VARIABILITY OF KRAFT PULPS OPACITY – A CASE STUDY

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ABSTRACT

Opacity is one of the most relevant properties for assessing the potential of a given papermaking pulp, specially when printing and writing papers are considered. In this study, an attempt to interpret small differences in the opacity (lower than 2% ISO) of commercial kraft pulps in terms of the corresponding fibre characteristics has been carried out. For that, ECF bleached kraft pulps of eucalypt (100% *E. globulus* and mixtures of *E. globulus* and *E. grandis*) and of mixtures of eucalypt and pine were analyzed regarding the fines content, fibre biometry and hemicelluloses and extractives content, in order to evaluate the influence of these parameters on printing opacity. The results reveal that, even when pulps are similar in composition and fibre characteristics and have quite close values of opacity, the influence of fibre length, number of fibres/mass and fines content on opacity is important.

INTRODUCTION

For the market of printing and writing papers, optical properties like brightness, light scattering, opacity, gloss and colour are extremely important. Among these, opacity is one of the most widely used for evaluating the papermaking potential of pulps and is much influenced by the fibre properties, namely length, wall thickness and number of fibres/mass. Since these properties depend on the wood seasonality, it is essential to know how they affect pulp opacity in order to better control the pulping and papermaking processes and to assure the stability of the final product quality.

This study aims at interpreting the variations in the opacity of commercial bleached kraft pulps in function of the fibre characteristics after cooking and bleaching. Eucalypt based kraft pulps were considered. In spite of the relevant number of results that may be found in the open literature regarding the interaction between opacity and the other physical and mechanical papermaking pulp properties and also regarding how wood properties and process variables affect opacity, there are not many studies about the origin of small differences in pulp opacity which are frequently found in industry. These differences, although minor, are often a consequence of the variability in wood quality and have a significant impact on pulp printing quality.

EXPERIMENTAL

In this work, five eucalypt kraft pulps (A, B, C, D and E), bleached in a ECF sequence, were used. These pulps were beaten in a PFI mill in order to obtain a 30°SR beating degree and, after, handsheets with 60, 80 and 100 g/m^2 basis weight (w/w, OD) were produced. The printing opacity of these handsheets [Vaarasalo, 1999; Bierman, 1996; Van den Akker, 1967) was determined according to the ISO 2471 standard. All beaten pulps were characterized in terms of fibre length, width, wall thickness, coarseness, curl and flexibility (as defined by Steadman and Luner). The number of fibres/mass and the fines content (fines considered as all the fibrous material inferior

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to 200 µm in length) were also quantified. These measurements were performed with the FQA (Fiber Quality Analyzer), an microscope (Dialux 20EB, Leitz) with dedicated software (IM500, Leica) and the CyberFlex apparatus (Cybermetrics). In addition, the pentosane content and the extractives content (DCM) of the pulps were determined. As for the handsheets they were characterized in terms of the most common structure, mechanical and optical properties, following the ISO standards. Besides, their porosity and surface roughness were determined by mercury intrusion porosimetry and optical profilometry, respectively. Further, a pine kraft pulp (P), beaten at 23°SR, was used with the objective of confirming the influence of long fibres on opacity. For that, mixtures of this pulp with pulps A, B and C (having 0, 5, 10, 15 and 20% (w/w) of pulp P), were prepared for producing 80 g/m^2 handsheets.

RESULTS

Table 1 summarizes the values of opacity of the eucalypt kraft pulps. As can be seen by comparing the handsheets with 80 g/m^2 basis weight, the differences between the various pulps are quite small (not superior to 2% ISO). On the other hand, for the same pulp, the increase in the handsheets basis weight strongly increases the opacity, as expected.

