# DEPITHED BARK: A NEW SOURCE OF FIBERS FOR KRAFT PULPING

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## ABSTRACT

Bark of commercial pulpwood trees is a huge source of fibers, which is being neglected by most pulp producers. Usually bark is pulped together with chips, in a conventional procedure. A new technology is suggested in this paper for using bark. This technology is supposed to let the utilization of bark fibers without bringing problems to the operation of digesters, screeners, evaporators, washing filters, etc. It also brings no significant differences in pulp quality, compared with the pulp obtained from debarked chips. The technology is as follows: a) pulpwood comes with bark to mill site; b) bark is removed using conventional debarkers; c) bark is depithed, probably by means of conventional depithing equipments. Depithing is defined as the removal of non-fiber materials from bark. Depithing yields have been found around 40 - 50% for most eucalypt species. Eucalyptus urophylla was the raw material used for testing; d) depithed bark is added to normal wood chips to feed the digester. The use of depithed bark mixed with eucalypt wood chips let a 1000 a.d.t. bleached pulp/day mill to increase production in 7,000 a.d.t./year or to economize 25,000 solid cubic meters of round-wood per year. Non-fibrous bark materials may be discarded, burned as fuel or transformed in wood panels.

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There are no doubts that predictions of fiber shortages in a near future are correct. Available wood fiber supply has to be increased to avoid problems in the pulp and paper production. One of the most promising approaches is the increasing usage for bark. Bark of commercial pulpwood trees is a huge source of fibers which is being neglected by most of pulp producers. The reasons are well known: when wood chips containing bark are pulped, many operational problems appear and pulp quality decreases. This is true also for kraft pulping, the only chemical pulping process that has no limitation of fibrous raw materials.

The conventional idea for using bark is to chip the roundwwod as received and to pulp bark and wood chips together. This idea is not recent and now-a-days it has been very used, although the problems it carries with. Nothing has been done to improve the quality of the bark which goes to the digester.

The purpose of this paper is to suggest a new way for using bark. This new technology is supposed to let the utilization of bark fibers without bringing problems to the operation of digesters, screeners, evaporators, washing filters, etc. It also brings no significant differences in pulp quality, compared with the pulp obtained from debarked chips.

It is well known that the bark of the trees has as constituents a certain percentage of fiber-like cells and a large percentage of non-fibrous cells (cortical tissue, parenchyma cells, epithelial tissue, etc). These last types of cells are not desired for pulping since : a) they will require a higher chemical charge; b) they are not fibrous and pulp strengths will go down because their presence; c) they usually contain high amounts of extractives and lignin, so, they make cooking and bleaching more difficults; d) because of their small cell dimensions, they plug wires, they cause incrustation in evaporators, etc; e ) they have a great ability to swell in alkaline conditions and this usually causes plugging in continuous digesters.

Eucalyptus urophylla was the raw material selected for testing. In general, bark represents 10 to 15% of eucalypt round-wood o.d. weight. If non-fibrous cells are conveniently removed from bark, this will lead 5 to 7,5% of bark fibers, based on o.d. wood weight. These bark fibers represent a huge amount of material that can be used for a pulp mill without operational and pulp quality problems. For instance , a kraft pulp mill , which produces 1,000 a.d.t. of eucalypt bleached pulp/day, requires a minimum of 2,000t. of equivalent oven-dried wood/day. Depending on wood species and tree age, the weight of bark which comes with the logs is around 200 to 300 o.d. tons. If this bark be conveniently separated and non-fibrous cells removed, the available bark fibers for the mill will be around 100 to 150 t. of dry material. Non-fibrous bark material looks like a coarse powder, usually rich in ash content, which may be discarded, burned as fuel, or transformed in wood panels.

Using the same terminology as that for preparation of sugar-cane bagasse for pulping, we can call this step in bark purification as depithing. Procedures for depithing many materials, as agricultural residues, are well developed. It can be assumed that no major changes have to be made for depithing bark. In laboratory trials, the barks of several eucalypt wood species were easily depithed .

The technology which the authors of this paper are proposing is the following: a ) pulpwood comes with bark to mill site; b) bark is removed using conventional mechanical debarkers; c) bark is depithed, probably by means of conventional depithing equipments. Depithing yields have been found around 40-50%; d) depithed bark is added to normal wood chips to feed the digester. The charge of depithed bark to the digester should be around the same percentage of bark fiber content which enters the mill with roundwood.

The authors carried out an extensive research program on kraft pulping of eucalypt wood containing bark or not. Wood chips were blended with several different percentages of normal and depithed bark. The pulps obtained from wood chips plus bark (depithed or not) were compared with the pulp obtained from 100% eucalypt wood chips. It was found that the maximum content of depithed bark on total o.d. blended chips weight should be about 10%, to assure pulp quality similar to that obtained from debarked chips. This charge is normally a little higher than the depithed bark content based on wood, which results after the removal and purification of bark by depithing.

