Energy and production costs of cellulose nanofibres obtained by different pretreatments

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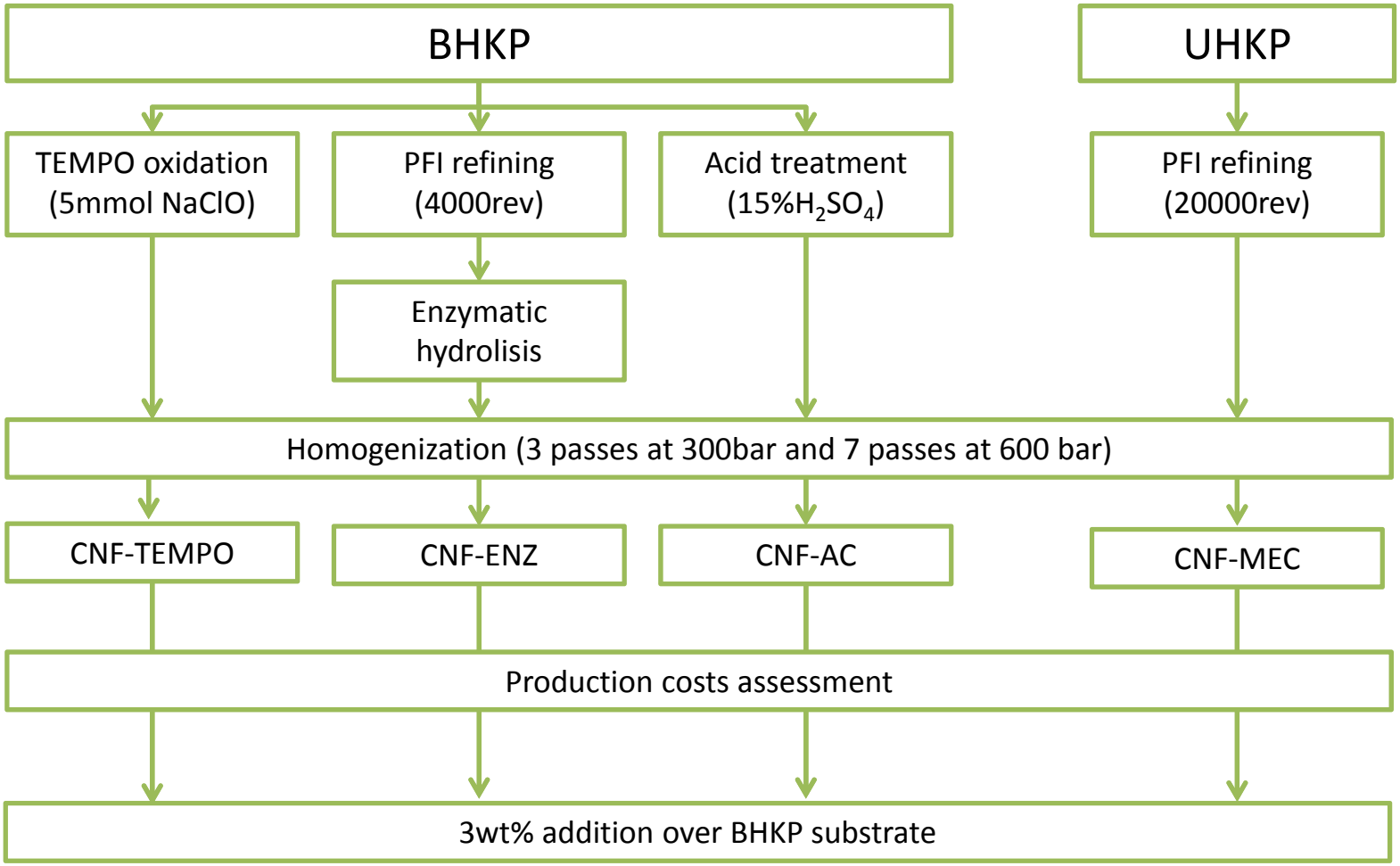
Objectives

- To determine the production costs (laboratory scale production) of different types of cellulose nanofibers (CNF).

