

# Relevance of retention systems when using cellulose nanofibers as strength additives in papermaking

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**CNF**

**Improvement of paper strength**



Retention agent  $\longrightarrow$  Cationic Starch  
*Effect on drainage process*



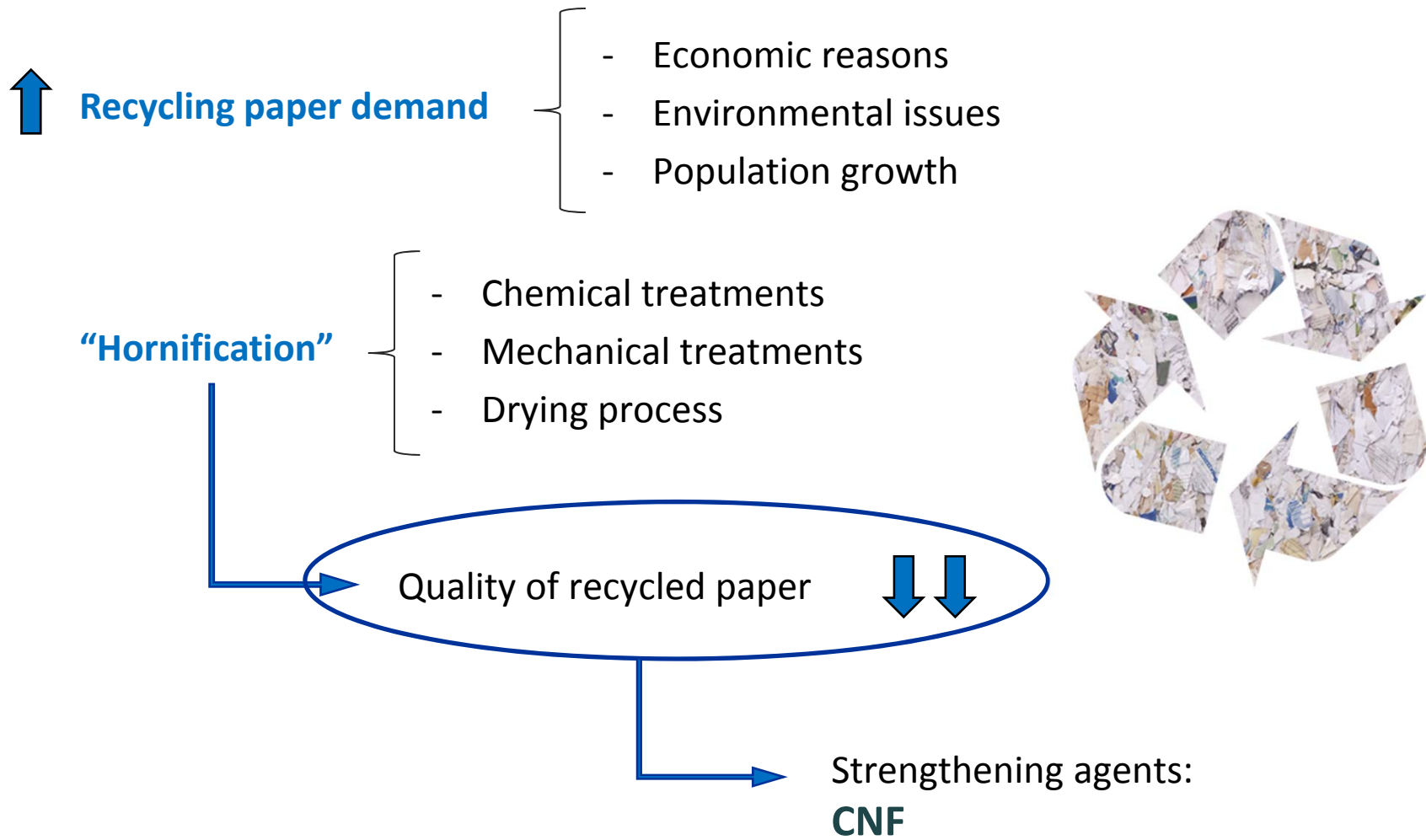
**Retention system is already used in the papermill**



Process is optimized with it



Retention of CNF with the system used in the papermill



Cellulose sources: Eucalyptus globulus ECF bleached kraft pulp

Cellulose

Cellulose + TEMPO catalyst + NaBr + NaClO (pH = 10)

