

# Effect of beaten in *Eucalyptus* and *Pinus* Kraft pulps

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## Abstract

This paper summarizes the main findings concerning the effect of beaten intensities in physical, mechanical and optical pulp properties produced from eucalypt and pinus kraft pulps obtained after oxygen delignification stage. The pulp beaten contributes to improve the pulp strength, on the other hand the pulp brightness and opacities were negatively impaired.

**Keywords:** eucalyptus; pinus; pulp properties; beaten.

## Introduction

In the paper production, an important step is the beating. During beating, fibers are usually beaten by one or more passed between the rotor and stator in a typical beater [1]. The outer layers of fibers are defibrillated, with some of them passing to a fibrous suspension in the form of fines. Defibrillating allows the swelling of fibers by hydration [2]. In addition, beating also decreases the fibers length due to the cutting effect and superficial fibrillation, fibers exhibit more flexibility and the bonding ability between fibers is enhanced in the last stages of drainage when the distance between them becomes short enough to improve the paper sheet cohesion.

This treatment enables to produce from the same cellulose papers with different properties. The final paper properties are influenced by fiber type, cooking process, bleaching and intensity of bonding between the fibers [3] and valued by through physical tests. According Smook [4], these tests may be grouped into 4 categories: mechanical properties and resistance, surface properties, optical properties and fluid permeability.

This study aimed to analyze the changes in physical, mechanical and optical properties of pulp properties produced from eucalypt and pinus kraft pulps obtained after oxygen delignification stage submitted to different beaten intensities.

## Experimental

For the realization of the work, was used oxygen delignified kraft pulps of *Eucalyptus* spp (kappa number=9.48, viscosity=808 dm<sup>3</sup>/kg, brightness=54.4 %ISO) and *Pinus taeda* (kappa number=16.2, viscosity=715 dm<sup>3</sup>/kg, Brightness=54.4 %ISO) produced in the Pulp and Paper Laboratory of the Federal University of Viçosa. For the determination of pulps physical and mechanical properties, the pulps were beaten in a PFI mill at 10% of pulp consistency, handsheets were formed and physical tests according to the Tappi T248 sp-08 [5] and conditioned for 24 h in acclimated room (50 ± 2% relative humidity and 23 ± 1°C). Following, they were tested for physical-mechanical and optical properties according to the methodologies presented in the Table 1.

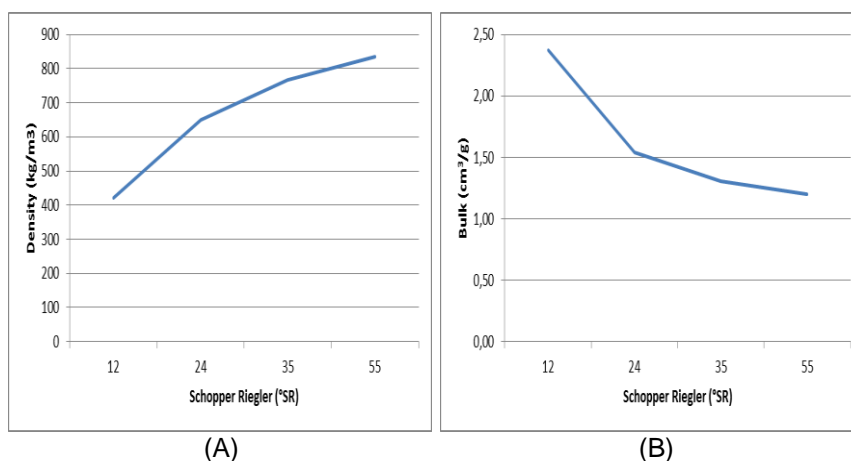
**Table 1:** Physical-mechanical and optical tests.

Test	Methodology
Grammage	TAPPI 410 om-08
Thickness	TAPPI 411 om-97
Resistance to air flow	TAPPI 536 om-96
Tensile index	TAPPI 494 om-06
Burst strength	TAPPI 403 om-02
Tear index	TAPPI 414 om-98
Brightness (%ISO)	TAPPI T525 om-86
Opacity	TAPPI 1214 sp-07

