EUCALYPTUS FIBRE FOR FIBRECEMENT COMPOSITES

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ABSTRACT

The use of refined wood fibres as raw material for fibrecement products has proved successful in pilot plant trials, industrial, and laboratory applications. The normal world wide applications are related to long fibre pulp production replacing asbestos. The aim of this work was to evaluate the replacement of softwood fibres with hardwood fibres (eucalyptus wood) as raw material for fibrecement products.

The main issues discussed prior to laboratory and industrial application were the refining characteristics of short fibre compared with long fibre. After the refining process the fibre structure is modified, additional surfaces are created, and the fibre's conformability is increased. The refining has a great influence on the fibre bonding, producing more flexible fibers, which are easier to bond, leading to higher strength properties.

The following characteristics of refining were evaluated: pulp, intensity (specific edge load), consistency, refiner linings and rotation speed. The effect of refining on pulp was compared in terms of pulp quality properties (strength), fibre morphology (fibre breakage or cutting) and drainability (°SR). Analysis of morphological data and comparisons between the two fibre types showed that it is possible to work with eucalyptus pulp having good properties. Mechanical testing of these materials demonstrated that the samples possessed sufficient strength and toughness to provide an alternative to long-fibre for the production of non asbestos fibrecement.

It is important to stress that the industrial process control parameters need to be adjusted particularly the refining parameters need to be understood when replacement of long for short fibre is required.

The non asbestos fibrecement products, in terms of physical and mechanical properties, produced by using eucalyptus fibres was approved and could be considered good as non asbestos fibrecement products using long fibers.

This practical work was developed by interfacing with the research institute and fibre cement factory.

The studies was performed for corrugated fibre cement roofing with natural aging and using synthetic fibres for reinforced the cement matrix, like PVA (Polyvinyl acetate) and/or PP (Polypropylene).

KEYWORDS:

Corrugated fibrecement products, short fibre, eucalyptus fibre, refining and fibre morphology.

INTRODUCTION

Brazil, the biggest eucalyptus pulp producer in the world, supplies almost all of its fibre as raw material for paper production. However other applications for this pulp are always being evaluated and the fibre cement market is one option.

It is common to use long fibre to replace asbestos in the fibre cement composites and this is the situation in Europe where asbestos using was banned.

Usually in Brazil fibrecement production utilizes long fibre as raw material, but recently a new development using eucalyptus fibre was started as an alternative technology.

The main issue allowing the use of eucalyptus fibre for this application became the determination of refining system parameters appropriate to eucalyptus fibre processing and it was found necessary to replace the refiner linings.

Other important consideration is the higher quantity of fibre population if it is considered eucalyptus pulp. Comparing with long fibre, the fibre population from eucalyptus pulp is more than 3 times from the long fibre population (22 million fibre per gram compared with 7 million fibre per gram from the long fibre pulp).

This issue allows us to reduce the fibre application keeping the same quality of the fines retention in the process.

It is important to stress that the industrial process control of refining needs to be adjusted and the refining condition needs to be understood when replacement of long by short fibre is required. Tonoli (2006) commented that all changes noted in the fibre structure are influenced by refiner type, grade of pulp (hardwoods, softwoods and non-woods) and refining process conditions.

Manfredi (2004) comments as a general rule, chemical pulp fibres used directly from the bales do not provide adequate strength. They must be physically modified and refining is the mechanical treatment which improves the fibre characteristics. During this treatment, pulp fibres are subjected to drastic mechanical actions. The fibre structure is modified, additional surfaces are created, and the fibre's conformability is increased. Refining has a great influence on the fibre bonding, producing more flexible fibres, easier to bond and leading to higher strength properties. In general, the refining process produces a number of modifications to the fibre morphology, such as fibre breakage or cutting, external fibrillation and secondary wall delamination.

Refining requires large amounts of energy and the structural modifications on fibre structure are not reversible. Because refining is so important to the final results, it has been intensively studied, and during the last decades, several refining models ("refining theories") have been developed that are relevant to paper. These models allowed a better understanding of the process itself, quantifying refining and allowing comparison between different refiners. The "refining theories" have changed understanding of the process from art to science. The concept of refining intensity, expressed as the ratio between effective refining load and edge length per unit of time was introduced and the concept of specific edge load (SEL) was also developed demonstrating the dominating role played by bar edges in fibre treatment. Specific energy was also recognized as an important refining parameter. This was the origin of the "specific edge load theory" as it is known nowadays in the paper area.