TEMPO pretreatment

Characterization  
Carboxylic content

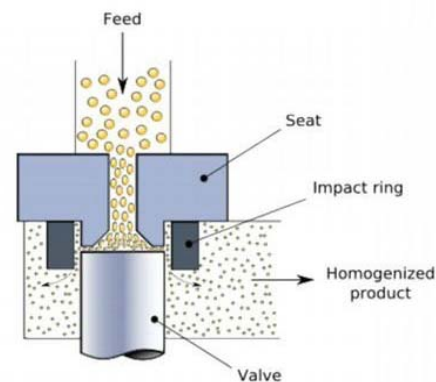
CNF



Homogenization

Characterization

- High degree of fibrillation
- Low polymerization degree



Carboxylic groups (mmolCOOH/g)	Cationic demand (meq/g)	Polymerization degree (monomers)	Yield (%)
0.59	0.465	267	>95

## DRAINAGE MEASUREMENTS

Equipment for drainage experiments → Drainage Freeness Retention (DFR)



0.5 wt% pulp consistency  
+ CNF  
+ Retention System

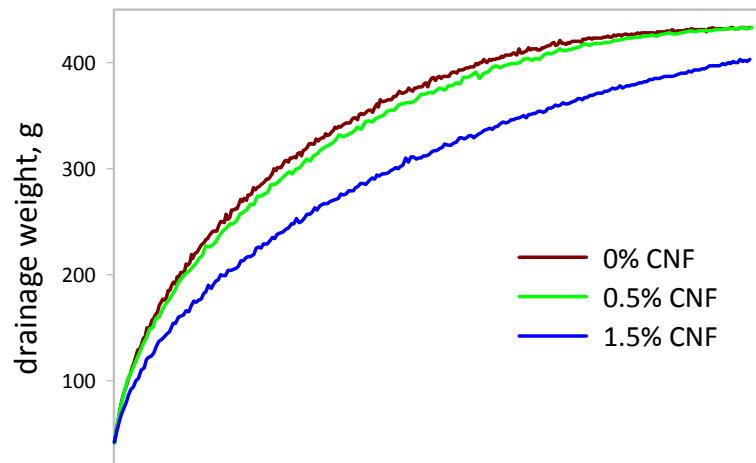
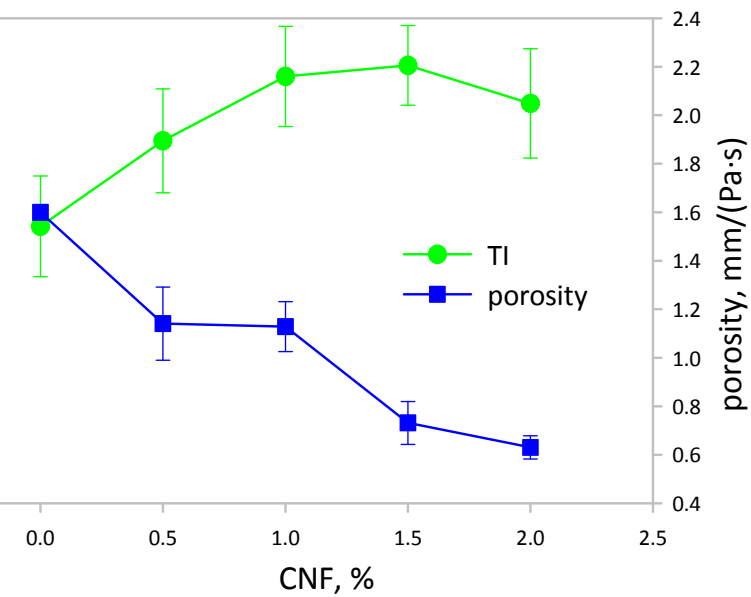
DRAINAGE CURVE  
(mass of drained water vs. time)

Drained water:  
Total solid content  
Total retention

**Parameter W300: time needed to drain the first 300 g of water during the drainage process**



F added to the recycled pulp **without retention system** were retained  
creasing paper strength



