

The role of CNF on paper recycling process

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Abstract

In recent years, recycling has been a topic of interest for many researchers. Recycling cycles, due to drying steps, causes hornification. It has been demonstrated that this phenomena causes reduction in the shear bond strength and the relative bonding area (Hubbe 2013). It has been demonstrated that the addition of CNF enhances mechanical properties of paper (González et al., 2012). The present work aims to find an alternative to the conventional beating during the recycling process for a bleached chemical eucalyptus pulp is proposed. This work attempts to substitute mechanical refining processes by CNF addition in order to avoid the loss of properties due to recycling cycles. After five recycling cycles through CNF addition, breaking length was higher than those papers that were simply recycled. Regarding to the drainage rate, α SR reached values that imply decreasing the speed of the paper machine. As a conclusion, hornification is something that cannot be solved through CNF addition, but these ones provide to the recycled paper some competitive properties without fibre deterioration. It also can be said that through the addition of drainage agents, the Schopper – Riegler degree could be decreased.

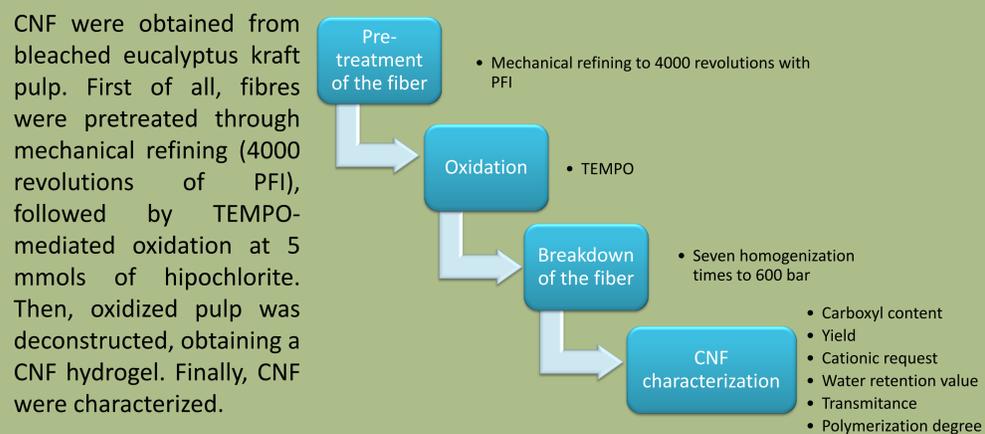
Introduction

In recent years, recycling has been a topic of interest for many researchers since it contributes to reduce deforestation and subresidues generation. The main concern has been the avoidance fibre quality loss caused by fibre hornification due to the recycling cycles (Hubbe 2013).

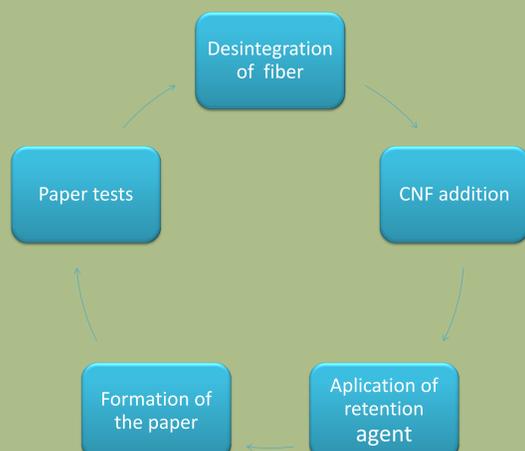
It has been demonstrated that cellulose nanofibers added in bulk enhance the mechanical properties of papers (González et al., 2012). The present work attempts to assess the role of CNF in recycling processes.

Experimental

The following flowchart shows the experimental procedure for the obtention of CNF through TEMPO-mediated oxidation:



CNF were added in bulk to the recycled pulp slurry after the disintegration process in order to avoid the loss of properties. The optimal amount was also studied in order to maintain mechanical properties, as is shown in the flowchart below:



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Results and discussion

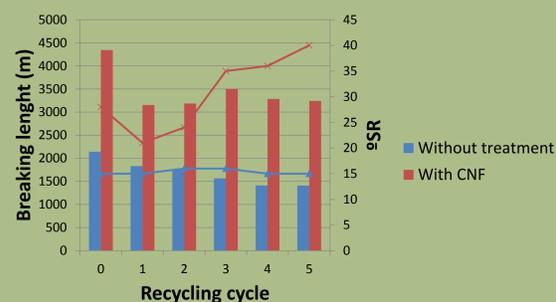
CNF characterization is reflected in the following table, as well as the chemical reagents and energy consumption:

CNF 5mmol	
Carboxyls content (ueq·g/g)	881
Yield (%)	>95
Cationic demand (ueq·g/g)	123,8
WRV (gH ₂ O/g)	8,2
Transmittance (%)	90
Polymerization degree	488
Energetic Cost (€/kg)*	3,41
Chemical Cost (€/kg)**	154,8

* Price of energy 0,06€/kw-h

** Catalyst recuperation not taken into account

The graph below shows the comparison between recycling paper without any treatment (in blue) and through CNF addition (in red):



Regarding the evolution of recycling cycles without any treatment, the loss properties is evident. While increasing the recycling cycles, breaking length decreases. This fact makes necessary the implementation of some treatments in order to avoid this loss.

Papers with CNF in bulk also experiment a loss in breaking length, but, on the other hand, through the addition of CNF it is possible to maintain the properties. Regarding to the drainage rate, while in recycling cycles without any treatment it remains constant, in papers with CNF in bulk α SR increases. This fact confirms the presence of CNF despite of recycling cycles (36wt% from previous addition).

Due to this presence, the loss on mechanical properties is not much pronounced.

Conclusions

The main conclusions of this work are listed below:

- CNF have an important role in recycling processes. Through their addition in bulk, it is possible to provide good properties to recycled paper.
- Through the addition of CNF during recycling cycles, it is possible to maintain mechanical properties. On the other hand, Schopper – Riegler degree increases until levels that make difficult their runnability.
- Drainage rate can be improved through the addition of polyethyleneimine-based drainage agents.
- Hornification can not be solved through CNF addition, but these ones provide to paper competitive properties without deteriorating the fibres.

References

- Hubbe, M. A. (2013). Prospects for maintaining strength of paper and paperboard products while using less forest resources: A review. *BioResources*, 9(1), 1634-1763.
- González, Israel, et al. "Nanofibrillated cellulose as paper additive in eucalyptus pulps." *BioResources* 7.4 (2012): 5167-5180.