The most common theoretical measures of refining are the "specific energy consumption" (expressed as kWh/t) and the "specific edge load" (expressed as Ws/m), respectively, the amount and the severity (intensity) of refining. The specific edge load determines the intensity and quality of refining. Reducing refining intensity (Ws/m) will improve fibre strength for all short fibres furnishes and for any type of refiner. It is reported that higher specific edge load values (higher "refining intensity") lead to "cutting" of fibres while lower values tend to fibrillate them. In addition, according to the model, all refiners can be compared at the same specific edge load and net refining energy.

The SEL parameter is the most important variable to be considered, but the parameters refining consistency, refiner linings and rotation speed are important and need to be included in any analysis.

Consistency has a strong influence in industrial refining operations because any variation of its value results in a variation of the refiner's throughput in tonnes/hour (production). In industrial operations refining consistency must also be controlled within a narrow range. In addition, the flow rate through a refiner is an important variable which together with stock consistency affects the fibre mat thickness between rotor and stator when energy is applied. In general, higher amounts of fibres on the bars and better stability of gap clearances, gives better fibre development and lower energy consumption. For short fibre pulp, refining at consistencies of 4 to 6 % range is recommended (MANFREDI, 2004).

Baker (2000) stated that changing the refiner linings is, in most cases, the most cost-effective way of changing the type of refining and by changing the liner bar configuration, the action of a refiner can be varied from fibrillation to cutting. Energy savings of 40-60% have been found by a modification of liner design combined with changes in SEL. The main parameters of a refiner lining are: the number and width of the bars (cut edge length), the cutting angle of the bars (degrees), the material of the bars and the depth of the grooves and their width.

The refiner motor speed of rotation determines the “no load”, the cutting edge lengths and the specific edge load; the higher rotation speed, the higher the “no load”. Therefore, although one can lower SEL and increase fibrillation, major changes in rotation speed will reduce refiner energy (BAKER, 2000).

It is common for paper technology to use the concepts of SEL, consistency, disk linings and rotation speed. In this work these concepts were adapted for corrugated fibre cement roofing production, in order to control the production process.

The aim of this work was to evaluate the replacement of softwood fibres with hardwood fibres (eucalyptus wood) as raw material for corrugated fibre cement roofing.

RESULTS AND DISCUSSIONS

STEP 1 – EUCALYPTUS PULP REFINING CONDITIONS OPTIMIZATION

In this part of the study, performed in the fibre cement facility, refining parameters (table 1) were monitored, as well the pulp quality. Samples were collected and then analyzed in a pulp mill laboratory, in order to obtain the refining curves, showing the behavior of the pulp during all trials.

The following characteristics of refining were evaluated: pulp, intensity (specific edge load), refiner linings configuration and power, see table 1.

Table 1 – Refining conditions used during the optimization phase.

Pulp Grade	Refiner linings	Power (kW)	SEL (W.s/m)
Eucalyptus	5'' x 5'' x 7º50'	310 – 240 - 190	1.02 – 0.71 – 0.49
Long Fibre	3'' x 4'' x 7º30'	310 – 240 - 190	1.64 – 1.14 – 0,78

The power of the system was varied to obtain the different Specific Edge Loads (SEL), shown in table 1.

The effect of refining on both pulps was compared in terms of pulp quality properties Tensile strength, fines content (fibre breakage or cutting) and drainability (°SR).

Figures 1 and 2 show the behavior of tensile strength during the refiner operation as a function of pulp drainability.

