Annals of Warsaw University of Life Sciences - SGGW
Forestry and Wood Technology № 86, 2014:82-85
(Ann. WULS - SGGW, For. and Wood Technol. 86, 2014)

Influence of number of drying cycles on cellulose fibers hornification process

DUBOWIK MARCIN, PRZYBYSZ PIOTR, KUCNER MARTA, BUZAŁA KAMILA

Institute of Papermaking and Printing, Technical University of Lodz, Poland

Abstract: *Influence of number of drying cycles on pulp hornification process.*
The main aim of this paper is to assess papermaking ability of pulps, after subjecting of multiple simple model processed on paper (drying-refining cycles). This article assesses properties of respectively obtained pulps, and properties of paper sheets obtained from this pulps. With our laboratory results, it can be seen degree of deterioration of pulp and paper properties, as the proceeding drying-refining cycles. The results show influence of changes in cell wall structure in raw material on pulp and paper properties.

Keywords: hornification, modeling, wastepaper, drying, refining, paper properties

INTRODUCTION

Secondary pulps, which are also known as waste paper pulps, are characterized by a significantly less usefulness for the paper production (papermaking potential), than virgin pulps[1,2]. A decrease in the papermaking potential of waste paper pulps is due to multiple mechanical treatment (refining process) and thermal treatment (drying process). As a result of multiple mechanical and thermal processing adverse and irreversible changes in raw material occurs [3,4].

The most important factors showing deterioration papermaking ability of raw material in waste pulps are: fibers hornification, an increase in the fines content of secondary pulp and fiber shortening[4,5].

MATERIALS

This paper is based on model tests. Pulp used for research has been processed by multiple drying-refining cycles. Pulp used for research did not contain any non-fibrous additives. Studies were made so as to simulate waste pulp recirculation process. It was decided to circumvent the study of the impact of non-fibrous additives, that occurs in waste pulps in paper mills, on pulp and paper properties.

The performance of the examination was used pine kraft pulp. To comply studies 4 samples of refined pulp, at the optimum refining time (2 min) were prepared. Each of the samples consisted of three batches of PFI mill (67,5g absolutely dry pulp). Part of refined pulp (initially 3 samples, subsequently 2 samples, and at the end 1 sample) were inserted into the thermal test chamber, at the temperature 130°C, for 2 hours. Pulp samples were soaked for 24 hours and were after that refined for 2 minutes in PFI mill in accordance with PN-EN ISO 5264-2:2004, after each drying. One sample was subsequently taken away for performing measurements of the pulp properties and so as to form laboratory test sheets of paper. The remaining part of pulp was inserted back into thermal test chamber.

The formation laboratory test paper sheets was performed in accordance with PN-EN ISO 5269-2:2001. Each laboratory test paper sheets was characterized by basis weight of 75 g/m². Prior to performing measurements of paper properties, paper samples were kept in constant temperature and humidity room, under the following conditions (temperature 23°C, humidity 50% RH) according to PN-EN ISO 187:1990.

The most relevant method of assessment of the refining process progress is Schopper-Riegler freeness test. Measurement of this property of pulp is based on study of gravity water removal from pulp, under strictly defined, standard conditions[6]. To perform Schopper-Riegler freeness test an appropriate device was used. Measurement of Schopper-Riegler freeness was performed in accordance with ISO 5267-1:1999.

Increase of water absorption is one of the basic effects of refining process. Therefore measurement of WRV parameter is a significant factor in assessment of progress of pulp refining process. The most common method of measuring the water retention within fibers is simplified Jayme and Rothamel centrifugal method. This method is based on centrifugation of swollen pulp sample and determining ratio of water to weight of bone dry sample[6].

Designation of the breaking length was done on the tensile testing machine INSTRON 5564 in accordance with the guidelines contained in the PN-EN ISO 1924-1:1998 P.

RESULTS

The following results wer obtained::

The value of Schopper-Riegler freeness of pulp, which has been triple processed to drying-refining cycles, increased significantly. Growth of Schopper-Riegler freeness property can be assessed on the basis of the figure 1.