Table 1 – Basis weight and opacity of the handsheets of the various eucalypt kraft pulps

Pulp		W (g/m^2, OD)	Opacity (% ISO)	SD (%)
A	*E. globulus* + *E. grandis*	80	80,44	0,20
B	*E. globulus* + *E. grandis*	80	79,50	0,32
C	*E. globulus*	60	71,05	0,44
		80	78,64	0,23
		100	82,27	0,42
D	*E. globulus*	60	72,36	0,60
		80	79,17	0,24
		100	83,58	0,33
E	*E. globulus*	60	72,53	0,34
		80	79,62	0,24
		100	83,57	0,43

The results of the eucalypt pulps characterization and of the fibre biometry analysis did not reveal any influence of fibre width, wall thickness, coarseness and flexibility on the handsheets opacity, most probably because the differences in the cross-section dimension of the distinct pulps fibres are not significant. For the same reason, no effect of the pentosane and extractives content was perceived. On the contrary, it was found, unsurprisingly, that opacity tend to increase as fibre length decreases and, accordingly, as the number of fibres/mass and the fines content increase (Figure 1). In fact, with small and more numerous fibres, the interface area for light reflection is larger.

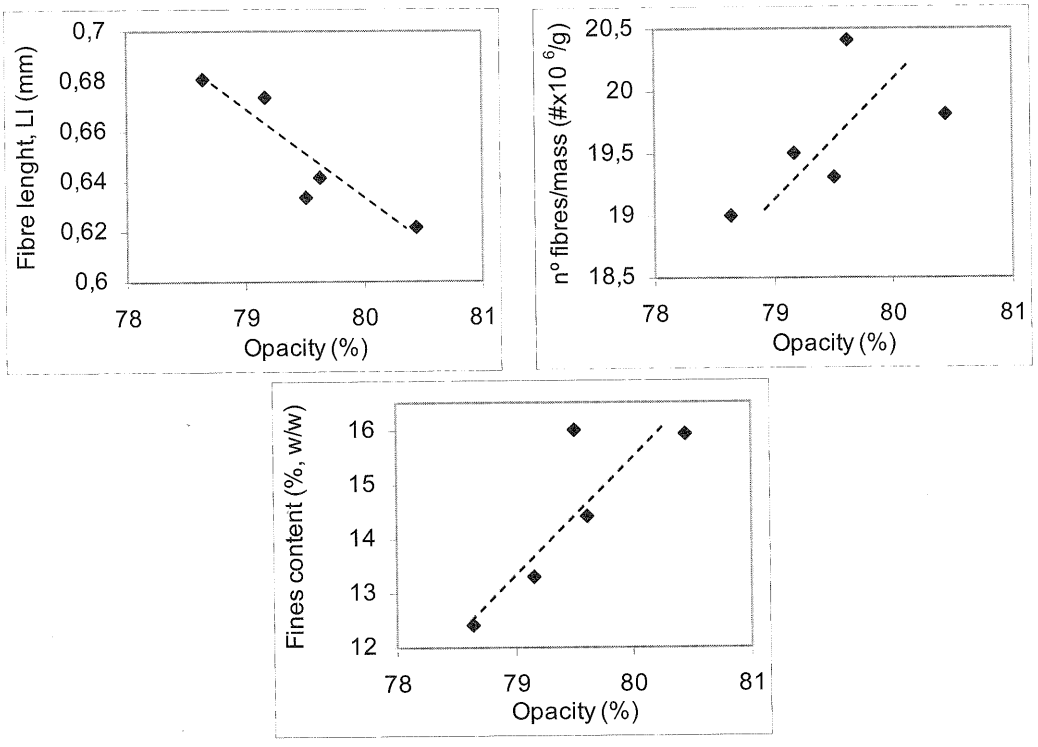

Figure 1 – Relation between handsheets opacity and mean fibre length, number fibres/mass and fines content of the various eucalypt kraft pulps (Table 1)

For the eucalypt pulps, the variation of opacity with the other structure, mechanical and optical common properties followed, in general, the usual tendencies (only the 80 g/m^2 handsheets were considered): an increase of opacity with the increase of bulk (R^2=0,98) and light scattering (R^2=1,00) and with the decrease of tensile strength (R^2=1,00), elongation (R^2=0,93) and internal bonding (Scott test, R^2=0,95). No correlation was detected between opacity and handsheets porosity or surface roughness, as measured by profilometry, but it was found that opacity increases with Bendtsen roughness (R^2=0,84).

