INFLUENCE OF WOOD STORAGE TIME IN THE PAPER PROPERTIES OF *Eucalyptus globulus*

Maria Pereira[1], Gabriel Sousa[2] and Ofélia Anjos[1,3,4]
[1]ESA/IPCB – Escola Superior Agrária – Instituto Politécnico de Castelo Branco
[2]RAIZ – Research Centre of Forestry and Paper (grupo Portucel Soporcel)
[3]CERNAS – Research Centre of natural resources studies environmental a society
[4]CEF – Forestry research centre, Instituto Superior de Agronomia

ABSTRACT

In this work we studied the effect of moisture and chip pile storage time of *Eucalyptus globulus* wood, regarding the impact in kraft cooking and papermaking.
Experimentally, chip samples were collected with different storage times (0, 15, 30, 60 and 90 days) from two distinct piles (wet and dry). The cooked chips after disintegration, screening and washing were submitted to a bleaching stage, in ECF sequence following five stages ($D_0E_1D_1E_2D_2$). The pulps were beaten in a PFI mill at 1000, 2000 and 3000 revolutions. For the cooking results we observed higher yield and lower alkali consumption for the wet pile chips and lower storage time (15 days).
The results showed that storage time is a significant factor (ANOVA results) for almost paper properties studied and influenced mainly the internal fibre links. For what paper properties are concerned, the difference between piles isn't so evident, the major differences are observed for the lower storage time (15 days).

Keywords: *Eucalyptus globulus*, wood moisture, Kraft process, storage time.

INTRODUCTION

In Portugal wood is one of the main cost inducing factors on the pulp and paper industry. Therefore, is desirable that wood should be efficiently processed. This includes all wood yard process operations, especially woodchip pile storage management. Woodchip pile storage has both harmful and beneficial effects over kraft pulping process. It reduces pitch formation potential (Freire, 2003), which hinders pulp quality and generates equipment deposits. It also eliminates wood's low molecular components that would inevitably consume cooking alkali. On the other hand, severe woodchip pile storage conditions can promote an extensive cellulosic material degradation resulting in a pulp yield loss. In addition to this, pulp quality can also be affected, namely bleached pulp's beatability. Woodchip pile moisture and temperature, along with storage time, are probably the main factors influencing woodchip quality and thus kraft process itself. Outside chip pile storage is inevitably affected by climate variations, inducing seasonal moisture and temperature variations. Therefore in this project we studied the effect of moisture and chip pile storage time of *Eucalyptus globulus* wood, regarding the impact in kraft cooking and papermaking properties.

MATERIAL AND METHODS

Eucalyptus globulus chip samples were collected from two different pilot piles (wet and dry) with different storage times (0, 15, 30, 60 and 90 days). The chips samples were cooked with the following reaction conditions: AA=16-17% (as Na2O) for constant kappa number; sulfidity =28%; liquor/wood ratio=4/1; initial temperature = 40ºC; time to temperature = 120 min; time at temperature (160 ºC) = 60 min. Cooked chips were thereafter disintegrated, screened and washed:
After cooking, pulps were submitted to an ECF bleaching sequence ($D_0E_1D_1E_2D_2$) until 90% of brightness is reached. Bleached pulps were beaten in a PFI mill at 1000, 2000 and 3000 revolutions, and laboratory paper sheets were produced, including the unbeaten pulps, which made 4 samples per storage time and for each moisture piles. Some mechanical and optical properties and the correspondent suspension fibre characteristics were determined.

We used variance analyses and principal components analysis to investigate the differences in fibre characteristics and paper properties, as well as their interaction. Each value of these variables represents a mean of 15 tests, for the paper sheets.

RESULTS AND DISCUSSION

The samples were submitted to cooking under the reaction conditions described previously, which were selected in order to produce an *E. globulus* kraft pulp with kappa number 14, which is the usual range for this species. Table 1 presents the results for pulp yield, rejects, active alkali consumption (as Na_2O), kappa number and pulp viscosity.

Table 1 – Cooking results for different storage times.

	Pile storage time (PST)	Active Alcali / Wood Weight	Pulp Yield	Rejects	Kappa number	AA/PM consumption
Reference	**0**	0.170	55.2	0.8	14.0	0.163
Dry pile	**15**	0.165	54.9	0.5	14.3	0.159
	30	0.160	54.9	0.5	14.3	0.159
	60	0.165	54.9	0.4	14.5	0.159
	90	0.165	55.5	0.6	14.1	0.158
Wet pile	**15**	0.160	56.0	0.4	14.6	0.154
	30	0.160	55.7	0.4	14.4	0.154
	60	0.165	55.3	0.4	13.8	0.158
	90	0.170	55.6	0.4	14.4	0.163

According to our experience with other samples cooked in the same equipment, the standard deviation of the pulp yield is close to 1 unit. The higher pulp yields were observed for the wet pile but this gain decreased with storage time. This result could be explained by a higher degradation of wood's low molecular components that don't contribute for cooking yield. For the dry pile, yield differences are marginal. For every pile conditions it was observed lower alkali consumption for the first 30 days of storage. After this period, and for wet pile conditions, alkali consumption reverted. The decrease in alkali consumption is probably related to the degradation of wood's low molecular components during the storage period.

In what concerns with fibre properties, we observed an increase of fines number and a decrease of weighted averaged fibre length with the pile storage time, explained by a possible degradation of the fibre surface or a preliminary fungal attack. Table 2 reveals that fibre length was very influenced by storage time that explained 73% of the total variation. For coarseness there was no significant difference between piles (wet and dry) but storage time explained 37% of the total variance. For residence time of 90 days it was observed a higher coarseness value for the wet pile, caused probably by the fibre swelling. We observed a higher kinks value for the wet pile and for higher storage times but the Kinks number evolution with the refining level presented a different behaviour in wet and dry pile (68%; ***).