ut as expected, negatively affecting the

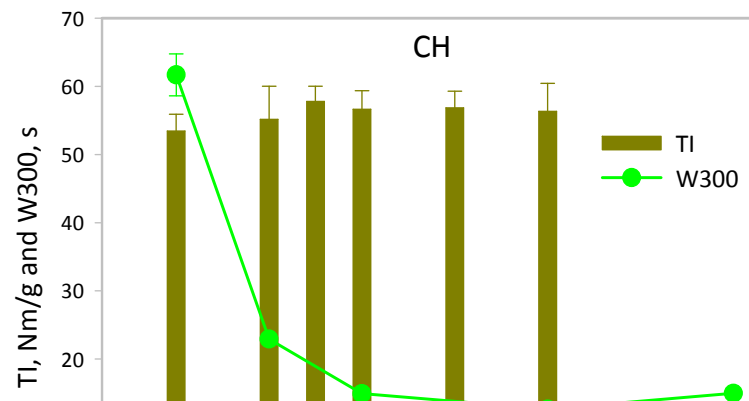
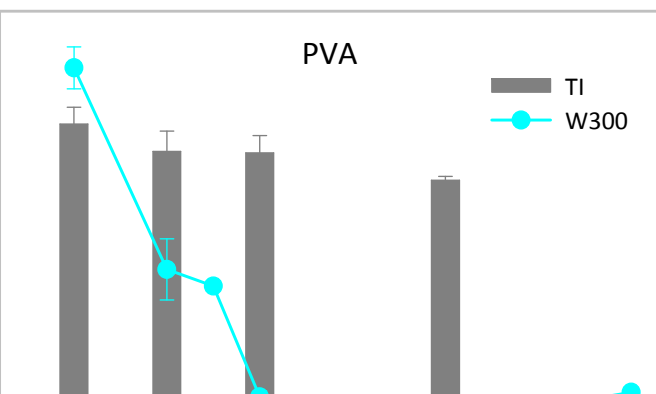
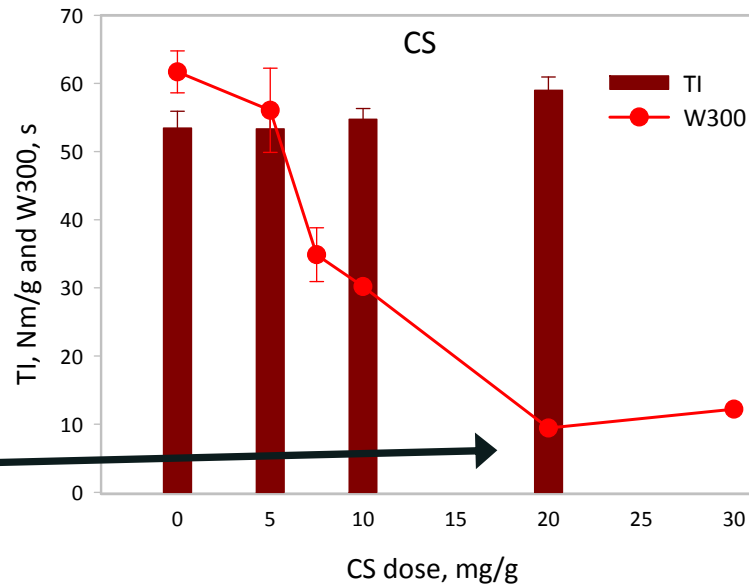
## EFFECT OF RS ON STRENGTH AND DRAINAGE



