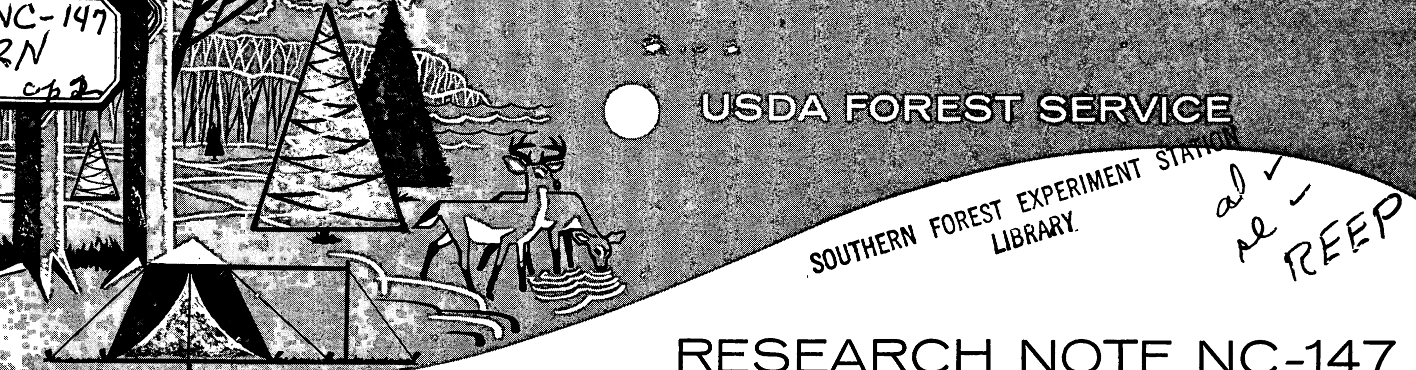

RESEARCH NOTE NC-147

NORTH CENTRAL FOREST EXPERIMENT STATION, FOREST SERVICE—U.S. DEPARTMENT OF AGRICULTURE

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COMPRESSION DEBARKED CHIPS FROM A WHOLE-TREE CHIPPER

ABSTRACT. — Discusses case study results of debarking whole-tree aspen and red oak chips produced with a whole - tree chipper. The results indicate promise for successful bark removal after chipping and strengthen the argument for continued research.

OXFORD: 821:825.71. KEY WORDS: pulpwood, chip debarking, bark removal, beneficiation.

Millions of tons of "usable" residue pulpwood material (tops, limbs, etc.) are not used primarily because of technical and economic restraints. As Erickson (1972) recently stated, "To leave such large quantities of good fiber (bonus wood) in the forest to rot is an embarrassment and a challenge to the wood-using industry." This neglected wood residue is equivalent to 40 percent or more of our National pulpwood needs.

Along with wood fiber recovery, numerous other benefits relating to visual pollution, site preparation, fire danger, and residue disposal are accrued by utilizing this material. These benefits are pointed out in a recent announcement by the USDA Forest Service. As an option in National Forest management, they have introduced a new timber sale contract that provides incentives for utilizing this "bonus wood." Under the old contract, standard prices had to be paid for below-minimum size material removed from the sale. Thus, the stimulus for more complete utilization exists. However, one of the major deterrents to residue utilization is the problem of removing bark. Most pulp and paper mills are not yet ready to accept unbarked whole-tree chips as a complete mill furnish nor to blend with "clean" chips, but this possibility is receiving more attention.

In an effort to utilize this residue material and to extend forest resources, the Forest Engineering Laboratory at Houghton, Michigan, is conducting research on bark removal after chipping. This research has included an extensive test program on compression debarking of three Lake States species (aspen, jack pine, and hard maple) and some southern pine (Arola and Erickson 1972). Other species have been tested on a "case study" basis and future efforts will be expanded to satisfy National interests. Additionally, treatments are being investigated that improve upon or are complementary to the compression process.

Briefly, compression debarking involves the passage of unbarked wood chips between two rotating compression rolls that have an adjustable nip spacing less than the chip thickness. Bark is removed from the mix as a result of two actions — the bark either adheres to the roll surfaces and is scraped into a waste area or it fragments into small pieces permitting removal by screening. The basic compression debarking process was initially researched by Hosmer Machine Co. (now HMC Corp.), but the system was not commercially developed (Blackford 1961, 1965, 1966; Blanchard 1962).

In July of 1971 the Forest Engineering Laboratory obtained a small quantity of whole-tree chips from a test trial of the Metro-Chiparvester[1] (manufactured by Morbark Inc.) in the Lower Peninsula of Michigan. The stand contained predominantly mature aspen of 5- to 9-inch diameter and also some red oak (Anon. 1971, Hensel 1971). Chip debarking tests were conducted on this material and the results are presented herein. These case-study results further indicate the promise for beneficiating whole-tree chips.

ANALYSIS AND TEST

A random 10-pound sample of the "as received" chips was screened into five size fractions on a standard Williams round-hole classifier. An analysis of each size fraction of the whole-tree chips revealed the free wood, free bark, and bark/wood contents within each size fraction and as weighted percentages of the total mix (table 1). The three largest size fractions represented approximately 90 percent of the total mix and the 3/16 and fines fractions each represented about 5 percent. The percentage of free bark within each fraction increased with decreasing chip size. The weighted calculations show that the 5/8 and 3/8 fractions had over 40 percent of the total free bark content. Even though the 3/16 size fraction contained 26.5 percent free bark, it contributed less than 10 percent of the total free bark content to the total mix.

