ALTERNATIVES TO IMPROVE EUCALYPT KRAFT PULP REFINING

Braz J. Demuner
Aracruz Celulose S.A.- Centro de Pesquisa e Tecnologia, C.P. 33.1011, Aracruz-ES, 29.197-000, Brasil

The main objective of this summary is to present how eucalypt pulps have been refined and to arise some technological alternatives to enhance tensile strength development with refining energy saving.

Refining is one of the most important processes in papermaking that affects stock properties in a generalized way. With refining, fibers undergo structural modifications that will help achieving the desirable combination of properties in the end paper. Among other targets, increased paper strength with minimum energy consumption is a primary objective of pulp refining. The strength increase is governed by the *amount* of applied net energy and *how* is the energy applied, which in turn is quantified by the balance between total *net energy* input and the *number* of impacts vs. impact *intensity*.

There are several ways in which cell wall is modified, each way to a greater or lesser degree depending on the nature of the bar to bar impact. Generally, gentle impact is associated with swelling of the cell wall and a fibrillation of the external surface of the fiber, while more severe impacts are thought to produce splitting of the wall, and in the extreme case cutting the fiber. The *type* of cell wall modification is largely affected by the magnitude of the deformation, often referred to as the *severity* of impacts. The *degree* of cell wall modification can be related to the *number* of impacts.

Many research works have shown that pulps respond much better to a large number of gentle impacts, with respect to strength development, rather than a reduced amount of high intensity ones (1-5). This is much more evident for eucalypt pulps (3,6), which is related to their much greater difficulty to form coherent networks than some long and flexible fibers, which accounts for the excellent paper formation.

The question of an optimum refining action for strength development also raises the question of how refining intensity should be measured. Nowadays, it is well recognized that refining specific edge load and specific energy per impact are good methods to measure the refining intensity. Despite the fact that methods to measure the refining intensity have been developed and studies have shown ways to increase strength with energy saving (2,3,5-7), refining still remains as an intensive energy consuming process.

Based on these findings, one basic question arises with respect to the strength development: what is the maximum impact intensity that a fiber can support? In order to answer this question, the first step was to find references to the amount of energy theoretically necessary to modify the fiber to its elastic limit, without rupturing it. Then, the reference value was compared with the intensity levels that have been regularly practiced in the full scale refining. Answer for this question can be taken from the numbers presented in Table 1. Under the theoretical point of view, only 5.4 to 8.6 kJ/kg.Impact is necessary to modify a fiber (8,9), which can be an important reference in refining, including eucalypt pulps. More recently, as previously indicated by Kerekes (10), Croney (5) demonstrated that the increase in tensile strength became larger with decreasing intensity down to specific energy per impact around 10 kJ/kg. Therefore, the intensity of 10 kJ/kg.Impact was postulated to be other practical value for pulp refining.

Table 1 – Theoretical estimates and Current Mill Practices of Specific Edge Load and Specific Energy per Impact

Pulp Type	Specific Edge Load (J/m)			Specific Energy per Impact (kJ/kg.Impact)
	Estimated from the Theoretical limit 5.4kJ /kg.Impact (8)	Estimated from the best results found by Croney (5) 10kJ/kg.Impact	Current Industrial Practices	Current Industrial Practices
EUCALYPT	0.1	0.2	0.5 to 1.0	28 to 55
SOFTWOOD	0.7	1.3	2.0 to 3.0	16 to 24

Therefore, table 1 clearly demonstrates that in current industrial practices specific edge load and specific energy per impact have been used somewhat greater than theoretical estimates of the energy necessary to impose permanent deformation on fibers, especially for eucalypt pulps. In other words, reduced number of impacts of higher intensity is still being applied upon eucalypt fibers. As a consequence, greater part of total energy input is being used to introduce undesirable fiber cell wall modifications, like fines and fiber cutting, rather than fiber fibrillation and fiber swelling, which account to strength development. This fact seems to be a good explanation why refining still remains as an energy consuming process, and clearly indicates window for improvements.

Knowing all these facts, the main challenge ahead to improve eucalypt pulp refining is the development of alternatives to reach reduced values of specific edge load (and specific energy per impact), as those levels presented in table 1. Two basic possibilities to achieve this target are: a) reducing the no-load; and b) increasing the cutting length (both as maximum as possible). Among others, alternatives that are going in this direction are:

- Fine plate patterns (bar and grooves width as narrow as possible) to increase cutting length and thus to reduce the specific edge load;
- Refiner with multi zones, which allows higher cutting length, lower no-load, and lower net energy consumption, with lesser capital investment. The multi-disk is designed to produce specific edge load < 0.5 J/m, which is suitable for eucalypt pulps;
- Disk refiner with a dispersing unit to allow the refining of individual fibers with very fine plate pattern and narrow gap. A reliable technology of control is necessary to avoid contact between plates;
- Adequate cutting angles (e.g. a range of 40 to 55º) to increase cutting length and fiber fibrillation;
- Stock consistency as higher as possible (>5%), which is advantageous to increase the residence time of fibers in the refiner and hence improving the chance of fibers to receive more number of impacts of low intensity;
- Active diameter reduction, with appropriated levels of rotor refiner speed, and groove volume to reduce no-load; and
- Separate refining systems for the eucalypt pulps and the softwood components, as the refining requirements of these different pulps are very distinct (table 1).

REFERENCES

1. Levlin, J-E. 1986. The response of different fiber raw materials to refining. *In: Pira International Refining Conference.* Vol. II. Birmingham – England. 31p.

2. Danfort, D.W. 1986. Effect of refining parameters on paper properties. *In: Pira International Refining Conference.* Vol. II. Birmingham – England. 12p.

3. Manfredi. V and Claudio-da-Silva Jr, E. 1986. Refining – Operational variables vs. Raw materials. *In: Pira International Refining Conference*. Vol. II. Birmingham – England. 41p.

4. Kerekes, R.J. 1990. Characterizing of pulp refiners by C-Factor. *Nordic Pulp and Paper Res. J. 1*:3-8

5. Croney, C.; Ouellet, D. and Kerekes, R.J. Characterizing refining intensity for tensile strength development. *In: 5th Pira Int. Refining Conference.* Vienna–Austria. 17p.

6. Baker, C. 2001. The challenge of lowering refining energy consumption. In*: 6th Pira International Refining Conference.* Toronto, Canada. 18p.

7. Albert, K.P. 2001. Enhancing refiner performance and lowering energy consumption with overhung plates. *In: 6th Pira International Refining Conference.* Toronto, Canada. 8p.

8. Nissan, A.M. 1977. *Lectures on fiber science in paper*. Edited by W.C. Walker, Pulp and Paper Technology Series. Joint Textbook Committee of the Paper Industry. Nº4. p27.

9. Leider, P.J. and Nissan, A.M. 1977. Understanding the disk refiner – the mechanical treatment of the fibers. *Tappi J. 60* (10): 85-89.

10. Kerekes, R.J. et alli. 1995. New perspectives on refining intensity. *In: Pira 3rd Int. Refining Conf.* Altanta. 23p.