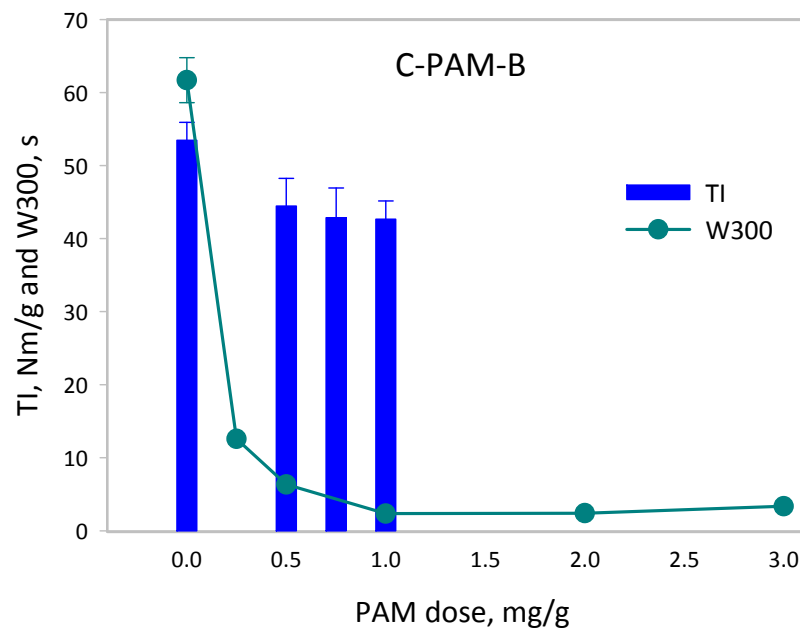
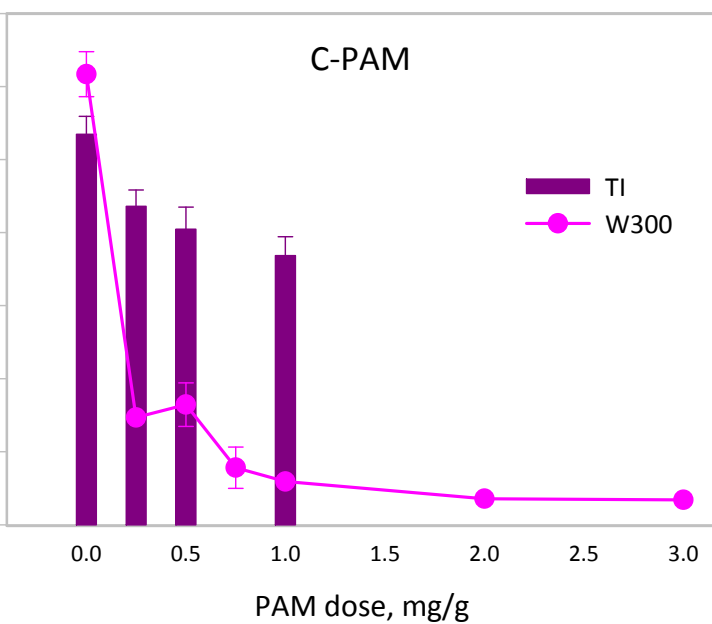
Retention systems added to the recycled paper without CNF affected differently the strength of the paper

W300 (s) is the time needed to drain 300 g of water

High doses of cationic starch are needed to reduce drainage time

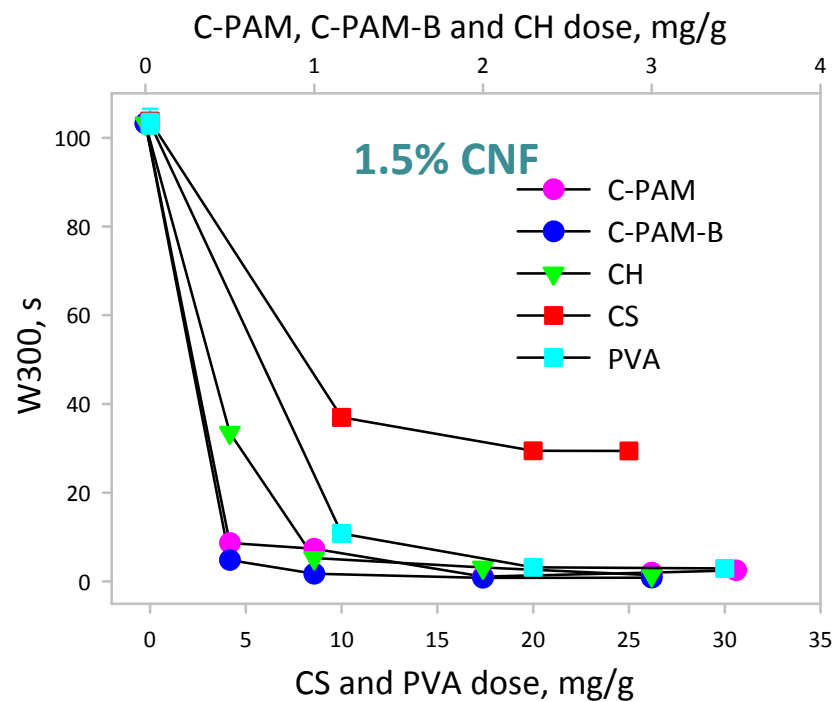
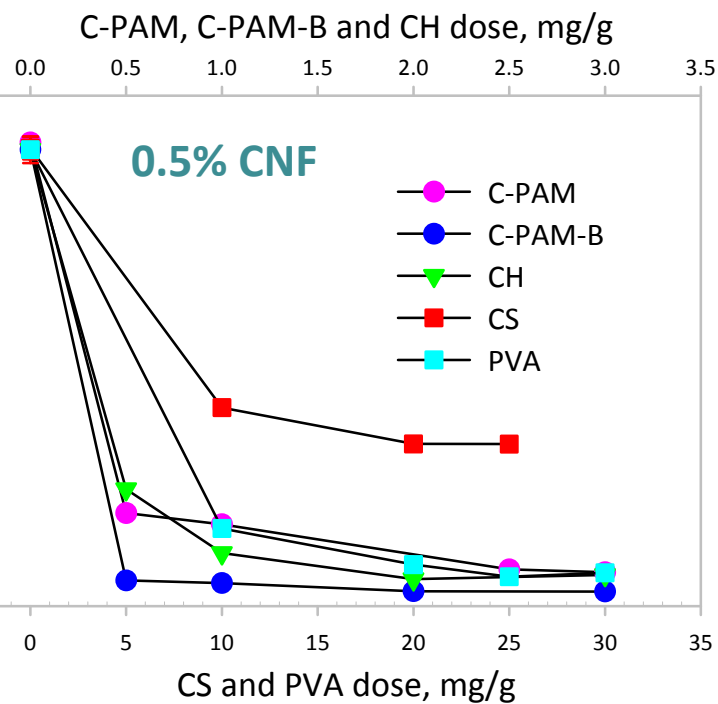


