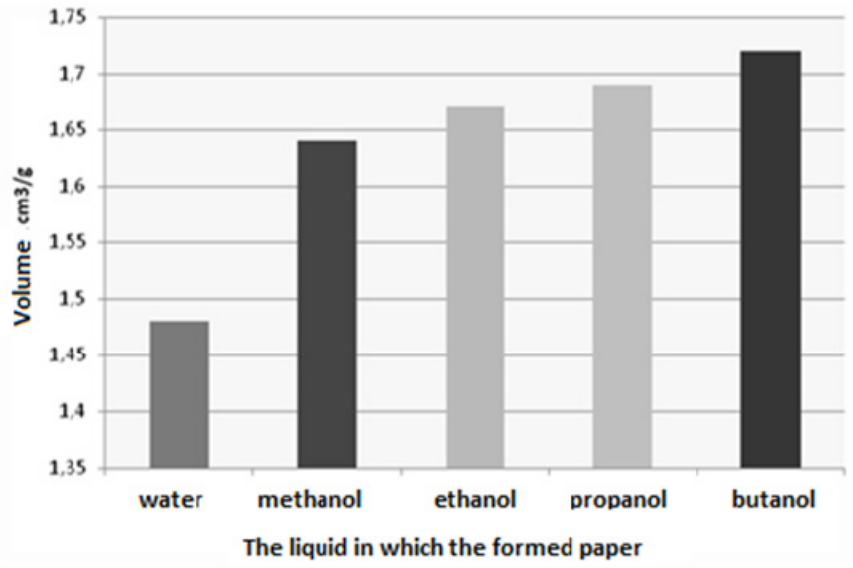


**Fig. 1** Influence of polarity of the medium in which were formed on the volume of paper

The volume of paper increases its value with decreasing polarity of the liquid in which the paper was formed. A sheet of paper formed in water was characterized by the lowest volume. Papers obtained by forming in alcohols, have much less compact structure. Comparing the dynamics of change in volume to change of polarity of liquid in which the paper was formed, it can be seen that the largest decrease in the compactness of the structure is visible between water and methanol. Between alcohols bulkiness of structure has grown less rapidly. Volume of paper obtained by forming in methanol, was approximately 10% higher than in the case of paper formed in aqueous medium. The differences in the volume of the sheets formed in alcohols were much smaller and did not exceed 2%.

Observing the nature of the changes of volume, while decreasing the polarity of the liquid in which the paper was formed, it can be assumed that using other fluids, characterized by even lower polarity, probably would give the product more and more bulk.

The value of the **breaking load** of papers formed in different alcohols, as in the case of volume, was significantly different. The nature of changes in the properties is illustrated by *Figure 2*. Papers formed in alcohols have much worse values of breaking load. The less polar was alcohol, the less value of the breaking load was obtained for paper formed in this alcohol.

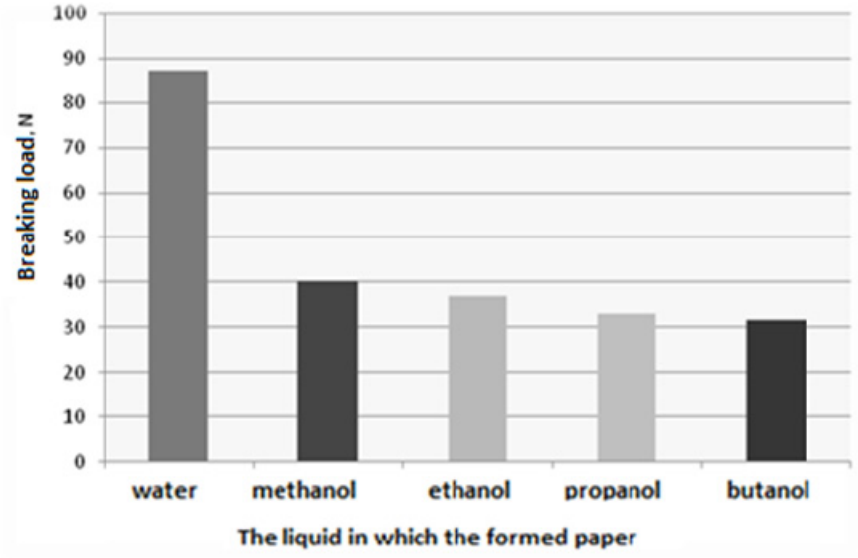


**Fig. 2** Influence of polarity of the medium in which paper was formed on the breaking load of paper

The biggest difference in breaking load is observed between papers formed in water and methanol. Paper formed in water reached twice the value of this parameter, rather than paper formed in methanol. Differences between the breaking load of papers formed in different alcohols are not so large. Nevertheless, further decrease of this parameter is noticeable for less polar forming liquids.

RESULTS

The aquatic environment is optimal and indispensable in process of forming of paper. Comparing properties of test papers formed in water to the properties of the sheets formed in alcohols, it can be noticed that properties of test sheets formed in water are much higher.].

Paper formed in alcohols are more bulk and characterized by a much poorer static tensile properties. In particular, deterioration of the mechanical properties, significantly limits the scope of usage for such papers.

REFERENCES

1. DUBOWIK M.; thesis „Influence of dielectrical constant of the liquid on forming of paper”
2. PRZYBYSZ K. 2007: Technologia papieru: Papiernicze masy włókniste, część 1. WIST, Łódź.
3. LEKS-STĘPIEŃ J. 2007; Woda substancja znana i nieznana. Przegląd Papierniczy 63, 4.
4. PRZYBYSZ K., SOKOŁOW W. 2001: Uwagi o budowie i osobliwych właściwościach wody. Przegląd Papierniczy 57.
5. MODRZEJEWSKI K., OLSZEWSKI J., RUTKOWSKI J. 1977: Metody badań w przemyśle celulozowo-papierniczym. WPŁ, Łódź.
6. Broszura informacyjna firmy Europapier; „Badanie i wybór papieru”
7. SMOOK G.A. 1999: Handbook for pulp & paper technologists – second edition. Angus Wilde Publications Inc., Vancouver.
8. HOLIK H. 2006: Handbook of Paper and Board. Willey, John&Sons Incorporated.
9. ROBERTS J.C. 1996: The Chemistry of Paper. Royal Society of Chemistry.
10. CONNERS T.E., BANERJEE S. 1995: Surface Alalysis of Paper. CRC Press.

**Streszczenie:** *Wpływ stałej dielektrycznej cieczy na proces formowania papieru*. Głównym celem pracy było porównanie wpływu działania wody i podobnych substancji chemicznych (alkoholi) o różnej stałej dielektrycznej na proces formowania papieru. W tym artykule oceniono właściwości arkusików papieru otrzymanych z masy włóknistej zmielonej w wodzie i następnie formowanej w wodzie i różnych alkoholach. Właściwości gotowych arkusików papieru są zamieszczone w niniejszej pracy. Otrzymane wyniki pokazują, ze woda jest istotnym czynnikiem, biorącym aktywny udział w tworzeniu wiązań w papierze, podczas procesu formowania. Wszystkie wyniki pozwalają pokazać znaczny wpływ wody na proces produkcji papieru.

Corresponding author:

Marcin Dubowik
ul. Wólczańska 223,
90-924 Lodz,
Poland
e-mail: marcin.dubowik1989@gmail.com