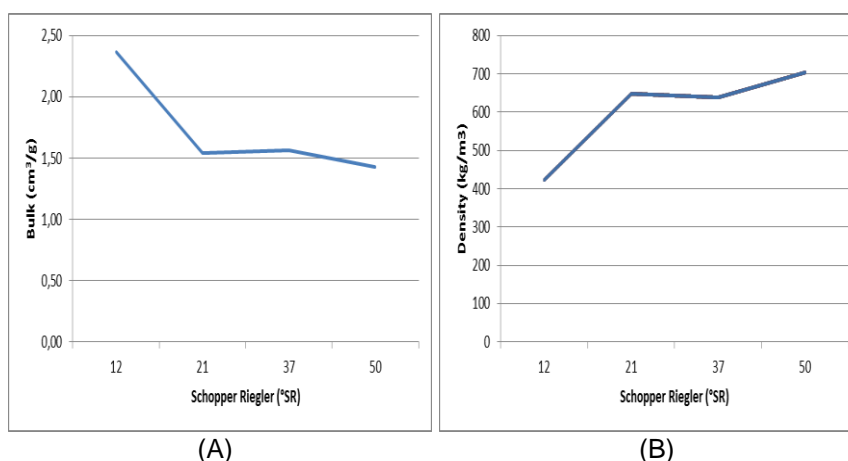
## Results and Discussion

It was observed that the beaten caused an increase of density (Figure 1a and 2a), and decrease bulk (Figure 1b and 2b). for both pulps.

Bulk and density are structural properties which have been related to the consolidation of the paper structure. The figure 1 and 2 show the performance of bulk and density as a function of the resistance to drainage with the evolution of beaten. This result can be explained by the beaten effects in the fibers, decreasing the fibers length due to the cutting effect and superficial fibrillation, fibers exhibit more flexibility and produces fines that results in more bonds among the fibers.



**Figure 1:** Physical-mechanical properties as measured (A) density and (B) bulk for the *Eucalyptus* spp pulp at a given drainage degree (°SR).



**Figure 2:** Physical-mechanical properties as measured (A) density and (B) bulk for the *Pinus taeda* pulp at a given drainage degree (°SR).

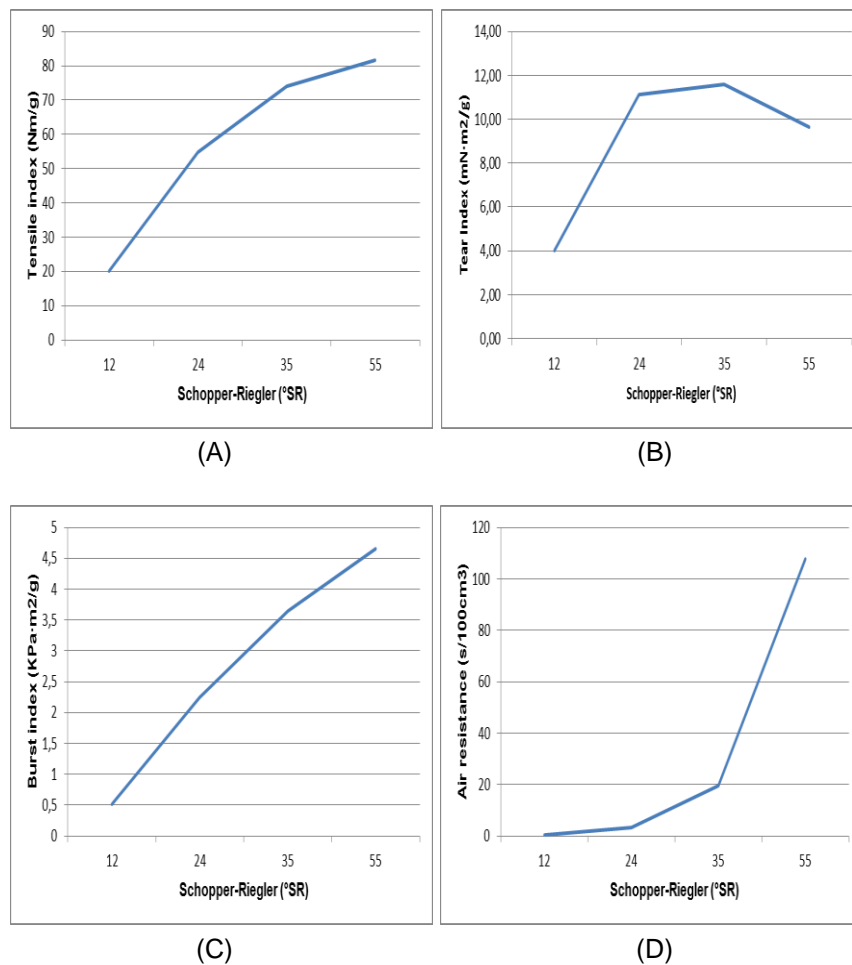
The tensile index expresses the strength of paper to traction and derives from the traction force responsible for the rupture sample in relation to width and grammage. The number of inter-fiber bonds during paper formation is the parameter that most influences this property.