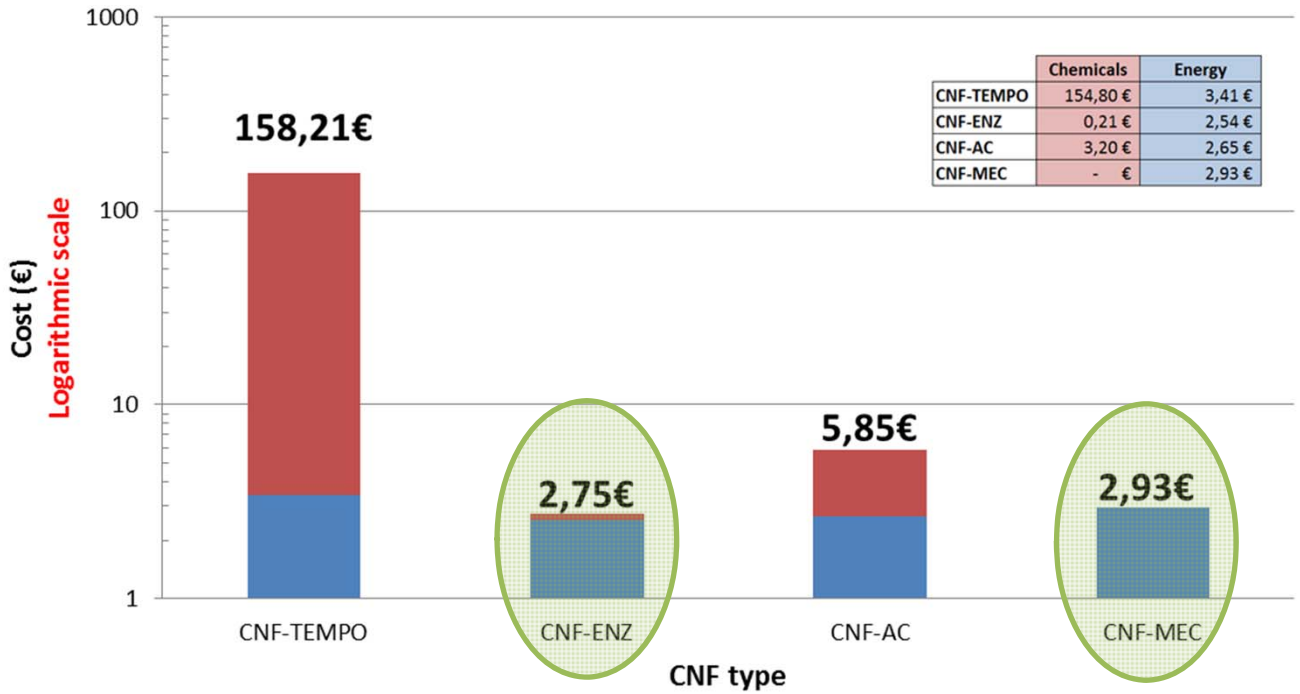
- To estimate the comparative cost with regard to CNF in the production of a paper (made of bleached kraft hardwood pulp) with 4.200m of breaking length (isotropic formation).

Methodology



Results

Production costs for 1kg



	Chemicals	Energy
CNF-TEMPO	154,80 €	3,41 €
CNF-ENZ	0,21 €	2,54 €
CNF-AC	3,20 €	2,65 €
CNF-MEC	- €	2,93 €

CNF performance

Bleached hardwood kraft pulp substrate: B.L. = 2054m; 16ºSR

	BHKP CNF			UHKP CNF
	CNF-TEMPO	CNF-ENZ	CNF-AC	CNF-MEC
	5mmols	*0,83wt%*	*15%*	-
Breaking length (m)	4129 (+101%)	3902 (+89%)	3594 (+75%)	3841 (+87%)