The opacity values of the 80 g/m^2 handsheets produced with mixtures of eucalypt and pine fibres are listed in Table 2. As would be expected, the addition of the long fibres (P) reduces the opacity and, besides, the differences between the distinct pulps are larger than when only the eucalypt pulps are considered (Table 1). On the other hand, the previous findings regarding the influence of the average fibre length, number of fibres/mass and fines content of eucalypt pulps on the corresponding handsheets opacity are confirmed by the results obtained with the pulp mixtures, as can be seen in Figure 2. For these pulps, the variation of opacity with bulk, light scattering, elongation and internal bonding is also the same than the one obtained with the short fibre pulps. Only pulps C + P were characterized by mercury intrusion porosimetry and the results (not presented) revealed that internal porosity increases with the increment of the long fibres content.

Table 2 – Long fibre content and opacity of the handsheets produced with mixtures of eucalypt and pine fibres (handsheets basis weigth 80 g/m^2; A, B and C refer to the eucalypt pulps of Table 1)

Pulp	A + P				B + P				C + P				P
Long fibre content (P) (%, w/w)	0	10	15	20	0	0	15	20	0	10	15	20	100
Opacity (% ISO)	80,4	79,3	78,6	77,9	79,5	79,0	78,1	77,7	78,6	78,1	77,0	78,4	68,9

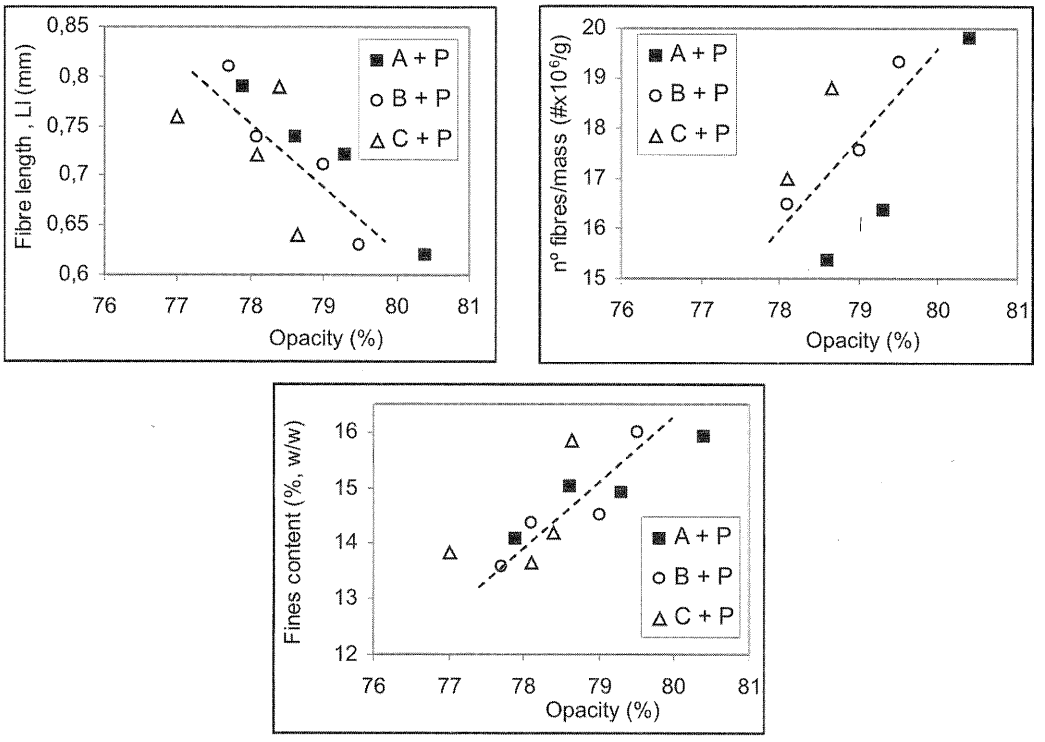

Figure 2 – Relation between handsheets opacity and mean fibre length, number fibres/mass and fines content of the handsheets produced with mixtures of eucalypt and pine fibres (Table 2).

CONCLUSIONS

The origin of small differences in the opacity of commercial kraft pulps (lower than 2% ISO) has been investigated, and the results show that fibre length, number of fibres/mass and fines content are important parameters. The impact of long fibres on the opacity of eucalypt based kraft pulps was also assessed. Moreover, it was demonstrated that, for the narrow range of variability in the characteristics of the pulp fibres considered in this work, fibre cross-section dimensions, as well as chemical composition (pentosanes and exctratives content), do not present any impact on pulp opacity.

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