When normal bark was blended with wood chips, even in amounts as low as 5% on o.d. weight, pulp quality decreased. Pulp tensile strength was the property found to be most sensitive to bark content . Bark content affects mainly the following pulp properties: pulp yields; reject content; unbleached and bleached pulp CED viscosity and pulp GE brightness; total active chlorine and total caustic soda charges in pulp bleaching; post color number of bleached pulp; tensile and burst strengths of bleached and unbleached pulp. The effect of normal bark content was very significant, but depithed bark addition results only in a slightly change of pulp quality.

The use depithed bark mixed with conventional eucalypt wood chips let a 1,000 a.d.t. eucalypt bleached pulp/day mill to increase production in 7,000 a.d.t./year or to economize 25,000 solid cubic meters of roundwood per year.

Important consideration is that a new source of fibers becomes available, pulp quality is not affected by the controlled addition of the depithed bark , chemical consumptions are lower than those for pulping bark-containing wood, and operational problems in digesters, evaporators, screeners and filters are supposed to be mostly avoided.

## EXPERIMENTAL

_Eucalyptus urophylla_ wood was debarked and the logs chipped by an industrial chipper. Bark was divided in two fractions: one was handly chipped and the other was depithed. Depithing was done by the following way: a) wet bark was passed through a disc refiner with maximum clearance between discs; b) the defibered material was screened by washing with water in a 1 mm hole diameter wire. The retained material was considered to be fibers and the fine materials, the pith. Depithing yield was found to be 40 to 50%.

Pulping followed the kraft process . Pulping conditions were as follows: Active alkali = 14% $Na_2O$; Sulfidity = 25%, Liquor to wood ratio = 6:1; Maximum temperature = 170°C; Time to 170°C = 90 min.; Time at 170°C = 60 min.

The following mixtures with normal wood chips were tested: 5; 10; 20 and 100% of depithed bark; 5; 10; 20; 40; 50 and 100% of normal bark; 100% wood chips. A total of eleven treatments was studied.

Unbleached pulps were washed, screened and the following determinations were performed in them: total pulp yield, screened pulp yield; reject content, kappa number, CED TAPPI viscosity and GE brightness.

Pulp bleaching was performed according to $CE_1HD_1E_2D_2$ bleaching sequence. Chemical charges in the three first stages were varied according to pulp lignin content. The objective was to obtain bleached pulp with 92-93°GE brightness and CED viscosity around 13 cP.

Bleached and unbleached pulps were beaten in a PFI mill to develop strengths. Handsheets were formed according to TAPPI Standard T 205 and tested according to TAPPI Standard T 220. Prior to testing, handsheets were conditioned at 65% relative humidity and 20°C temperature.

## RESULTS

| TREATMENT | % DEPITHED BARK | | | | |
|---|---|---|---|---|---|
| | 0 | 5 | 10 | 20 | 100 |
| **Cooking** | | | | | |
| Total yield, % | 50.4 | 48.3 | 46.5 | 42.3 | 36.1 |
| Screened yield,% | 48.5 | 47.2 | 44.7 | 39.1 | 36.0 |
| Reject content, % | 1.9 | 1.1 | 1.8 | 3.2 | 0.1 |
| **Unbleached pulp** | | | | | |
| Kappa number | 17.6 | 17.4 | 17.7 | 20.4 | 27.4 |
| Viscosity,cP | 39.6 | 40.7 | 37.2 | 20.4 | 18.3 |
| Brightness, °GE | 29.6 | 29.4 | 29.4 | 25.1 | 14.3 |
| Properties at 350 CSF | | | | | |
| - PFI revolutions, $10^3$ | 11.0 | 11.0 | 9.5 | 10.0 | 0.6 |
| - Density, g/cm$^3$ | 0.628 | 0.638 | 0.648 | 0.680 | 0.514 |
| - Breaking length, km | 8.5 | 8.4 | 8.6 | 6.8 | 3.5 |
| - Burst factor | 67 | 63 | 71 | 66 | 17 |
| - Tear factor | 123 | 123 | 128 | 120 | 37 |
| - Double folds, MIT | 425 | 392 | 345 | 195 | 6 |
| - Stretch, % | 3.0 | 3.9 | 4.0 | 3.3 | 2.6 |
| **Bleaching** | | | | | |
| Total active chlorine, kg/t | 60.6 | 58.2 | 59.6 | 64.3 | 80.2 |
| Total caustic soda, (without caustic to prepare hypochlorite), kg/t | 29.6 | 29.3 | 29.4 | 30.3 | 34.3 |
| **Bleached pulp** | | | | | |
| Viscosity, cP | 14.8 | 13.8 | 13.0 | 13.7 | 6.0 |
| Brightness, °GE | 93.0 | 92.7 | 93.2 | 93.6 | 88.1 |
| Post-color number | 0.48 | 0.45 | 0.46 | 0.47 | 0.52 |
| Properties at 350 CSF | | | | | |
| - PFI revolutions, $10^3$ | 10.0 | 7.5 | 6.5 | 5.8 | 0.6 |
| - Density, g/cm$^3$ | 0.630 | 0.670 | 0.725 | 0.685 | 0.579 |
| - Breaking length, km | 7.3 | 7.1 | 7.0 | 5.8 | 3.7 |
| - Burst factor | 50 | 51 | 51 | 46 | 18 |
| - Tear factor | 124 | 127 | 105 | 95 | 42 |
| - Double folds, MIT | 90 | 230 | 175 | 75 | 4 |
| - Stretch, % | 3.5 | 3.0 | 2.3 | 1.9 | 3.6 |
| - Light scattering coefficient, cm$^2$/g | 360 | 345 | 385 | 370 | 509 |

