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# BENEFICIATION OF COMPRESSION DEBARKED WOOD CHIPS

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ABSTRACT.--Presents the results of a preliminary study of secondary beneficiation of compression debarked chips to reduce residual bark to acceptable amounts. Ballmilling is a feasible method of reducing residual bark and minimizing wood loss.

OXFORD: 821:825.71. KEY WORDS: pulpwood, bark, segregation.

## INTRODUCTION

Recent developments in the design of remote chippers have opened the door to a completely new harvest, transport, and process system for pulpwood. The new chippers can go into the woods to chip whole trees or the residue after a conventional harvest, thereby greatly increasing the utilization of fiber available.

The removal of bark and foliage from unbarked chips is the major problem preventing the complete utilization of these chips. Although new developments in pulping may facilitate the use of unbarked chips in the pulping process (Horn and Auchter 1972), no more than 3 percent bark in chips is now acceptable in most pulping processes. Also, the removal of foliage from the chip mass will eliminate many problems in materials handling.

The Forest Engineering Lab (FEL) has devoted over 3 yr to solving the problem of bark removal after chipping (Erickson 1972). A system has been developed that has the potential of removing all but 3 percent of the bark for some species during certain periods of the year.

The heart of the removal system developed at the FEL is the compression debarker (Arola and Erickson 1973). By itself, the compression debarker can remove 50 to 70 percent of the bark in a chip mass, and with the addition of a presteaming treatment, an additional 20 percent can be removed.

The objective of the present study was to evaluate further beneficiation of the chips after compression debarking to determine if residual bark could be reduced to less than 3 percent at all times of the year.

Earlier investigation by Arola and Erickson (1973) showed that most of the bark left after compression debarking is in the small size fractions (chips that will pass a 3/8-in. screen but not a 3/16-in. screen). Additional experience indicated that much of the remaining bark is very friable, that is, easily fragmented by rubbing the particles between the hands. We therefore decided to construct a device that could further break down the friable bark particles to facilitate their removal by screening and to evaluate its efficiency in terms of total bark removal.

Complete elimination of the small size fractions from the compression debarker output is another possible way to reduce the residual bark content. The drawback of this approach is that all the fiber in the removed material is lost to the pulping process.

## PROCEDURE AND METHODS

A bench-sized ballmill similar to those used in the mineral processing industries was used to beneficiate the compression debarker output (figure 1). We felt that the tumbling action of the wood chip mass and

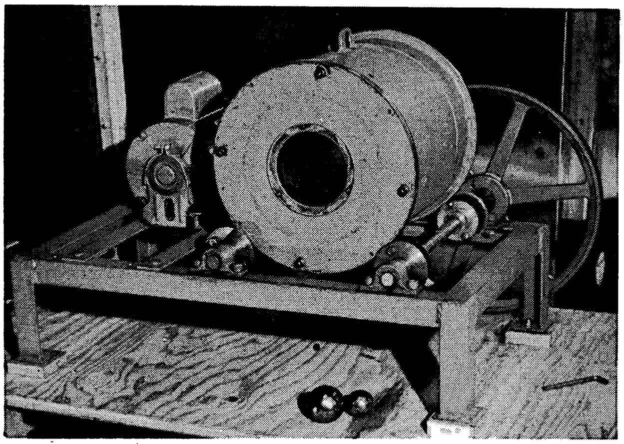

Figure 1.--*Experimental ballmill.*

the grinding media would fragment the remaining bark particles so they could be removed by screening.

The experimental ballmill consisted of a 10-in. diameter cylinder 10-in. long with one removable end flange to facilitate loading and unloading. Four 1/2-in.-high ribs the length of the mill were attached to the sides of the cylinder, parallel to its axis, to aid in the tumbling action created by the mill's rotation. A rubber friction-wheel drive and electric motor rotated the mill at a constant speed of 60 r/min. Fifty pounds of 2-in.-diameter steel balls were normally used as the grinding media in the mill.

