

THE MIXTURE OF EUCALYPTUS AND PINE PULPS FOR PAPER

Silvia Bugajer, Head of Pulp & Paper Department

Technical Center in Pulp and Paper (CTCP/IPT), Sao Paulo, Brazil

In Brazil most writing and printing paper is produced with 100% eucalyptus pulp. In other countries, those grades of papers are produced with fibers from other species or with mixtures of these fibers with eucalyptus.

This paper reports on the behavior of eucalyptus and pine pulps with regard to their refining and papermaking characteristics. The pulps used in this study were bleached kraft, the eucalyptus pulp produced in Brazil, and pine pulp in Finland.

The pulps were separately refined, and the energy demand for each registered and compared. The effect of refining on the fibers was estimated from the results of Bauer McNett fiber classification and from the values of the physical characteristics of the pulps.

Pulps with different freeness were mixed in various proportions in order to determine the influence of the freeness of each pulp and of the proportion used, on the physical characteristics of handsheets made with those mixtures. The values obtained in this evaluation generated a mathematical model that permits to anticipate the physical characteristics of the sheet made with a certain mixture without having to produce it in the laboratory.

REFINING OF THE PULPS: The refining was carried out using a single disc refiner, of 300-mm diameter, keeping constant the following parameters: stock consistency 4.2%; stock pH 6.0; disc clearance 0.07mm; outlet pressure 216kPa; operating speed 1200 rpm.

Two pair of discs were used, with the characteristics:

	Disc	
	3x3	5x5
Bar width	3.0mm	5.0mm
Groove width	3.0mm	5.0mm
Bar angle	5°	5°
Groove depth	5.5mm	4.0mm
Pulp used	E	E;P

The refining energy demand for both pulps was measured and the values plotted against freeness (Figure 1).

In refining the eucalyptus pulp, it was noticed that the use of a 3x3 disc results in a lower energy consumption, than the use of a 5x5 disc. Decreasing the bar and the groove width increases the number of edges for the same amount of applied energy, causing a higher number of impacts on the fibers. Consequently the pulp stock arrives faster to a certain freeness and consumes less energy. In addition, to reach the same freeness, eucalyptus pulp refined with a 3x3 disc demands less energy than pine pulp.

The 5x5 disc has bars with shallower groove depth than the other disc. Discs with the same bar width, but with shallower groove depth consume less energy due to less dissipation during pumping. Therefore, if the bars of both discs would have the same groove depth, the energy demand on refining with the 5x5 disc should be even higher than that which was observed.

The effect of refining on the fibers can be evaluated from the data obtained by a Bauer McNett fiber classification, whose values are presented in Figure 2.

Moreover, for refining eucalyptus pulp, the 5x5 disc requires a higher energy than the disc with narrower bars, and also it causes more damage to the fibers. In consequence, a pulp with lower physical properties is produced.

Equally for eucalyptus, reducing the bar and the groove width diminished the fiber cutting, and the pulp produced shows higher physical characteristics.

PHYSICAL CHARACTERISTICS OF THE PULPS: The physical characteristics of eucalyptus and pine pulps are presented numerically in Table 1 and are plotted in the Figures 3 and 4 respectively. Except for higher bulk and opacity, eucalyptus pulp shows lower characteristics than pine pulp. With refining, both pulps show a decrease of bulk and an increase of tensile and burst strengths, folding endurance and air resistance. The tear strength for the eucalyptus pulp increases up to 45° SR and decreases thereafter. For the pine pulp, it remains almost constant up to 30° SR, decreasing from then on. The opacity of eucalyptus pulp remains almost unchanged with refining, but decreases for pine pulp.

MIXTURES OF THE PULPS: Mixtures of eucalyptus and pine pulps were prepared using the following variables, giving a total of 48 combinations.

Eucalyptus pulp freeness	15, 30, 45, 60°SR
Pine pulp freeness	15, 30, 45, 60°SR
Eucalyptus and pine proportion	1:3, 1:1, 3:1

For each mixture, handsheets were made with a basis weight of 60g/m², and their physical characteristics evaluated. When the mixture is made with slightly or unrefined pulps, the resulting tensile and burst strengths remain practically unchanged with varying the relative amount of eucalyptus. But the bulk and the opacity increase and the tear strength decrease drastically with increasing amounts of eucalyptus.

The most important factors that influence tensile and burst strengths are the number of inter-fiber bonds and their resistance. Therefore, the low tensile and burst strengths of mixtures obtained with pine and eucalyptus pulps, slightly or unrefined, should be attributed to the low number of interfiber bonds.

By refining the pulps, the number of interfiber bonds increases, and consequently so do the tensile and burst strengths.

In the case of tear strength, two factors interfere: the force necessary to pull out the fiber from the sheet structure and the force necessary to rupture the fiber itself. When the mixture is made with slightly or unrefined pulps, the number of interfiber bonds and their resistance are both low, so the force required to pull out a fiber from the sheet structure depends essentially upon the fiber dimension, and its value is directly proportional to the fiber length. This explains the decrease of tear strength with the relative increase of eucalyptus in the mixture.