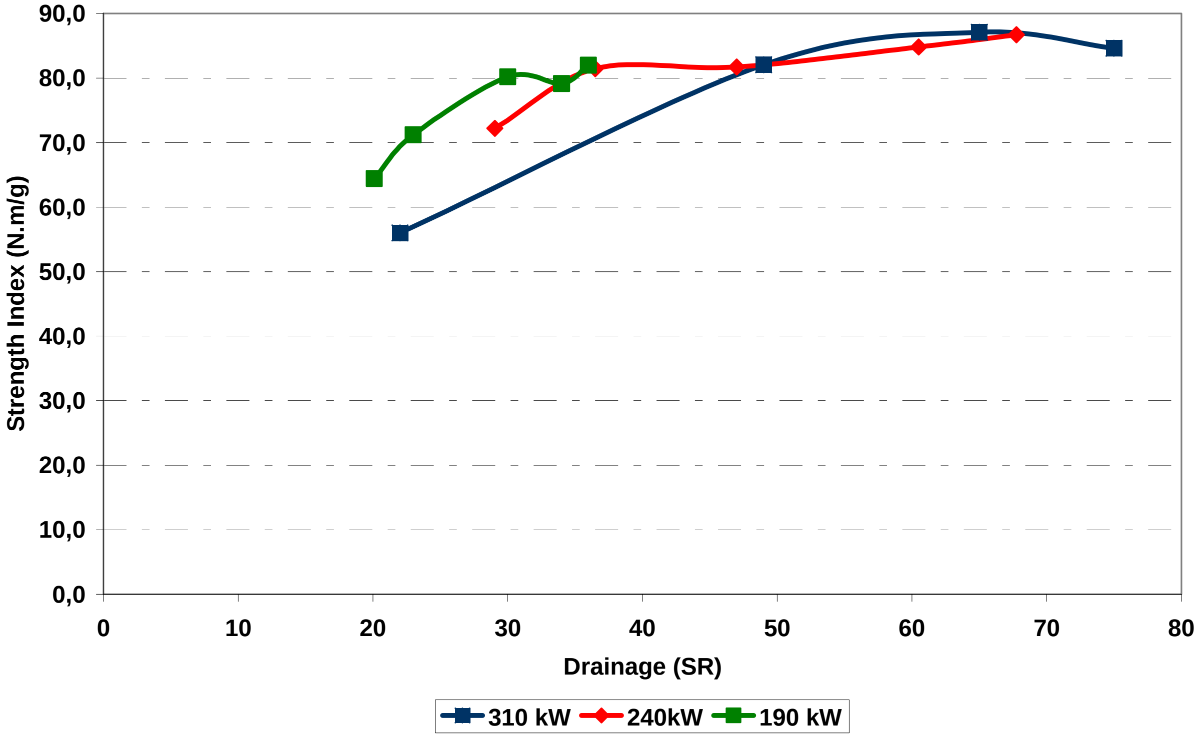

Figure 1 – Drainability versus Strength Index at different power levels for Long Fibre.

