

VESSEL PICKING AND INK REFUSAL: EFFECT OF ENZYME ACTIVITY

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ABSTRACT

Objective: Vessel picking occurs due to picked vessel elements in the paper surface during printing. Ink refusal is caused by the hydrophobic character of vessel elements, resulting in further printing problems due lack of ink absorption, Vessel enzymatic passivation, altering its adhesion to the fiber network and reducing its hydrophobicity may address these phenomena. The primary object of this study was to study how enzymatic treatment by xylanase and by an enzymatic cocktail containing cellulases and laccases affect ECF bleached *Eucalyptus globulus* vessel and fiber porosities, bulk chemistry, and surfacechemical composition. This enzymatic activity was expected to reduce vessel picking by increasing vessel to fiber bonding strength through beating aided by enzymatic treatment, and to decrease vesselhydrophobicity by altering surface chemistry.

Experimental Procedure: Enriched vessel and fiber rich samples were obtained via size exclusion methodologies. Parallel enzymatic hydrolysis treatments of the two samples were performed with a commercial xylanase and a commercial enzymatic cocktail containing cellulase and laccase activities. Thermoporosimetry measurements were performed on a Mettler Toledo DSC 3+ differential scanning-calorimeter equipped with an intracooler. The two fractions were hydrolyzed following the laboratory analytical procedure for the determination of structural carbohydrates and lignin in biomass, from the National Renewable Energy Laboratory. The surface chemical composition of the samples was analyzed with an X-ray photoelectron spectroscopy, using an AXIS Ultra spectrometer with monochromatic Al K α irradiation source at 100 W. The IGT Reptest testing system was used to characterize vessel picking. Water contact angles measurements and surface energy studies were made on fibers and vesselpellets using an OCAH 200 apparatus.

Main Results: Thermoporosimetry revealed the vessel structure to be more porous, surface analysis showed its lower O/C ratio and bulk chemistry analysis its higher hemicellulose content. Enzymes had different effects on porosity, bulk and surface composition of fibers and vessels, affecting vessel adhesion and hydrophobicity. Enzymatic treatments additionally reduced vessel picking up to 94 %. Water-contact angles and surface energy studies clearly showed vessels to be more hydrophobic than fibers. The treatments changed vessels morphology and made them more hydrophilic, while the dispersive/polar ratio showed a tendency of treated vessels to approach the value of fibers.

Conclusions: It is proposed that differences in vessel and fiber porosity structures affect the enzymatic attacks, eventually causing vessel passivation. The results showed that enzymatic treatments affect pulp vessel elements, making them more susceptible to breakage during beating, affecting their bonding to the paper structure and decreasing their hydrophobicity, revealing the potential of combining mechanical and enzyme activities.

Keywords: vessel picking, ink refusal, *Eucalyptus globulus*, enzyme activity, vessel elements.

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