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

Table 1. — *Distribution of chip types by chip (screen) size for individual fractions and total mix (In percent of green weight)*

Screen size 1/ (inches)	By fraction: Free wood	By fraction: Free bark	By fraction: Bark/wood	By total mix: Free wood	By total mix: Free bark	By total mix: Bark/wood	By total mix: All chips
1-1/8	88.9	4.9	6.2	35.0	1.9	2.5	39.4
5/8	89.6	10.3	.1	27.2	3.1	2/ N	30.3
3/8	85.7	14.2	.1	17.3	2.9	N	20.2
3/16	72.6	26.5	.9	3.6	1.3	N	4.9
Fines	9.8	90.2		.5	4.7		5.2
Total				83.6	13.9	3/ 2.5	100.0

1/ Williams Classifier with circular hole screens.
2/ Negligible.
3/ Approximately 80 percent of the total bark/wood fraction is wood. Bark/wood is defined as wood and bark still attached after chipping.

In the test program the three intermediate size fractions were chosen as the input to the compression debarker. This assumes the 1-1/8 inch-size chips would normally be rechipped and added to the mix and the fines discarded. Thus, the input bark content to the compression process did not correspond to the bark content of the original mix. Also, the mixture of whole trees to the chipper did not come from 100 percent aspen or red oak and caused difficulty in obtaining a homogeneous sample of either species. Therefore, samples herein classified as aspen were "primarily" aspen and those as red oak were "primarily" red oak.

For the compression debarking tests the nip spacing between the rolls was set at 0.020 inch and the nip pressure at 1,400 pounds per lineal inch of roll face width (Arola and Erickson 1972).

Four test combinations were run on approximately 20-pound samples with no replications. The first test was only to compression debark the material to establish control conditions. The remaining three tests included one or two "conditioning" treatments used in conjunction with the compression process to increase the level of beneficiation over the control.

The two conditioning treatments were *steaming* of the bark-chip mass before compression debarking and *drubbing* of the compressed output to break down the bark to permit removal by screening. Steaming was done in a small autoclave for 10 minutes at 10 p.s.i.g. Drubbing was done in a rotating drum outfitted with impact hammers for 10 minutes. Much shorter steaming and drubbing times are anticipated for pilot or production plant operations.

After completion of each test, the processed chips were analyzed manually for output bark content. Additionally, the material removed from the rolls was analyzed for bark and wood content. The amount of bark and wood in fines was estimated. The input bark content was computed as the sum of the residual bark in the output, the bark removed by the compression rolls, and the bark fines. All percentages reported are based on wet weight.

RESULTS

Because of the different input bark content for each test sample, it is difficult to compare tests based on input-output bark content only. Theoretically, all test samples for the same species should have the same input bark content but they did not because of differences between random samples. For this reason, the percent bark removal has been calculated, which eliminates the effect of different input bark contents. Thus, the test having the greatest percent of bark removal corresponds to the "best" test.

For aspen, with only the compression treatment (C), the residual bark was 29.5 percent of the input bark, or the bark removal was 70.5 percent (table 2). When drubbing of the output was combined with compression debarking the bark removal increased to 78.6 percent. When the mix was presteamed and

Table 2.—*Summary of compression debarking tests on whole-tree aspen and red oak chips*
(In percent)

Treatment code 1/	Bark: Input	Bark: Output	Wood loss	Bark removal 2/
ASPEN				
C	18.5	5.4	2.5	70.5
CD	18.7	4.5	1.8	78.6
SC	16.5	2.9	7.5	82.6
SCD	22.7	2.3	5.7	90.0
RED OAK				
C	13.5	5.5	2.5	59.4
CD	15.3	4.9	2.6	67.8
SC	16.2	4.2	7.6	73.9
SCD	20.2	2.6	5.2	87.1

1/ C = compression debarking; D = drubbing; S = steaming.

2/ Percent bark removal = $\left(1 - \frac{\text{output bark}}{\text{input bark}}\right) 100.$

then compression debarked, the bark removal was 82.6 percent. The best test (as anticipated) resulted when the mix was presteamed, compression debarked, and then drubbed. The residual bark in this case was only 10 percent of the input bark or 90 percent bark removal. Results for the aspen chips were better than for red oak.

The wood fiber loss for both species was comparable and less than 8 percent for all tests — thus, 92 percent or more wood was recovered.

Based on the "best" test results for aspen, calculations have been made per 1,000 pounds of input bark-wood mix. For illustrative purposes, a 20-percent input bark content of the mix was arbitrarily assumed. The residual bark content in the processed mix was calculated to be 2.6 percent and the wood recovered to be 754 pounds out of 800 pounds.

The excellent case study results strengthen the argument for continued beneficiation tests on whole-tree chips.

Previous chip debarking research conducted at the Forest Engineering Laboratory has shown that bark removal by the compression process works best on wood cut during the growing season. The efficiency of the system drops off when wood is cut during the dormant season; however, presteaming of the mix tends to partially offset this significant effect of season. Further research is being conducted using steaming as a treatment in conjunction with compression debarking during all seasons of the year and reports will be forthcoming.

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