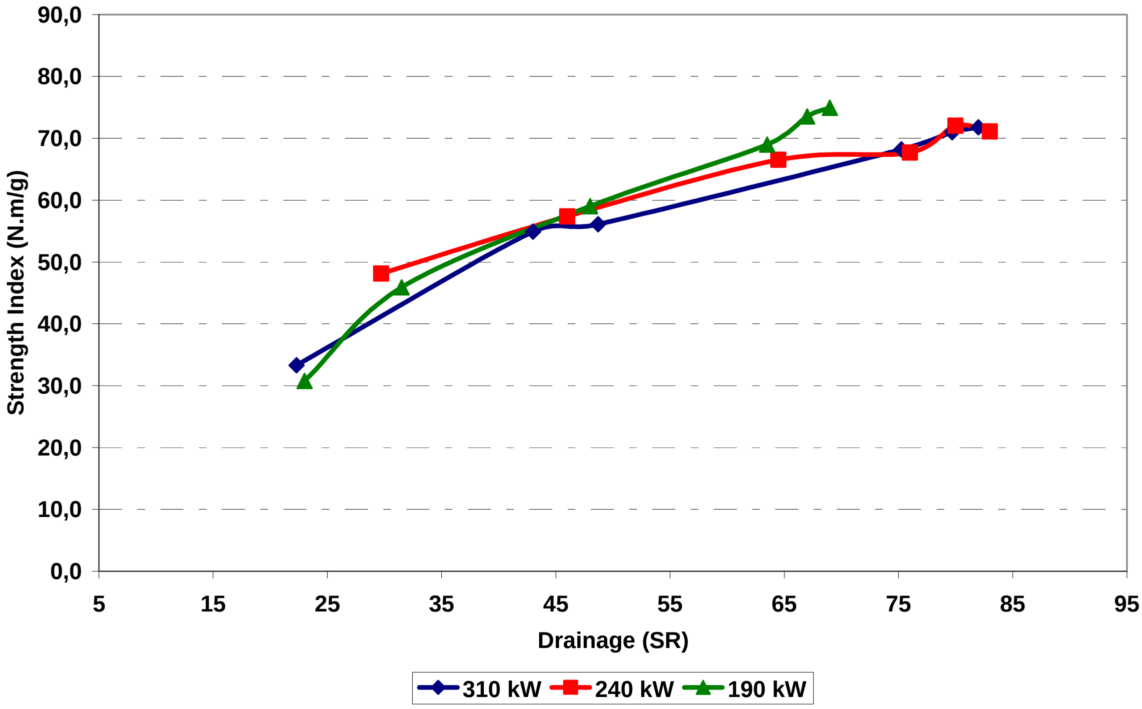

Figure 2 – Drainability versus Strength Index at different power levels for Eucalyptus Fibre.

Figures 1 and 2 show that the tensile strength index increases with increase in pulp drainability for both pulp grades. The eucalyptus pulp presents a more linear behavior compared with the long fibre pulp. The target tensile (60 N.m/g) was achieved by all power conditions in the both pulp grades. It is important to remember that refining requires a large amount of energy and the best conditions to operate the system were chosen based on this.

Figures 3 and 4 show the fines content of the pulp generated during refiner operation as function of pulp drainability.

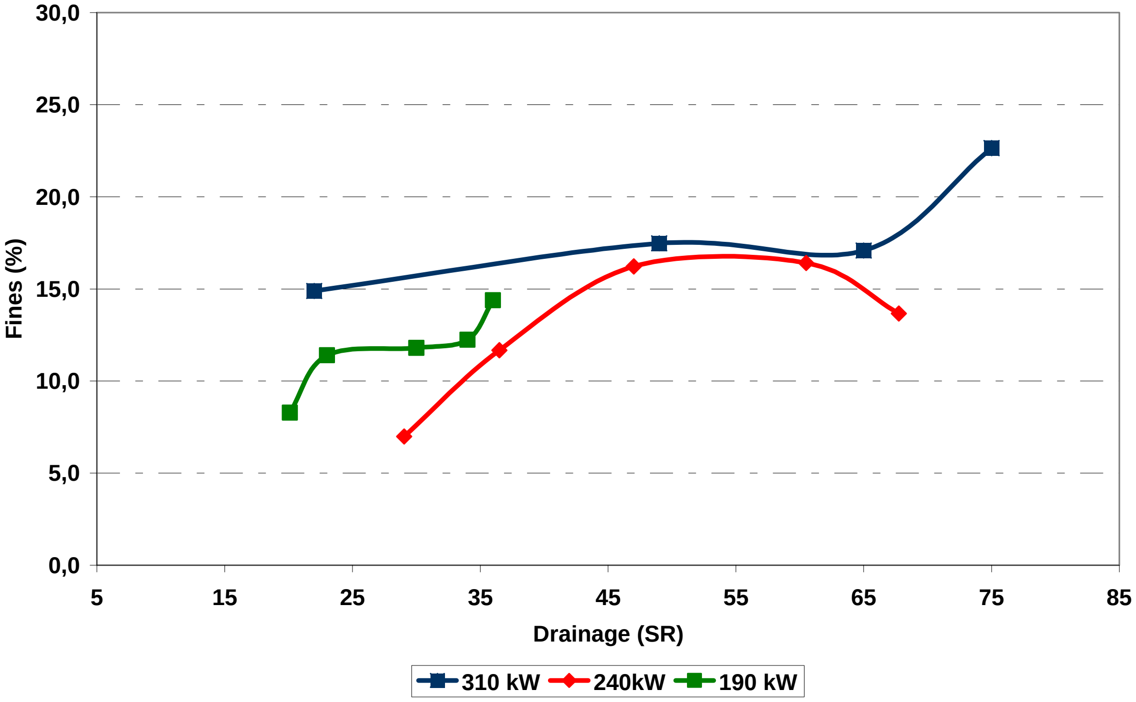

Figure 3 – Drainability versus Fines Content at different power levels for Long Fibre.