**l-based retention systems** affected the tensile index to a higher extent, but  
y were very efficient to reduce drainage time





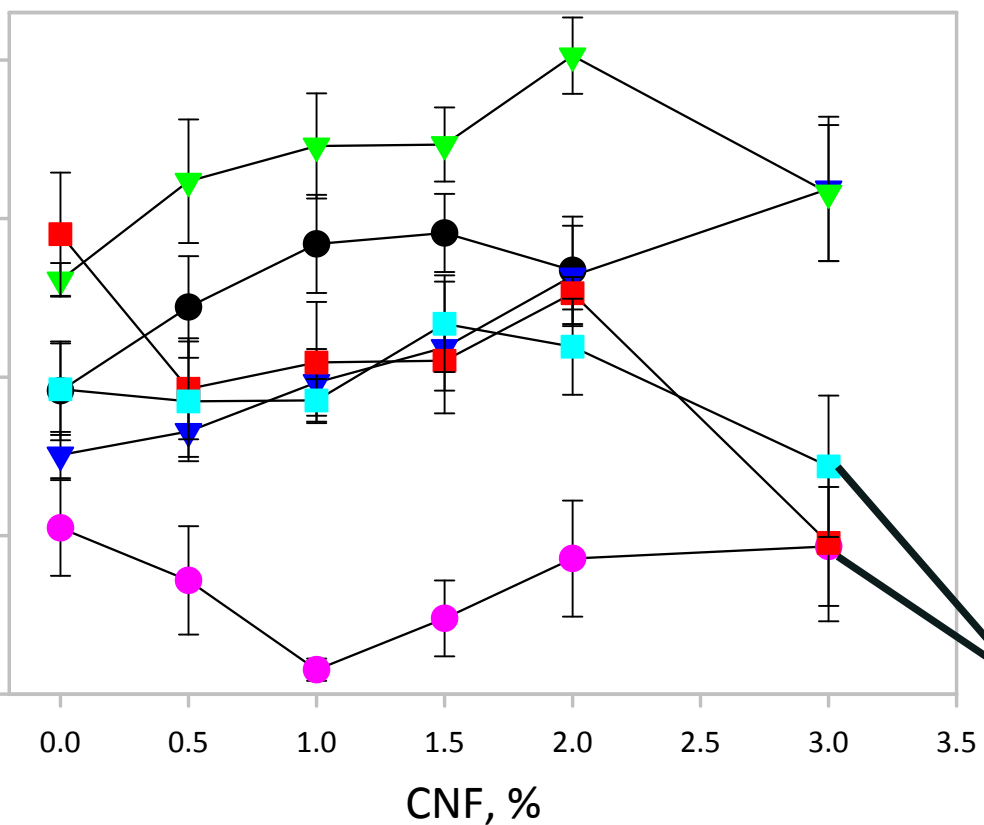
# EFFECT OF CNF + RS ON DRAINAGE TIME



Optimum doses for drainage

- 0.5 mg/g PAM in both C-PAM and C-PAM-B

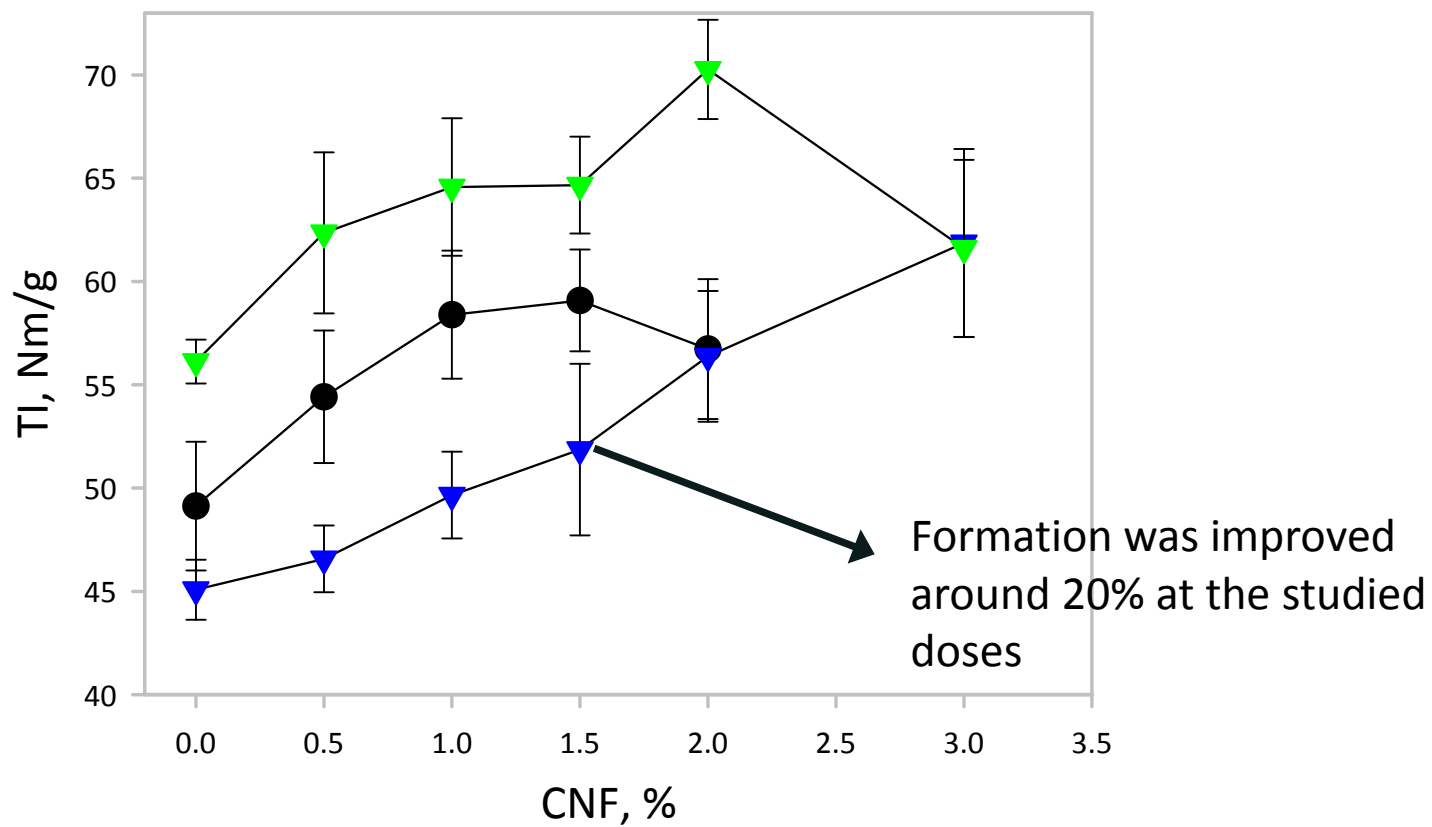
## EFFECT OF CNF + RS ON PAPER STRENGTH



Formation can be positively or negatively affected by CNF addition, depending on the retention system used

Formation was worsened up to 100%  
↓  
negatively affecting tensile index

## EFFECT OF CNF + RS ON PAPER STRENGTH





Drainage rate improves, sheet formation and mechanical properties worsen  
**could contribute to solve this contradiction in combination with the right RS**

**chitosan + 2% CNF** → **highest tensile index** → new chances for using recycled paper

2% CNF counterbalance tensile index decrease due to **C-PAM-B** system without affecting the drainage rate

**Higher doses of starch**, those required to increase drainage rate, **reduce tensile index** due to the high interaction between cationic starch and CNF. Therefore, starch can retain CNF, but another agent to improve drainage rate is needed

**Thank you for your kind attention**

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