The role of CNF in bulk and on surface: the case of SGW pulp

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Abstract

The effect of different application amounts of nanofibrilated cellulose (CNF), from 0 to 6%, on the physico-mechanical properties of the paper obtained from stone ground wood pulp fiber has been studied. For that, CNF were dispersed in the pulp slurries using a laboratory pulper. After that, papers were coated with a starch-CNF solution. In parallel, pulp slurries were also refined at different degrees (from 0 to 2500 rpm). The results were compared with the conventional beating process at different degrees (from 0 to 2500 rpm). Afterwards the effect of the application of CNF on the surface, in papers with and without CNF in bulk, was studied. The results showed that the paper stiffness and breaking length increased with freeness; however the ºSR increased significantly hindering drainage.

The contribution of CNF in bulk also increased °SR and breaking length, therefore the °SR beaten at 1500 rev was equivalent to a content of CNF between 4.5 and 6%, but its breaking length was found to be substantially greater. It can be concluded that the CNF in bulk can be viewed as an alternative to mechanical beating and that the application of CNF at the paper surface allows increasing strength properties without affecting the drainage capacity.

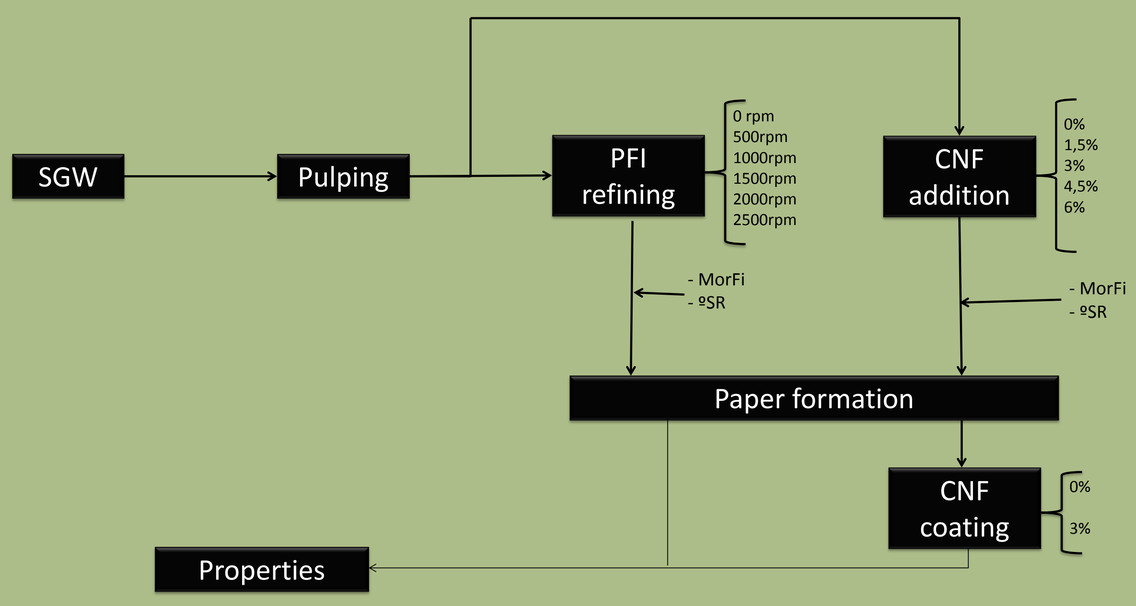
Introduction

SGW pulp is a fibrous material (Lennart Salmén, 1998), that is commonly produced from softwood through processes that can reach yields of 98,5%. The most common applications are graphic papers, newspapers, fiberboards and packaging (Hurter, 2002). The main process in papermaking process is refining fibers to enhance mechanical properties. This process is harmful for fibers, impeding the improvement of mechanical properties in the next recycling cycles (Delgado-Aguilar et al., 2015).

The present work attempts to find an alternative to this conventional processes by means the addition of CNF in bulk and on surface, assessing the interaction between CNF and SGW taking into account the differences of both type of fibers.

Experimental

The following flowchart shows the experimental procedure of the whole project:

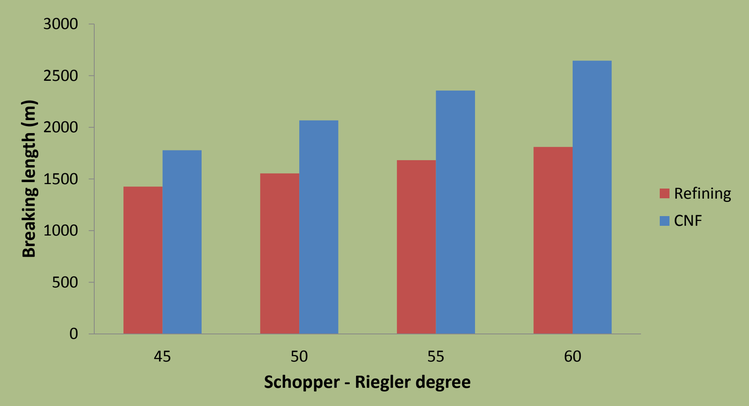


A commercial SGW dry pulp was disintegrated in a laboratory pulper and, in parallel, it was refined and different amounts of CNF were added in bulk. Both pulps, after treatment, were characterized from a morphological point of view (MorFi) and the drainage rate was determined. Pulps 0 and 3% of CNF in bulk were coated with a suspension 2,5% native starch and 0,45% CNF.

Finally, breaking length of all the sheets were determined. In addition, the grammage of coated papers was compared to those ones that were not in order to assess the weight increase.

Results and discussion

In order to compare the effect of CNF and the refining process, the following graph shows the breaking length evolution depending on the Schopper – Riegler degree (from 45 to 60ºSR).



As is possible to see, the performance of CNF besides refining is higher, since for the same Schopper – Riegler degree the breaking length is higher. These differences can be given by the differences between both fibers (CNF and SGW fibers). CNF are nearly pure cellulose and, on the other hand, SGW fibers have the same chemical composition than softwood since they have only been mechanically treated.

Sheets without and with 3% of CNF in bulk were coated with a suspension of 2,5wt% of native starch and 0,45% CNF. In order to assess the effect of the coating on papers with CNF in bulk, the following table shows the properties of these papers.

CNF (%)	Grammage (g/m^2)	ºSR	L_R (m)	Coated
0	75,71	34	1190	
	76,13		1549	X
3	75,83	49	1903	
	76,19		2606	X

When CNF are added as coating, there is an increase in the grammage. This is due to the retention of CNF. Further, since coating is a treatment post-formation, the Schopper – Riegler degree is the same and papers have an increase in the breaking length. For sheets without CNF in bulk, the increase in the breaking lenght is about 30%. Moreover, 3% CNF papers have an increase of 37%.

Conclusions

The main conclusions of this work are the following:

- Through the addition of CNF in bulk, it is possible to achieve higher values of breaking length than through refining mechanically the fibers.
- It is well known that starch as coating agent strengthens the paper. Moreover, it has been demonstrated that if a suspension of CNF and starch is coated to the paper, the stregnthening is higher.
- It is possible to increase the final mechanical properties without increasing the drainage rate through the addition of CNF on surface.

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