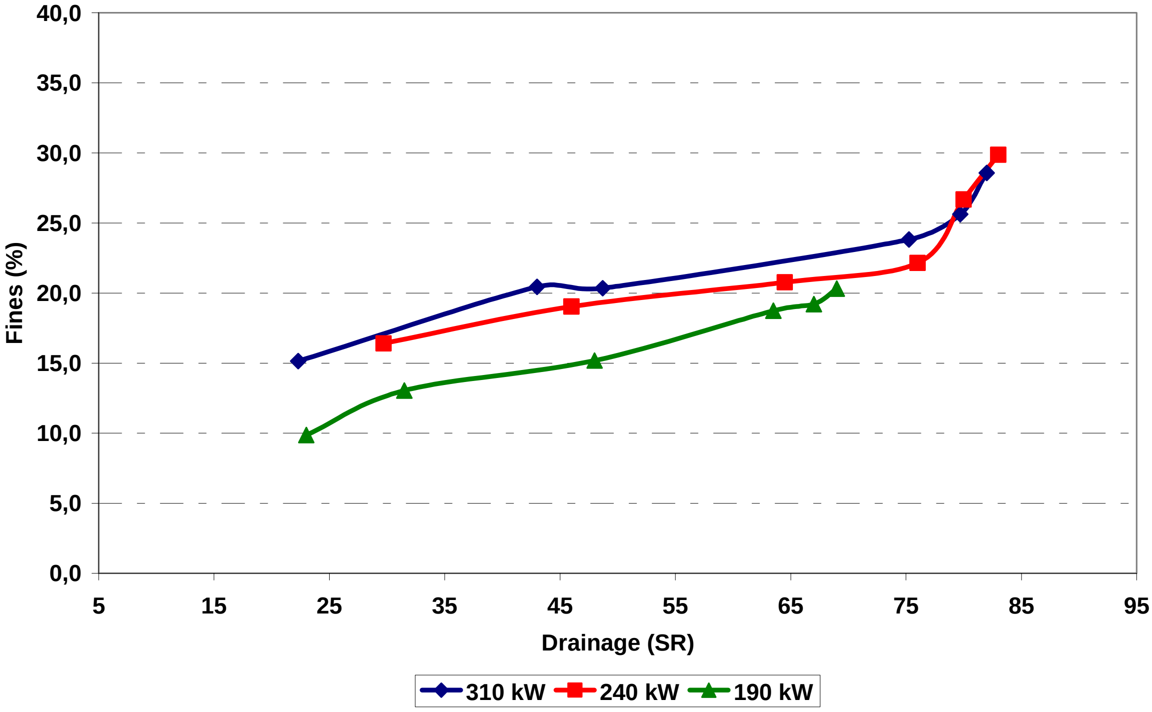

Figure 4 –Drainability versus Fines Content at different power levels for Eucalyptus Fibre.

Figures 3 and 4 show that the fines content (TAPPI method T-261 cm-94) increases as the pulp drainability increases and refining power applied for both pulp grades. It is necessary to avoid the fines generation and these figures show that the least fines are generated when lower power is applied. There was little difference between the 190 and 240 kW power levels and considering the saving of energy, the intermediate level was chosen.

The best operating conditions can found by analyzing the four figures above.. It was considered desirable to choose refining conditions that produce higher tensile strength with the lower fines generation. The standard condition used to compare was the long fibre as reference, and so the conditions selected for eucalyptus fibre were 240 kW of power with SEL of 0,70 Ws/m. The specific edge load determines the intensity and quality of refining. Reducing refining intensity (Ws/m) will improve fibre strength for all short fibres furnishes and for any type of refiner. It is reported that higher specific edge load values (higher "refining intensity") lead to "cutting" while lower values tend to fibrillate them. In addition, according to the model, at the same specific edge load and net refining energy, all refiners can be compared.

STEP II – FIBRECEMENT PRODUCTION BATCH RUN WITH EUCALYPTUS PULP

During the batch runs performed at Infibra mill in 2006, the following parameters were monitored: SEL(specific edge load), fines content, drainability of pulp, sheet thickness and flexural strength, In order to evaluate the refining system performance and fibre quality after the mechanical treatment

Figures 5, 6 and 7 show the fibre characteristics.

