

Influence of drying temperature on cellulose fibers hornification process

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Abstract: This work presents the impact of drying temperature on the tensile properties of both paper and pulp. Results from experimental show that properties of paper obtained directly from never-dried pulp are far better than for paper made from pulp previously dried at 150°C. Moreover, this results underline that drying contributes significantly to hornification and make impossible for fibers to return to their original state. Therefore, drying has such a tremendous impact on papermaking potential of pulp.

Keywords: drying, water retention value, strength properties, hornification, temperature

INTRODUCTION

Drying is one of the fundamental technological operations in the production of paper [2,3]. Pulp is dried not only in papermaking technological line, but also can be dried so as to prepare pulp for transportation at long distances (eg. Eucalyptus). The important aspect of drying is change in properties of fibres after this process [2,4]. So as to avoid any undesired changes of pulp properties the best option is to produce pulp in integrated plants, where pulp is produced in technological line which is located next to paper mill. In such a case it is possible to avoid hornification of fibres and deterioration of pulp and paper properties [1-10]. This is an important issue, because very often paper mills buy dried pulp in form of bales to produce paper. The dried pulps does not exhibit such a big swelling of fibers as wet pulp. Hornification leads to loss of elasticity and flexibility of the fibers [1,7]. In this work it was decided to investigate the effect of temperature of drying on basic effects of pulp and paper properties. This subject has been taken because, in the desire to deepening basic knowledge of state on pulp in the drying process. This research are of fundamental research, however, can lead to the understanding of this process, because there are still many unexplored issues in this field. Specially for this work a research methodology was developed. In the experimental part properties of paper and pulp were tested, for sample subjected to drying before refining process. Based on these results it can be concluded that the level temperature of drying plays an important role in the processing of pulp. It was confirmed in a scientific manner that never-dried pulp is the best raw material for production of paper.

EXPERIMENTAL

The research material used in the paper was unbleached and never-dried pine sulfate pulp delivered directly from pulp mill. For this pulp a refining curve was elaborated. Refining process was done in PFI laboratory refiner in which a single batch was 22.5 b.d. pulp, concentration was equal to 10%. One point experimental point consisted of three batches of the PFI refiner. Time of refining ranged from 0.5 min to 3 min. Before each refining, pulp was soaked in water for 24 hours. Unrefined pulp was also examined. After defibering and refining of pulp parallel samples were placed in mixers. After unification of concentration by

mixing, laboratory test sheets of paper were made on the Rapid-Kothen type apparatus. The sheets were made according to PN-EN 20187:2000.

Following investigation of pulp properties was performed:

- ✓ water retention value with fines,
- ✓ water retention value without fines,
- ✓ sliminess,
- ✓ fines content.

After performing test sheets, they were conditioned for 24 hours in the conditions of $23 \pm 1^\circ\text{C}$ and $50 \pm 2\%$ relative humidity. The following paper tests were performed:

- ✓ breaking length
- ✓ tear resistance
- ✓ extensibility
- ✓ roughness
- ✓ volume.

Then performed the same research for the pulp, which was dried in different temperature for 2 hours. Later the pulp was one again defibrated and refined for 2 min in PFI mill.

Temperature, which was used for research:

- ✓ 105°C ,
- ✓ 130°C ,
- ✓ 150°C ,
- ✓ and air-dry pulp (which had a longer drying time).

RESULT

Table 1. Table of selected properties of paper and pulp

Condition of pulp	Roughness	Breaking length	WRV with fines	WRV without fines
-	ml/min	m	%	%
Never-dried	510	9170	186	171
Air-dry	630	8410	167	150
Dried in 105°C	690	7740	162	149
Dried in 130°C	790	7470	155	145
Dried in 150°C	850	5570	141	132