cost
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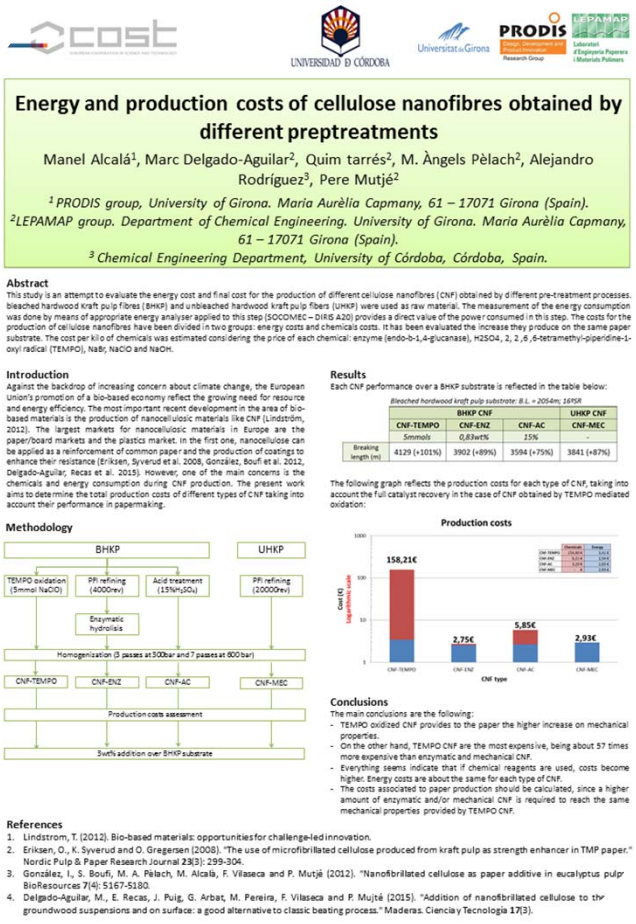
Conclusions

The main conclusions are the following:

- TEMPO oxidized CNF provides to the paper the higher increase on mechanical properties.
- On the other hand, TEMPO CNF are the most expensive, being about 57 times more expensive than enzymatic and mechanical CNF.
- Everything seems indicate that if chemical reagents are used, costs become higher. Energy costs are about the same for each type of CNF.
- The costs associated to paper production should be calculated, since a higher amount of enzymatic and/or mechanical CNF is required to reach the same mechanical properties provided by TEMPO CNF.



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Abstract

This study is an attempt to evaluate the energy cost and final cost for the production of different cellulose nanofibres (CNF) obtained by different pre-treatment processes. Bleached hardwood kraft pulp fibres (BHKP) and unbleached hardwood kraft pulp fibers (UHKP) were used as raw material. The measurement of the energy consumption was done by means of appropriate energy analyser applied to this step (SOCOMEC – DIRIS A20) provides a direct value of the power consumed in this step. The costs for the production of cellulose nanofibres have been divided in two groups: energy costs and chemicals costs. It has been evaluated the increase they produce on the same paper substrate. The cost per kilo of chemicals was estimated considering the price of each chemical: enzyme (endo-b-1,4-glucanase), H2SO4, 2, 2 ,6 ,6-tetramethyl-piperidine-1-oxyl radical (TEMPO), NaBr, NaClO and NaOH.

Introduction

Against the backdrop of increasing concern about climate change, the European Union's promotion of a bio-based economy reflect the growing need for resource and energy efficiency. The most important recent development in the area of bio-based materials is the production of nanocellulosic materials like CNF (Lindström, 2012). The largest markets for nanocellulosic materials in Europe are the paper/board markets and the plastics market. In the first one, nanocellulose can be applied as a reinforcement of common paper and the production of coatings to enhance their resistance (Eriksen, Syverud et al. 2008, González, Boufi et al. 2012, Delgado-Aguilar, Recas et al. 2015). However, one of the main concerns is the chemicals and energy consumption during CNF production. The present work aims to determine the total production costs of different types of CNF taking into account their performance in papermaking.

Methodology

Results

Each CNF performance over a BHKP substrate is reflected in the table below:

Bleached hardwood kraft pulp substrate: B.L. = 2054m; 16ºSR

	BHKP CNF			UHKP CNF
	CNF-TEMPO	CNF-ENZ	CNF-AC	CNF-MEC
	5mmols	*0,83wt%*	*15%*	-
Breaking length (m)	4129 (+101%)	3902 (+89%)	3594 (+75%)	3841 (+87%)

The following graph reflects the production costs for each type of CNF, taking into account the full catalyst recovery in the case of CNF obtained by TEMPO mediated oxidation:

Conclusions

The main conclusions are the following:

- TEMPO oxidized CNF provides to the paper the higher increase on mechanical properties.
- On the other hand, TEMPO CNF are the most expensive, being about 57 times more expensive than enzymatic and mechanical CNF.
- Everything seems indicate that if chemical reagents are used, costs become higher. Energy costs are about the same for each type of CNF.
- The costs associated to paper production should be calculated, since a higher amount of enzymatic and/or mechanical CNF is required to reach the same mechanical properties provided by TEMPO CNF.

References

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Thanks for your attention!

Have a look to the poster and do not hesitate to contact me for any inquiry!

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