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Ph.D. thesis (2017-2020)
LGP2 (D. Lachenal; C. Chirat)

Investigation of the consequences of the use of ozone in the bleaching of cellulosic fibers

Etude des verrous susceptibles de freiner le développement de l'utilisation de l'ozone dans le blanchiment des fibres cellulosiques

Context

Chlorine dioxide bleaching

- Elemental Chlorine Free (ECF)
- 80% of the world's bleached pulp
- Pollutant with organic chlorinated compounds ('AOX' or 'OCI'). *Recent scandal about baby diapers (Anses, January 2019).*

Ozone bleaching

A green technology that still faces mistrust from the paper industry

- Totally Chlorine Free (TCF)
- Green and potentially cheaper than ECF processes
- Achieve better Brightness stability than for conventional ECF pulps
- Lowers the **Degree of Polymerization (DPv)** of cellulose (measured by viscosimetrics)

Ozone bleaching is gaining interest as a green alternative to ECF bleaching. However, the industry is still reluctant to use it because it would lower paper mechanical properties.

Methods

Bleached pulp preparation

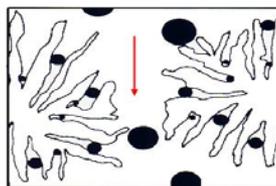
- Hardwoods** pulp bleached with ECF and TCF-ozone sequences (DEpDD vs. AZEoZEoZP)
- ECF-bleached pulp post-treatments: carbonyl reduction (NaBH₄), removal of hexA (A), alkaline extraction (E), residual lignin and unsaturated compounds selectively removed by different oxidants such as O₃, NaClO₂, H₂O₂...

UV Resonance Raman Spectroscopy

Aalto University, Espoo, Finland
Laser wavelength: 244 nm
Power output: 10 mW
Measuring transmittance: 25%
Spectral resolution ≈ 7 cm⁻¹

Gel Permeation Chromatography

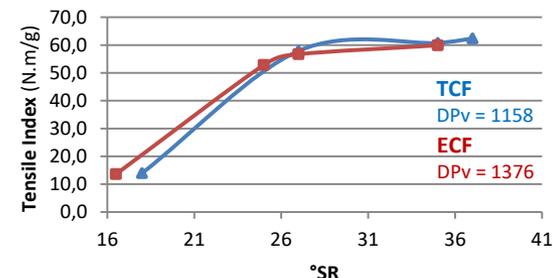
Direct dissolution of cellulose in DMAc/LiCl (8%)



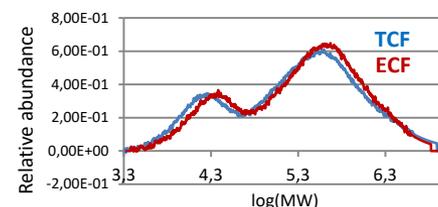
Results

Identical mechanical properties

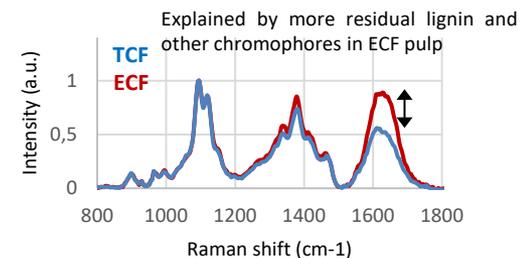
obtained for ECF and TCF-ozone pulps, despite a difference in DPv



Similar molar mass distributions



TCF better brightness stability



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