Table 1. Properties of the kraft pulps obtained from the wood of *Eucalyptus urophylla* containing different percentages of depithed bark.

| TREATMENT | % NORMAL BARK | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0 | 5 | 10 | 20 | 40 | 50 | 100 |
| Cooking | | | | | | | |
| Total yield, % | 50.4 | 46.1 | 45.5 | 43.1 | 41.8 | 36.4 | 34.1 |
| Screened yield, % | 48.5 | 44.4 | 42.1 | 39.0 | 24.6 | 19.2 | 32.4 |
| Reject content, % | 1.9 | 1.7 | 3.4 | 4.1 | 17.2 | 17.2 | 1.7 |
| Unbleached pulp | | | | | | | |
| kappa number | 17.6 | 18.1 | 18.3 | 21.5 | 32.9 | 47.2 | 67.4 |
| Viscosity, cP | 39.6 | 39.3 | 39.6 | 39.8 | 27.6 | 20.2 | 17.2 |
| Brightness, °GE | 29.6 | 28.8 | 27.4 | 25.3 | 19.6 | 17.0 | 10.4 |
| Properties at 350 CSF | | | | | | | |
| - PFI revolutions, $10^3$ | 11.0 | 10.0 | 10.0 | 10.0 | 2.0 | 0.6 | 0.1 |
| - Density, $g/cm^3$ | 0.628 | 0.616 | 0.691 | 0.690 | 0.515 | 0.556 | 0.580 |
| - Breaking length, km | 8.5 | 8.1 | 8.0 | 6.5 | 5.7 | 6.1 | 1.8 |
| - Burst factor | 67 | 63 | 57 | 65 | 41 | 35 | 4 |
| - Tear factor | 123 | 128 | 116 | 125 | 103 | 88 | 26 |
| - Double folds, MIT | 425 | 300 | 310 | 330 | 138 | 105 | 1 |
| - Stretch, % | 3.0 | 3.3 | 4.4 | 3.4 | 1.9 | 2.9 | 1.1 |
| Bleaching | | | | | | | |
| Total active chlorine, kg/t | 60.6 | 58.7 | 60.4 | 66.5 | 89.0 | 106.1 | 186.7 |
| Total caustic soda, (without caustic to prepare hypochlorite), kg/t | 29.6 | 30.3 | 29.6 | 30.7 | 37.4 | 42.0 | 56.6 |
| Bleached pulp | | | | | | | |
| Viscosity, cP | 14.8 | 13.6 | 11.7 | 12.4 | 7.0 | 6.0 | 4.1 |
| Brightness, °GE | 93.0 | 93.3 | 93.0 | 92.7 | 91.2 | 90.7 | 88.9 |
| Post-color number | 0.48 | 0.50 | 0.39 | 0.41 | 0.61 | 0.88 | 0.69 |
| Properties at 350 CSF | | | | | | | |
| - PFI revolutions, $10^3$ | 10.0 | 8.5 | 7.0 | 7.5 | 2.5 | 0.35 | - |
| - Density, $g/cm^3$ | 0.630 | 0.620 | 0.630 | 0.685 | 0.630 | 0.626 | - |
| - Breaking length, km | 7.3 | 6.1 | 6.3 | 6.4 | 5.9 | 6.1 | - |
| - Burst factor | 50 | 54 | 43 | 53 | 39 | 32 | - |
| - Tear factor | 124 | 123 | 124 | 105 | 70 | 74 | - |
| - Double folds, MIT | 90 | 125 | 45 | 56 | 49 | 41 | - |
| - Stretch, % | 3.5 | 3.3 | 2.7 | 2.9 | 2.6 | 3.1 | - |
| - Light scattering coefficient, $cm^2/g$ | 360 | 350 | 340 | 380 | 377 | 393 | - |

Table 2. Properties of the kraft pulps obtained from the wood of *Eucalyptus urophylla* containing different percentages of bark.

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