When the mixture is obtained with slightly or unrefined pine pulp and refined eucalyptus pulp the tensile and burst strengths increase considerably with the relative increase of eucalyptus whose fibers contribute to the numerical increase of interfiber bonds. The tear strength increases appreciably up to a 50% eucalyptus pulp addition, decreasing from then on. Adding a certain amount of refined eucalyptus fibers to unrefined pine pulp causes an increase of both the number of interfiber bonds and the resistance to pull out the fibers. But when in the mixture the amount of eucalyptus fibers surpasses that of pine, the effect of fiber length begins to become predominant. The bulk of the mixture decreases with increasing quantities of eucalyptus fibers because stronger interfiber bonding leads to sheets with lower thickness for the same basis weight. The opacity of the mixture increases with the quantity of eucalyptus incorporated into the system.

Adding slightly or unrefined eucalyptus pulp to refined pine pulp should be avoided because the tensile and burst strengths decrease drastically. Also, the tear strength increases very little with increasing quantities of eucalyptus while the bulk and opacity increase. The unrefined eucalyptus fibers will interfere with the interfiber bonding that would potentially be established among the pine fibers, and also contribute to a decrease in the average fiber length of the system.

When both pulps are highly refined, the amount of fines in the mixture increases with the quantity of eucalyptus pulp added to the system. These fines interfere with the interfiber bondings causing a decrease in the overall tensile and burst strengths. Moderate amounts of eucalyptus hardly interfere with the tear strength, but larger amounts decrease the tear strength. The bulk does not undergo great variations, but the opacity increases.

Figures 5 and 6 present the physical characteristics of mixtures prepared with pine pulp refined to 30° SR and eucalyptus pulp refined to 30° SR and 45° SR, respectively.

MATHEMATICAL MODELS: With the results obtained it was possible to construct mathematical models for estimating the values of the physical characteristics of a paper manufactured with mixtures of eucalyptus and pine pulps, using different degrees of freeness for each pulp, as well as various relative amounts of both pulps, without having to prepare laboratory handsheets and to evaluate

Table 1

PHYSICAL CHARACTERISTICS								
Pulp	Freeness	Bulk	Tensile Index	Burst Index	Tear Index	Folding Endurance	Air Resistance	Opacity
	°SR	cm ³ /g	N.m/g	kPa.m ² /g	mN.m ² /g	(Köhler-Molin)	(Gurley) s/100mL	(Elrepho) %
Eucalyptus	16	2.80	10.2	0.27	2.37	-	-	82.6
	32	2.10	48.8	2.74	8.16	18	6	82.0
	44	1.94	60.1	3.58	9.90	50	21	82.2
	59	1.79	61.8	4.09	8.24	72	62	82.3
Pine	15	2.46	18.7	1.02	14.7	4	2	77.0
	28	1.87	70.0	5.20	14.9	971	38	72.6
	41	1.82	88.3	6.55	13.8	1629	96	72.7
	53	1.73	89.4	7.24	13.3	1234	148	71.2