The tear resistance is the work performed by a pendulum required to tear a paper sheet set, after an specific cutting initial [3]. Tear index is the result of dividing the average force required to tear the sheet by grammage [6]. For *eucalyptus pulps*, burst index is affected by strength inter-fiber bonding, fiber length, thickness and total number of fibers participating in breakage of the sheet [7].

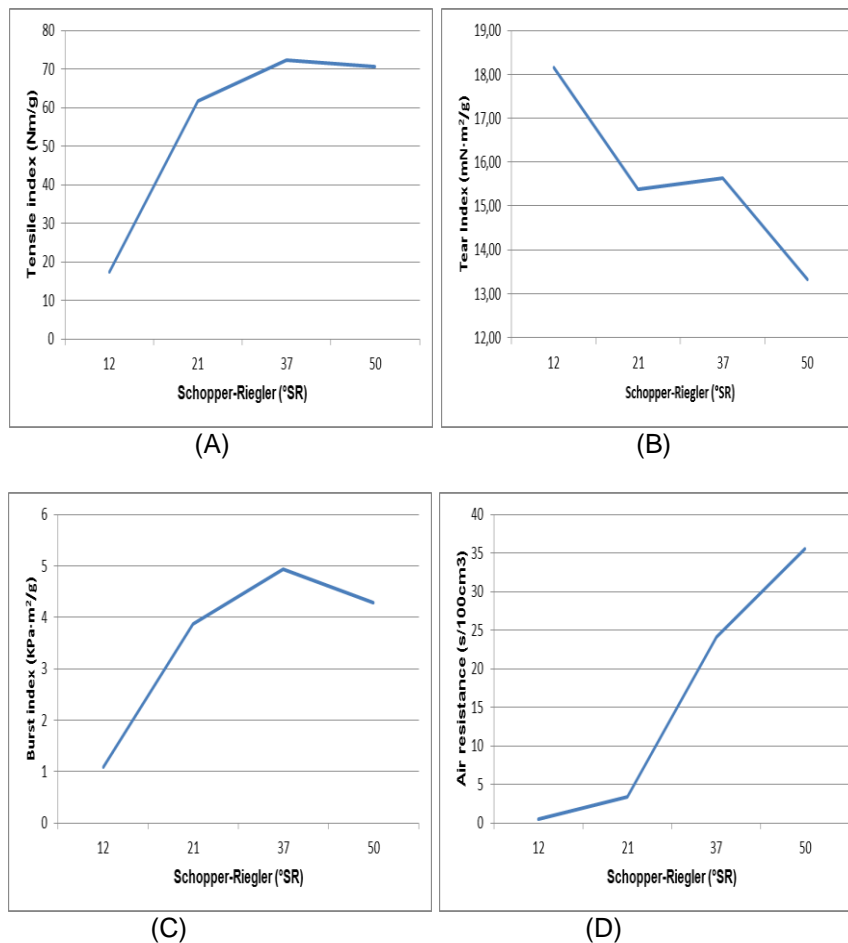
The resistance to burst is defined as the force required promoting the bursting of the paper sheet by applying increasing pressure transmitted by an elastic diaphragm with circular area [3]. The burst index is determined by dividing the resistance to burst by grammage paper. The property value is influenced mainly by the number of inter-fiber bonds and the strength of these connections.

The physical mechanical properties, measured by tensile index, burst index, specific elastic modulus, and air resistance at a given resistance to drainage degree ( $^{\circ}$ SR) were different between the evaluated pulps (eucalypt and pinus pulps), and among the beaten levels evaluated. In general, pulps from Pinus showed a higher value to the evaluated physical mechanical properties (Figs 3-4).

As observed in Figure 3 for *Eucalyptus spp.* there is an increasing trend in the values tensile index, tear index, burst index and air resistance. This result can be attributed to the sheets structure and inter-fiber bond promoted at beaten. But the tensile index and burst index in *Pinus taeda* pulp show different effect, because the increase at beaten promoted fall in this characteristic, once the beaten destroys the fiber structure.