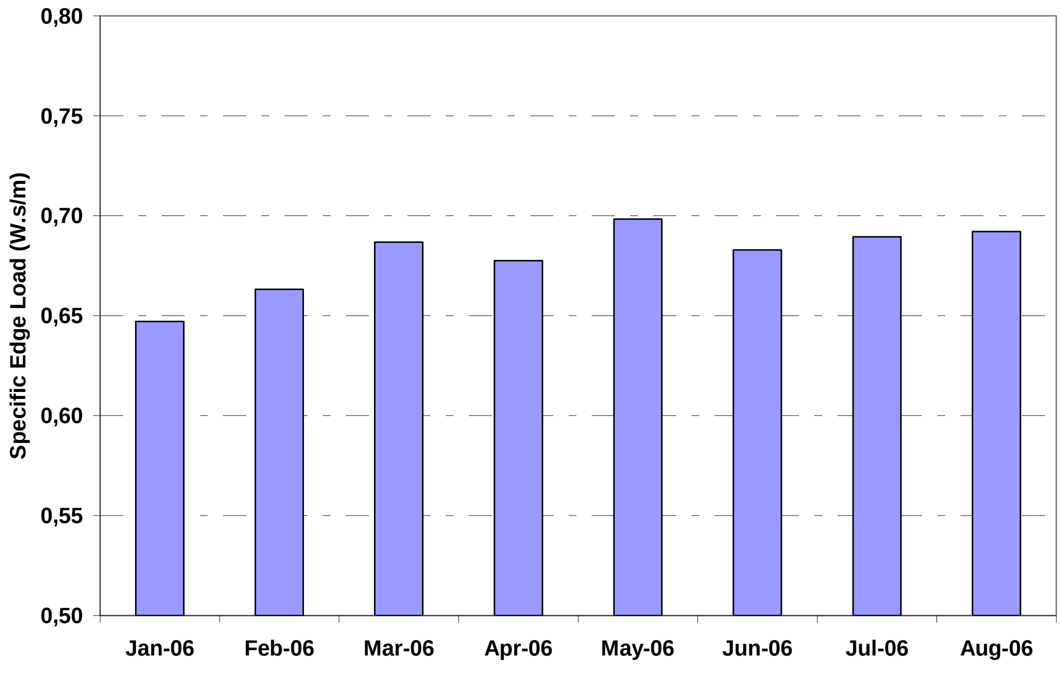

Figure 5 – Specific Edge Load during 2006 Industrial Production.

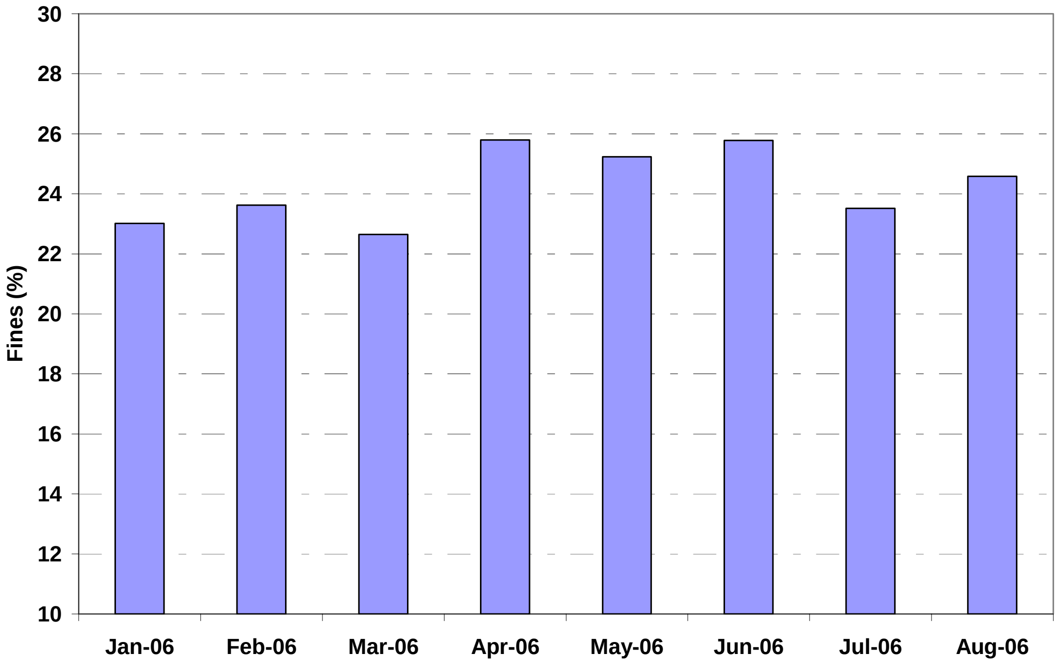

Figure 6 – Fines Content during 2006 Industrial Production.