Table 2 - Component variance analysis for fibre properties

	Source	**F.D.**	**Fcal**	**Sig.**	**Var (%)**
Length weighted in length (mm)	WD	1	7.48	0.0141 (*)	11
	(T)	2	29.19	0.000 (***)	73
	WD x T	3	0.139	0.8711 (n.s)	0
	Residue	17			16
Coarseness (mg/m)	WD	1	2.53	0.1301 (n.s)	8
	(T)	2	5.69	0.0069 (**)	37
	WD x T	3	1.563	0.2382 (n.s)	9
	Residue	17			47
Kinks number (/mm)	WD	1	0.037	0.8498 (n.s)	0
	(T)	2	10.84	0.0003 (***)	20
	WD x T	3	17.82	0.0001 (***)	68
	Residue	17			12

WD – Wet or Dry pile factor; T – Pile storage time; F.D. - Freedom degree; Sig. significance level; Var (%) – variance percentage

For the bulk properties it was observed a decrease with storage time but that effect diminishes with refining energy (Table 3). In fact, refining energy decreases paper bulk because it increases internal bonding between fibres. This behaviour is already well documented by several authors.

Table 3 – Bulk and Schopper Riegler degree (ºSR) of pulps for different storage times

		Bulk				ºSR			
Pile	**PST**	**0**	**1000**	**2000**	**3000**	**0**	**1000**	**2000**	**3000**
	0	1.71	1.52	1.41	1.38	17	20	27	30
Dry	**15**	1.87	1.49	1.39	1.34	17	21	26	35
	30	1.73	1.47	1.37	1.33	17	20	25	32
	60	1.69	1.48	1.35	1.3	18	21	25	34
	90	1.74	1.46	1.35	1.3	17	21	26	35
Wet	**15**	1.74	1.49	1.38	1.3	17	21	29	42
	30	1.67	1.49	1.41	1.32	17	21	25	34
	60	1.63	1.49	1.39	1.31	18	21	26	32
	90	1.66	1.5	1.37	1.32	17	20	25	33

Table 3 presents the drainability resistance data for bleached pulps, revealing that dry pile pulps are harder to refine for the first 30 days of storage, probably as a consequence of the fibre flexibility caused by the lower fibre moisture.

Regarding mechanical properties wet and dry piles don't exhibit a major differences for tensile and tearing resistance at a given PFI revolutions. Moreover, tear index was somewhat affected by storage time (Table 4).

The internal bonding strength given by the Scott Bond test was very influenced by storage time (ANOVA Results: ***) for all refining levels. That result is consistent with previously observed values for the bulk test. For higher storage times and for the wet pile the internal strength was higher, probably because the fibre are more collapsed and developed more internal links. Similar results were observed for the Gurley air resistance. Light scattering coefficient is an important property for writing and printing papers. Light scattering is higher for the wet and dry pile for a storage time of 90 days. That difference was higher for the wet pile but there aren't any great differences between dry and wet pile. Moreover, the variation of storage time for the too different piles are very different (WDxT:***, for all refining levels.)

Table 4: Component variance analysis for the paper properties

Paper properties	**Source**	**F.D.**	**Variance percentage (significant level)**		
			1000	**2000**	**3000**
Tear Index (mNm^2/g)	WD	1	**12** (***)	**5** (*)	**0** (*)
	(T)	3	**29** (***)	**12** (**)	**4** (***)
	WD x T	3	**58** (***)	**20** (**)	**3** (***)
	Residue	56	**1**	**63**	**92**
Tensile index (Nm/g)	WD	1	**0** (n.s.)	**9** (**)	**3** (n.s.)
	(T)	3	**0** (n.s.)	**2** (n.s.)	**3** (n.s.)
	WD x T	3	**2** (n.s.)	**0** (n.s.)	**1** (*)
	Residue	56	**98**	**89**	**77**
Gurley air resistance (100ml,s)	WD	1	**0** (n.s.)	**0** (n.s.)	**1** (*)
	(T)	3	**0** (n.s.)	**13** (***)	**31** (***)
	WD x T	3	**23** (**)	**49** (***)	**43** (***)
	Residue	56	**77**	**38**	**24**
interlayer strength Scott Bond Test (J/m^2)	WD	1	**33** (***)	**2** (**)	**4** (***)
	(T)	3	**12** (***)	**61** (***)	**88** (***)
	WD x T	3	**4** (***)	**11** (***)	**7** (**)
	Residue	56	**51**	**25**	**1**
Light scattering Coefficient (m^2/Kg)	WD	1	**0** (n.s.)	**4** (*)	**0** (n.s.)
	(T)	3	**5** (**)	**4** (*)	**13** (***)
	WD x T	3	**31** (***)	**36** (***)	**67** (***)
	Residue	56	**64**	**56**	**20**

CONCLUSIONS

Cooking trials revealed that pulp yield was virtuously unaffected, but alkali consumption decreased with storage time for both piles for the first 30 days. Bleached pulp's beatability was also affected with storage time and with chip pile storage conditions. Pulps are easier to refine in the first 30 days of storage, being this effect more pronounced for wet chip pile storage conditions.

The ANOVA test showed that storage time is a significant factor for almost all studied paper properties. It especially influenced internal fibre bonding. For the paper properties the difference between piles isn't so evident, the great differences are observed for the lower storage time (15 days) in some properties and for lower refining level (1000 rpm).

BIBLIOGRAPHY

Freire, C. S. R. (2003) – *Eucalyptus globulus* low molecular weight organic compounds: behaviour during wood kraft pulping and pulp bleaching, Doctoral thesis, Chemical Department, Universidade de Aveiro, Aveiro.