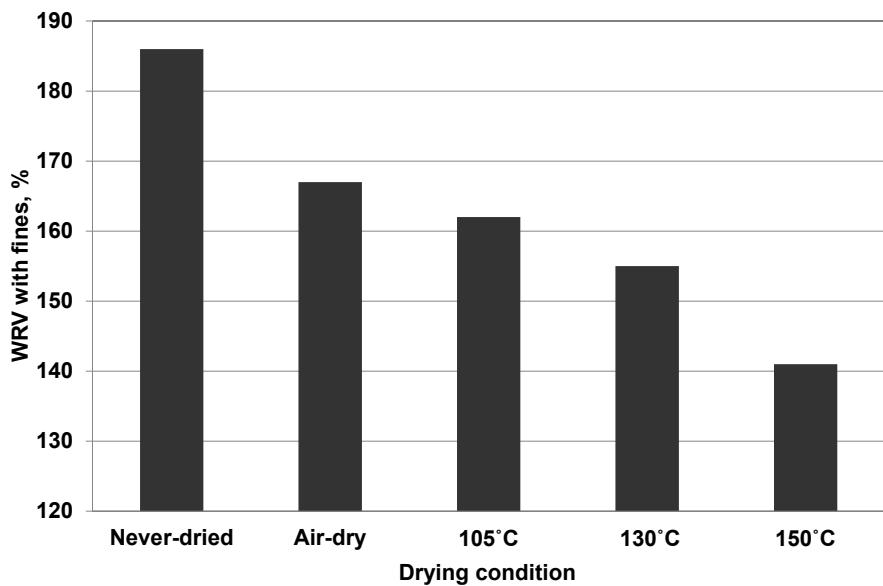


Figure 1. Changes in WRV of pulp with fines with respect to drying temperature

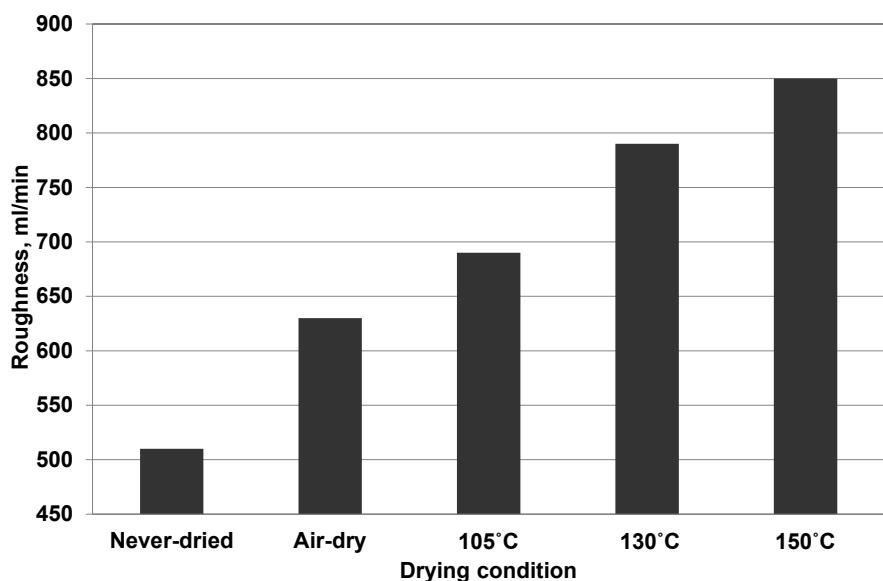


Figure 2. Changes in roughness of paper with respect to drying temperature

CONCLUSIONS

Pulps dried in higher temperature and further process into paper show increase in roughness that is caused by loss of elasticity and flexibility of fibres. It can be concluded that the increase of drying temperature reduces swelling of fibres. This may be caused hornification fibres. The study showed that never-drying pulp is the best possible raw material for papermaking process. Higher value of drying temperature has caused both reduction of pulp WRV and decrease in statistic tensile properties of paper. At the same time there was an increase of dynamic tensile properties.

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Streszczenie: Wpływ temperatury suszenia na rogowacenie włókien. W pracy przedstawiono wpływ temperatury suszenia na właściwości wytrzymałościowe końcowego produktu i właściwości masy włóknistej. Wyniki dla próbek wykazują, że właściwości papieru wykonanego z mokrej masy włóknistej są znacznie lepsze niż dla papieru wykonanego z masy włóknistej suszonej w 150°C. Ponadto wyniki podkreślają, że suszenie znacznie przyczynia się do rogowacenia i uniemożliwiają powrót włókien do ich pierwotnego stanu. Z tego też powodu, można stwierdzić, że suszenie odgrywa ważną rolę w procesie wytwarzania papieru.

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