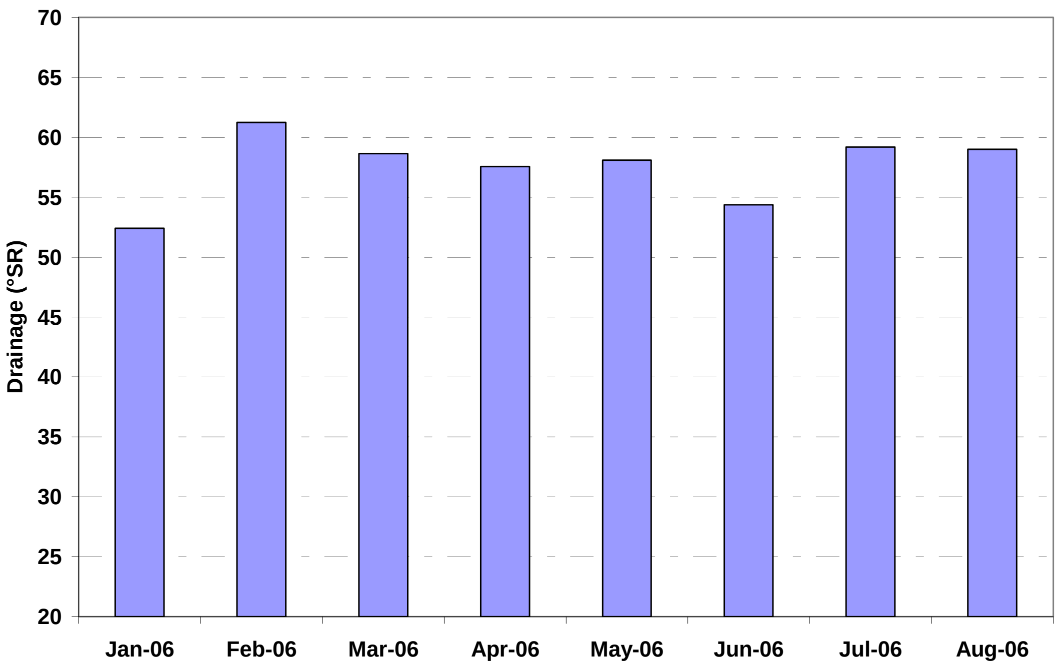

Figure 7 – Pulp Drainability during 2006 Industrial Production.

The control parameters used in the normal batch run production were the SEL (Ws/m) and drainability (SR). As resulted of the step 1, it was decided to use approximately SEL of 0,70 Ws/m and drainability range from 55 to 60 SR. These parameters assure to get a good tensile strength and not so much fines generation in the pulp. The figures 5, 6 and 7 permitted to conclude that the parameters control were followed.

It observed in the figures 8 and 9 the final quality of the undulated fibrecement roofing. The quality control of this products was checked by using the standard method ABNT NBR 15210. Product specification as stated by the method was: **flexural strength be higher than 2,500 N/m for thickness of 5 mm**.