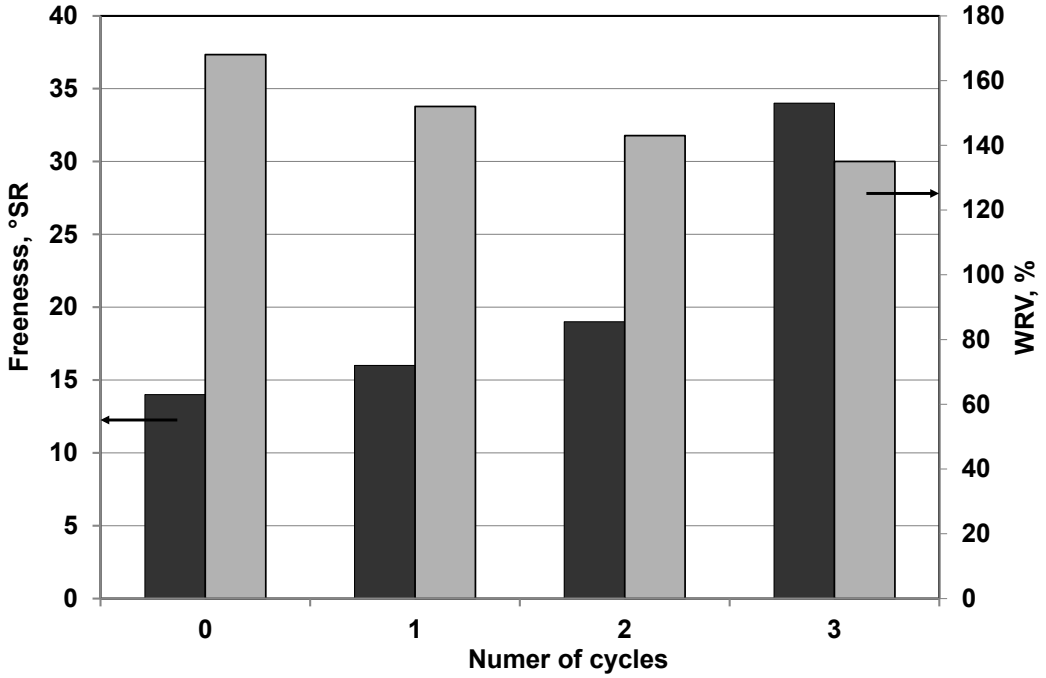

Figure 1. Freeness of pulp after given number of cycles

The *figure 1* also shows that pulp, which was processed to multiple drying-refining cycles, has lower WRV parameter, than before mechanical and thermal treatment. The pulp, which was processed three times, was characterized by WRV parameter at the level of 135%. The swelling ability of pulp, which has been triple processed, decreased almost 20%. The largest decrease of swelling ability of pulp occurred after first drying-refining cycle. Subsequent cycles of drying-refining also resulted in significant decrease of WRV parameter of pulp, but rate of changes of this parameter were smaller than in the case of first drying-refining cycle.

Observing figure 1 it can be concluded that pulp, which has been triple processed to drying-refining cycles, should continue to lose swelling ability of pulp. The decrease of

swelling ability of pulp, which was processed to multiple drying-refining cycles, is due to the intensifying hornification process of raw material.

The breaking length property often decides the suitability of the product for its further processing. Changes in the breaking length can be assessed on the basis of the figure 2. Observing figure 2 it can be concluded that breaking length of paper, obtained from pulps which was processed by multiple drying-refining cycles, decreases.