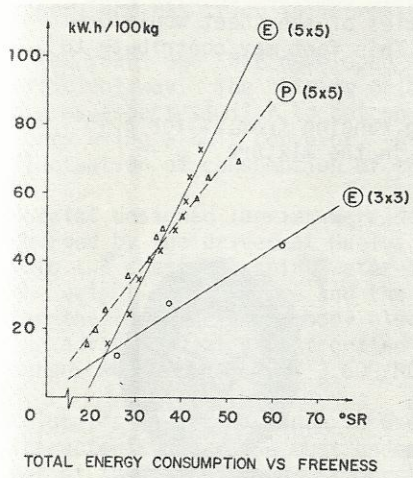


Figure 1

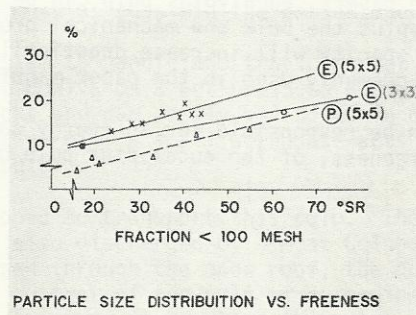


Figure 2

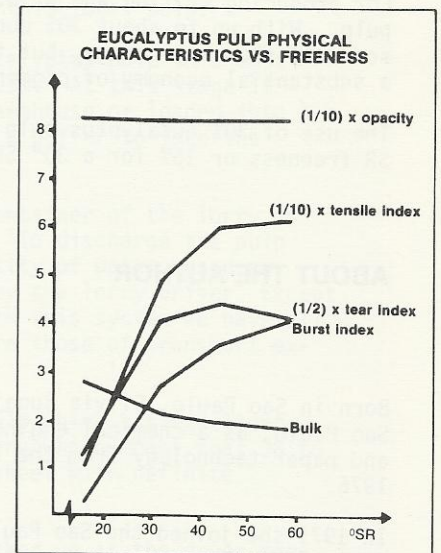


Figure 3

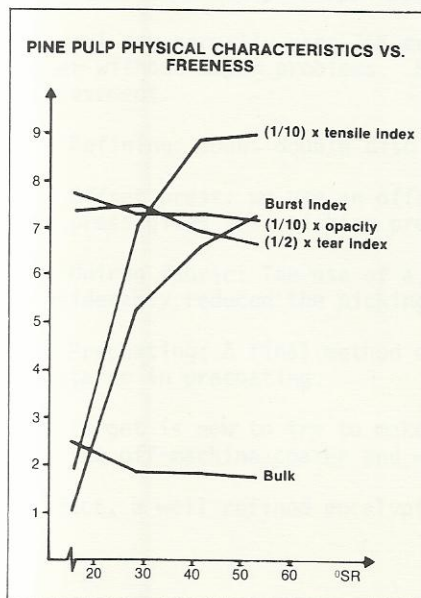


Figure 4

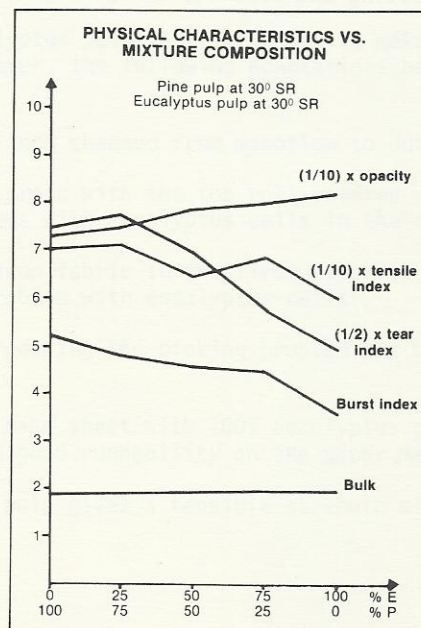


Figure 5

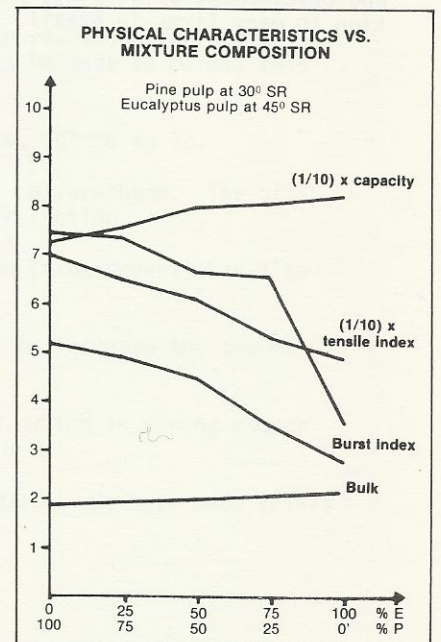


Figure 6

luate their physical characteristics. Table 2 presents the mathematical models.

TENSING METHODS USED: The freeness, expressed in Schopper Riegler, was measured according to the ABCP C 10/73 Standard Method. The fiber classification on the Bauer McNett apparatus was carried out using the SCAN M6 Standard. Laboratory handsheets were prepared on a Rapid Köthen type Former, according to Merkblatt V/8/57 (Zellcheming). The handsheets were preconditioned at 30% relative humidity, being conditioned and tested at 65% relative humidity and 20°C temperature, as recommended by ABCP P 4/70 Standard Method. The physical tests were performed according to the following standard procedures:

Bulk	TAPPI T220 m-60
Tensile strength	TAPPI T220 m-60
Tear strength	TAPPI T220 m-60
Burst strength	TAPPI T220 m-60
Folding endurance, Köhler-Molin	Merkblatt V/12/57 (Zellcheming)
Air resistance, Gurley	ABCP P 11/71
Opacity, Elrepho	ABCP P 8/73

In order to get the advantage of lower energy consumption when refining eucalyptus pulp, the correct disc has to be chosen. It would be wrong to refine eucalyptus with the disc recommended for pine pulp. In addition to a higher energy consumption, the pulp produced would exhibit poor physical properties due to fiber damage.

For producing writing and printing papers, eucalyptus pulp can be used in combination with pine pulp. With up to about 30% eucalyptus the bulk and mechanical properties of the sheet would scarcely show any change, but the opacity will increase drastically. This fact may contribute to a substantial economy of pigments commonly used in the paper manufacture.

The use of 30% eucalyptus pulp can be responsible for an energy saving ranging from 5% for a 45° SR freeness or 15% for a 30° SR freeness, of the eucalyptus pulp used in the mixture.

ABOUT THE AUTHOR

Born in Sao Paulo, Silvia Bugajer graduated from Mackenzie University, Sao Paulo, as a chemical engineer in 1970, and obtained an MSc in pulp and paper technology from the Institute of Paper in Appleton, Wisc. in 1976.

In 1971 she joined the Sao Paulo Technological Research Institute. Since 1976 Silvia Bugajer has been head of the CTCPIPT, working in research and development of pulping, papermaking and coating, and giving technical assistance and consultation to many firms in Brazil.



SILVIA BUGAJER