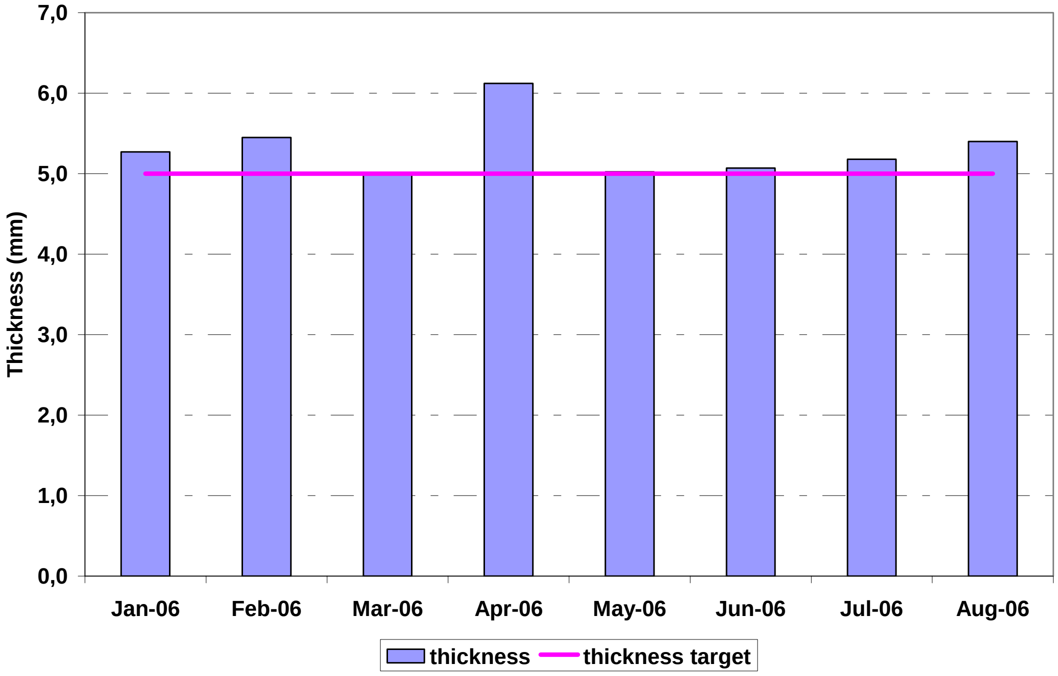

Figure 8 – Corrugated fibrecement roofing thickness.

Thickness target was achieved with the standard deviation of 0.36 mm in all batch runs demonstrating good process control for this parameter.

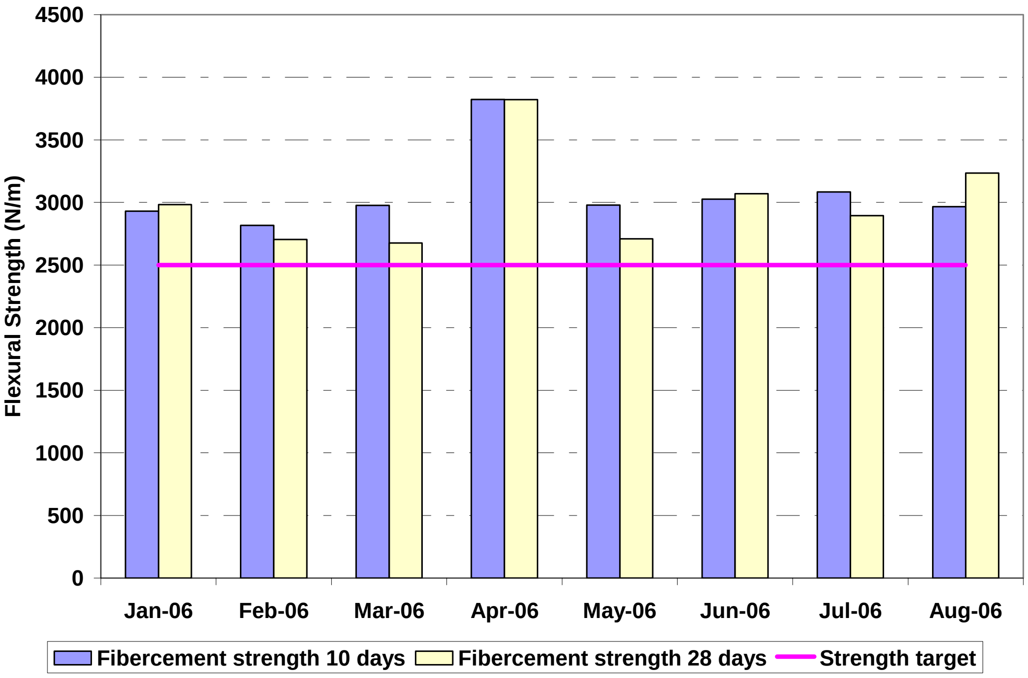

Figure 9 – Corrugated fibrecement roofing Flexural Strength.

Figure 9 shows very good and uniform results for flexural strength and all runs achieved the target as required by the standard method.

Considering higher quantity of the fibre population in the eucalyptus pulp it was possible to reduce the fibre application from 3,0% to 2,5%, keeping in the same range the fines retention in the process.

CONCLUSION

This work allowed to conclude that the non asbestos corrugated sheets, in terms of physical and mechanical properties, produced by using eucalyptus fibres was approved and these fibres could be considered as good as softwood fibres for industrial applications replacing asbestos. As already point out in the results, this fibre allows us to reduce the fibre application.

ACKNOWLEDGEMENTS

We wish to thank Infibra Permatex of Brazil for supporting this work.

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