Whole trees of aspen (*Populus tremuloides*), hard maple (*Acer saccharum*), and jack pine (*Pinus banksiana*) were chipped and used as the sample material. The trees were cut and chipped in January and June of 1973. All the material was obtained from the lands of the Ford Forestry Center of Michigan Technological University near L'Anse, Michigan. The chipping was done with a Morbark Chip-pac.[1]

The chips were presteamed for 10 min at 30 lb/in.$^2$ and run through the compression debarker at a 0.020-in. nip spacing. The hydraulic pressure on the rolls was 1,400 lb/lineal in., roll speed was 640 surface ft/min and feed rate was 1 ft$^3$/min. The output from the compression debarker was screened into five size fractions-- + 1-1/8-in., + 5/8-in., + 3/8-in., + 3/16-in., and fines--each was weighed, and a sample taken to determine the percent of wood, bark, and foliage present. All samples were analyzed on an oven-dry basis.

[1]*Mention of trade names does not constitute endorsement of the products by the USDA Forest Service.*

The 3/16-in. screen fraction of the compression debarker output was run through the ballmill in 1,000 gm batches for 3 min. The output of the ballmill was then rescreened, the 3/16-in. fraction being the output and the fines the reject, and the input and output were sampled to obtain the percents of wood, bark, and foliage present.

For both the compression debarker runs and the ballmill runs, the percent bark removed, percent foliage removed, and wood loss were calculated.

## RESULTS

The steaming and compression debarking process alone removed at least 50 percent of the input bark for all species in both the dormant and growing seasons; aspen (cut during the growing season) was the only species in which residual bark was reduced to less than 3 percent (table 1). Steaming and compression debarking was effective in removing foliage only in jack pine where nearly 60 percent of the input foliage was removed during both the dormant and growing seasons. Wood loss for the steaming and compression debarking varied from a low of 5.9 percent for aspen to a high of 16.0 percent for maple, both during the growing season. (A significant portion of the wood lost during the steaming and compression debarking process is wood that adheres to the knurled roll of the compression debarker. For instance, maple processed during the growing season had a total wood loss of 16 percent, 14 of the 16 percent, or 88 percent of the total wood loss, was wood removed by the knurled roll. The use of two smooth rolls on the compression debarker is being investigated as a means of reducing this loss.)

After compression debarking, from 5.5 to 15.0 percent of the total output was in the 3/16-in. size class, and most of the bark and foliage remaining after steaming and compression debarking was in this size class (table 2). Bark proportions ranged up to 47.0 percent for maple chips in this size class processed during the dormant season; foliage proportions in the same size class ranged up to 16.0 percent for jack pine processed during the dormant season.

Ballmilling the 3/16-in. class after compression debarking removed at least 50 percent of the remaining bark in all species, but again, the foliage removed was significant only in jack pine (table 3). Wood losses for the ballmilling ranged from 5.7 percent to 18.0 percent.

Table 1.--*Bark and foliage removed and wood lost during compression debarking*[1]

(In percent)

| Species | Cutting date | Bark: In input | Bark: In output | Bark: Removed as percent of input bark | Foliage: In input | Foliage: In output | Foliage: Removed as percent of input foliage | Wood loss as percent of input wood |
|---|---|---|---|---|---|---|---|---|
| Aspen | 1/73 | 18.5 | 3.6 | 84.8 | -- | -- | -- | 6.6 |
| | 6/73 | 18.6 | 2.5 | 89.7 | 0.8 | 0.7 | 28.6 | 5.9 |
| Maple | 1/73 | 14.4 | 7.4 | 56.8 | -- | -- | -- | 8.9 |
| | 6/73 | 14.1 | 8.8 | 50.3 | 3.6 | 3.6 | 20.4 | 15.9 |
| Jack pine | 1/73 | 10.6 | 4.5 | 66.5 | 5.0 | 2.5 | 59.4 | 12.3 |
| | 6/73 | 11.1 | 3.6 | 72.5 | 3.1 | 1.6 | 56.8 | 6.2 |

[1]All runs presteamed at 30 lb/in.$^2$ for 10 min. All analyses on oven-dry basis.

If the 3/16-in. size class is removed after compression debarking, the residual bark content of the remaining mix drops to the desired level in all but maple processed during the growing season (figure 2). However, removing this size class after compression debarking also increased the wood loss signigicantly, particularly during the dormant season when the 3/16-in. size class is a much larger percent of the total output (figure 3). By contrast, ballmilling the 3/16-in. fraction and then adding the recovered portion to the remainder of the compression debarked chips did not reduce the residual bark content as much as removing the 3/16-in. fraction completely, but wood loss was not nearly as great.