**Figure 3:** Physical-mechanical properties as measured (A) tensile index, (B) tear index, (C) burst index and (D) air resistance for the *Eucalyptus spp.* pulp at a given drainage degree ( $^{\circ}$ SR).

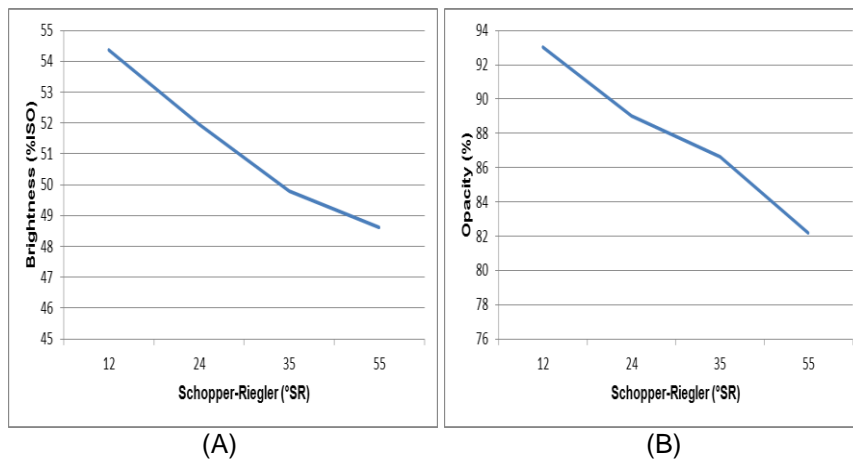


**Figure 4:** Physical-mechanical properties as measured (A) tensile index, (B) tear index, (C) burst index and (D) air resistance for the *Pinus taeda* pulp at a given drainage degree (°SR).

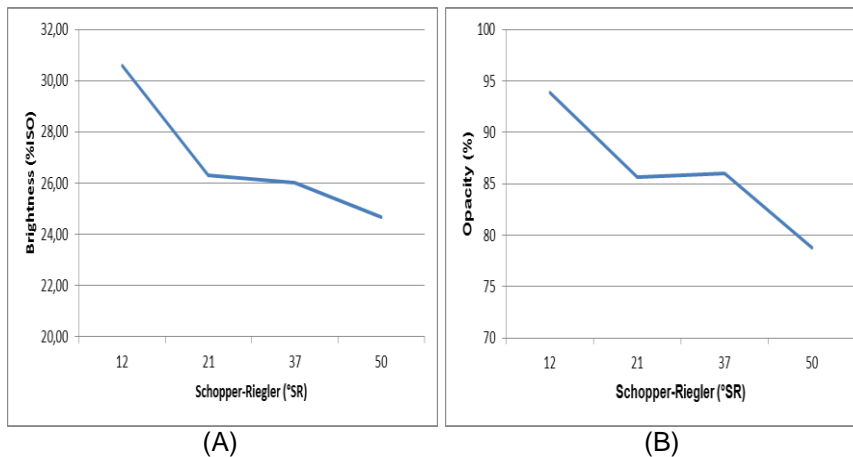
The brightness is an optical property generally used for evaluating the pulp quality after bleaching, which measures the diffuse reflectance factor in blue wavelength (length of 457 nm), that is, the light amount reflected by the pulp surface [8].

Opacity is the property relating to the light amount transmitted through the paper. Thus, a perfectly opaque paper is the paper that does not allow light to pass through its structure. The paper opacity depends on the type and fibers characteristics present in its structure, characteristic and amount of additives, the degree of pulp bleaching, coating material, etc., which cause optical phenomena of reflection, scattering and light absorption. These phenomena determine the paper ability to disperse and block the passage of light [9]. A lower opacity can be explained by the greater compression of the sheet structure, which reduces the number of interfaces fiber / air [10].

It was observed that the brightness and opacity values suffered negative effect of beaten, which is not desirable during the paper production.



**Figure 5:** Optical properties as measured (A) brightness and (B) opacity for the *Eucalyptus spp* pulp at a given drainage degree (°SR).



**Figure 6:** Optical properties as measured (O) brightness and (P) opacity for the *Pinus taeda* pulp at a given drainage degree (°SR).

## Conclusions

The final pulp properties are directly influenced by the beaten.

The pulp beaten contributes to improve the pulp strength, on the other hand the pulp brightness and opacities were negatively impaired

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