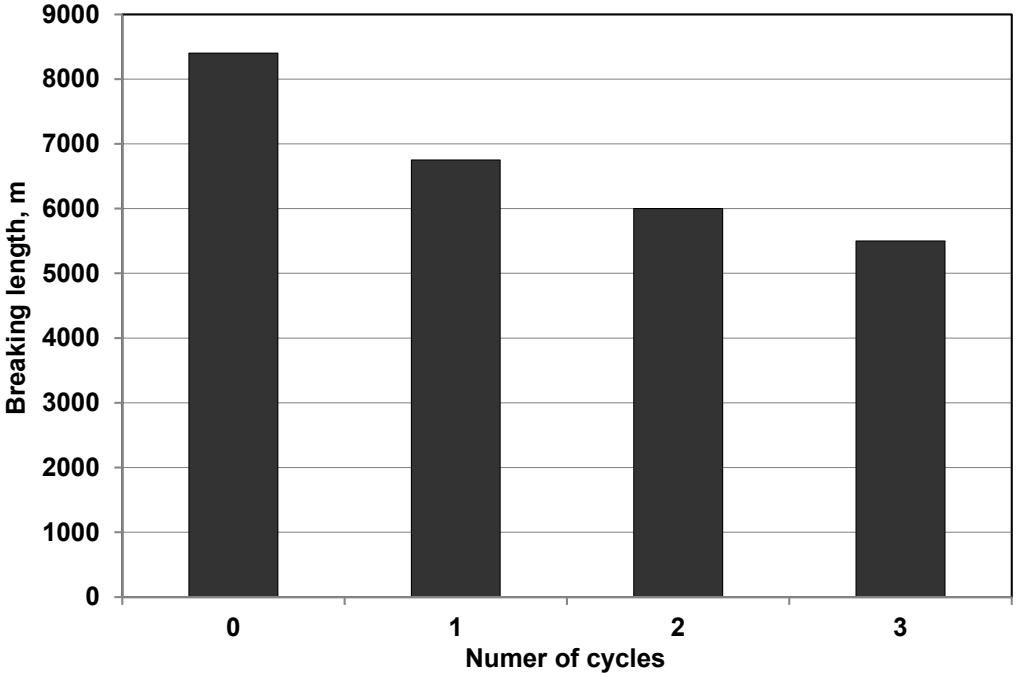

Figure 2. Breaking length of paper after given number of cycles

CONCLUSIONS

Raw material in pulp, which has been triple processed, can be used for papermaking process. Subsequent cycles of drying-refining resulted in deterioration of pulp and paper properties, but pulp, which has been triple processed, and paper obtained from this pulp had acceptable properties.

Paper obtained from pulp, which has been triple processed, has a lower static and dynamic strength properties of paper. The reduction of static strength properties of paper is due to the irreversible hornification process of raw material in pulp. The reduction of dynamic strength properties of paper is due to in pulp an increase in the fines content of secondary pulp and fiber shortening.

Significantly reduced strength properties of papers, obtained from pulps, which was processed to multiple drying-refining cycles, indicate the necessity other uses of this pulps. From the virgin pulp could be obtained bag paper, which was characterized good results of strength properties. On the other hand from the waste pulps, which were processed to multiple drying-refining cycles, it would be impossible obtained papers for the bag production.

An increase in the fines content of secondary pulp causes increase of Schopper-Riegler freeness of pulp. Subsequent cycles of drying-refining resulted in progress of degree of hornification process in raw material. Raw material after hornification process is characterized by lower swelling ability of pulp. Therefore, during the refining process raw material is severely damaged. Increase of Schopper-Riegler freeness of pulp is the reason of deterioration of water retention of pulp. In the papermaking industry deterioration of water retention of pulp is an undesirable effect.

Occurrence of deterioration of water retention of pulp causes reducing the speed of the paper machine. Along with the reduction of paper machine speed, efficiency of paper machine

is deteriorating. Deteriorating of paper machine efficiency is the cause of reducing of profitability of paper production.

REFERENCES

1. PRZYBYSZ P. 2011: Przerób makulatury i wykorzystanie wtórnych papierniczych mas włóknistych, Przegląd Papierniczy 67,8
2. PRZYBYSZ K. 2007: Technologia papieru: Papiernicze masy włókniste, część 1, WIST, Łódź
3. SURMIŃSKI J. 1997: Budowa i morfologia surowców i mas włóknistych, WAR, Poznań
4. BAJPAI P. 2014: Recycling and Deinking of Recovered Paper, ElSevier
5. PRZYBYSZ K. 1979: Rozprawy Naukowe Nr 19, Łódź
6. SZWARCSZTAJN E. 1963: Technologia papieru, część I, WPLiS, Warszawa

The authors gratefully acknowledge that this work was financially supported by the project LIDER/042/407/L-4/12/NCBR/2013 funded by National Center for Research and Development (Poland). The authors also wish to thank Mrs. Katarzyna Kowal for her help in collection and statistical elaboration of data.

Streszczenie: *Wpływ krotności suszenia na rogowacenie włókien*.
Głównym celem pracy była ocena zdolności papierotwórczej mas włóknistych poddanych wielokrotnemu modelowemu przerobowi na papier, czyli cyklom suszenie mielenie. Ocenione zostały właściwości odpowiednio przetworzonych mas włóknistych oraz arkusików papieru z nich otrzymanych. Dzięki uzyskanym wynikom laboratoryjnym, można zauważyć stopień pogarszania się własności masy i papieru z niej wytworzonego, w miarę postępujących cykli suszenie mielenie. Wszystkie rezultaty zamieszczone w tym artykule pokazują wpływ zmian w strukturze ścianek komórkowych frakcji włóknistej na właściwości mas włóknistych oraz papieru.

Słowa kluczowe: rogowacenie, modelowanie, makulatura, suszenie, mielenie, właściwości papieru

Corresponding author:

Marcin Dubowik,
Wólczańska 223
90-924 Lodz, Poland
email: marcin.dubowik1989@gmail.com
phone: +48 606 246 404