Table 2.--*Total output and bark and foliage remaining in chips of various sizes after compression debarking.*[1]

(In percent)

| Size class (In.) | Aspen (1/73) | Aspen (6/73) | Maple (1/73) | Maple (6/73) | Jack pine (1/73) | Jack pine (6/73) |
|---|---|---|---|---|---|---|
| TOTAL OUTPUT | | | | | | |
| 1-1/8 | 3.6 | 9.9 | 6.6 | 10.6 | 3.4 | 5.2 |
| 5/8 | 47.3 | 64.9 | 55.8 | 62.8 | 43.4 | 52.9 |
| 3/8 | 34.2 | 19.7 | 27.5 | 18.2 | 41.0 | 32.4 |
| 3/16 | 14.9 | 5.5 | 10.2 | 8.4 | 12.2 | 9.4 |
| BARK | | | | | | |
| 1-1/8 | 0.0 | 0.1 | 0.5 | 3.0 | 1.4 | 0.5 |
| 5/8 | .2 | .3 | .8 | 4.6 | .8 | .7 |
| 3/8 | 2.2 | 4.7 | 7.9 | 14.5 | 5.0 | 4.5 |
| 3/16 | 18.0 | 24.6 | 46.8 | 36.0 | 16.2 | 18.8 |
| Total | 3.6 | 2.5 | 7.4 | 8.8 | 4.5 | 3.6 |
| FOLIAGE | | | | | | |
| 1-1/8 | 0.0 | 1.0 | 0.0 | 1.1 | 0.0 | 0.0 |
| 5/8 | .0 | .4 | .0 | 2.7 | .1 | .0 |
| 3/8 | .0 | .8 | .0 | 5.8 | 1.2 | .7 |
| 3/16 | .0 | 3.3 | .0 | 9.6 | 16.4 | 14.4 |
| Total | .0 | .7 | .0 | 3.6 | 2.5 | 1.6 |

[1]Oven-dry basis.

## DISCUSSION

An additional treatment needs to be developed that will further reduce the total residual bark content to 3 percent or less for all species for all seasons of the year. Most of the remaining bark is in the small size fractions, primarily the 3/16-in. size. This fraction composes between 5 and 15 percent of the total output and can contain up to 50 percent bark, so the additional treatment should be concentrated on this material.

Complete removal of the 3/16-in. size fraction from the output for use in particleboard or fuel is one way to reduce the residual bark content, but it also increases the amount of wood lost to as much as 20 percent in some cases. Loss of this much fiber could make the steaming-compression debarking process uneconomical.

The alternative of further processing the 3/16-in. size fraction using an experimental ballmill did not reduce the residual bark content as much as eliminating the 3/16-in. size fraction from the output, but the total wood loss was significantly lower.

## CONCLUSIONS

1. Ballmilling the 3/16-in. chips after compression debarking is a feasible method of both lowering the residual bark content and keeping the loss of wood to a minimum.
2. Removal of the 3/16-in. chips after compression debarking is also a feasible alternative for lowering the content of residual bark if an economical use can be found for the material removed.
3. The ballmilling beneficiation process needs to be refined further and incorporated into a continuous system. The entire system will then be technically and economically evaluated in a pilot plant.

Table 3.--*Bark and foliage removed and wood lost in ballmilling of 3/16-in. chips after compression debarking*[1]

(In percent)

| Species | Cutting date | Bark: In input | Bark: In output | Bark: Removed as percent of input bark | Foliage: In input | Foliage: In output | Foliage: Removed as percent of input foliage | Wood loss as percent of input wood |
|---|---|---|---|---|---|---|---|---|
| Aspen | 1/73 | 19.5 | 9.4 | 63.0 | -- | -- | -- | 14.0 |
| | 6/73 | 24.0 | 7.4 | 78.0 | 6.3 | 3.3 | 47.0 | 5.7 |
| Maple | 1/73 | 48.0 | 30.0 | 59.0 | -- | -- | -- | 9.9 |
| | 6/73 | 35.0 | 23.0 | 53.0 | 12.0 | 14.0 | 16.0 | 18.0 |
| Jack pine | 1/73 | 18.0 | 12.0 | 54.0 | 17.0 | 5.7 | 77.0 | 14.0 |
| | 6/73 | 21.0 | 15.0 | 48.0 | 16.2 | 5.8 | 74.0 | 12.0 |

[1]Oven-dry basis.

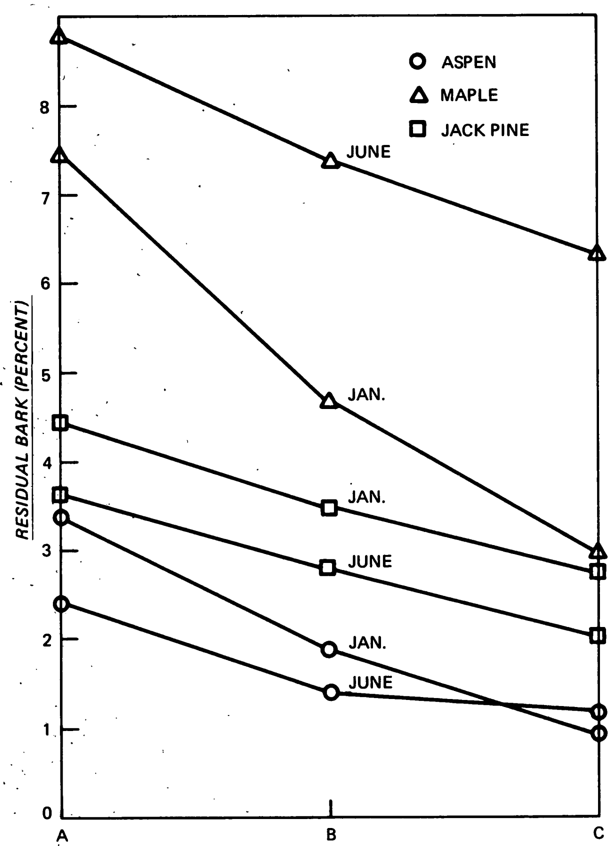


Figure 2.--*Comparison of percent residual bark for (A) compression debarked chips only; (B) compression debarked chips with 3/16-in. fraction ballmilled; and (C) compression debarked chips with the 3/16-in. fraction removed.*

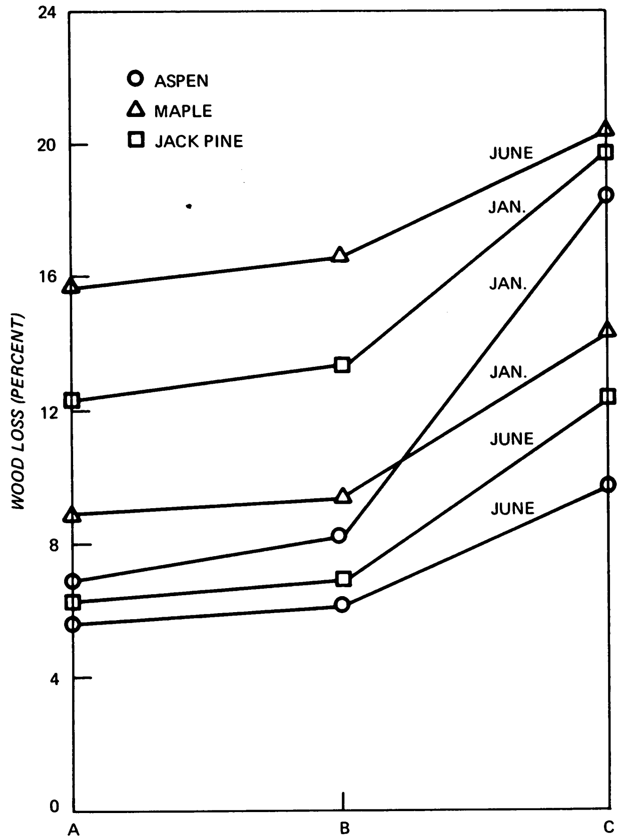


Figure 3.--*Comparison of percent wood loss for (A) compression debarked chips only; (B) compression debarked chips with 3/16-in. fraction ballmilled; and (C) compression debarked chips with the 3/16-in. fraction removed.*

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