USDA FOREST SERVICE
RESEARCH NOTE NC-164

NORTH CENTRAL FOREST EXPERIMENT STATION, FOREST SERVICE—U.S. DEPARTMENT OF AGRICULTURE
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CHIP DEBARKING OF SEVERAL WESTERN SPECIES

ABSTRACT.--Discusses processing and conditioning treatments before and after compression debarking of western hemlock, Douglas fir, red alder, and bigleaf maple. Bark removal and wood recovery from red alder far exceeded the other species tested. Approximately 90 percent of the wood fiber input was recovered at a residual bark content of less than 2 percent by weight.

OXFORD: 821:825.71(78/79):174.7:176.1. KEY WORDS: bark removal, wood chips, compression debarking, wood recovery, beneficiation.

Projected increased demand for pulpwood will necessitate greater utilization of existing supplies. Conventional methods of harvesting and transporting pulpwood are wasteful, leaving more than 40 percent of potential wood fiber in the woods to decay. Portable, whole-tree chippers are now commercially available and permit a new approach to pulpwood and harvest transport systems. However, by present pulping standards, a large percentage of bark from whole-tree chips must be removed before whole-tree chips and residue chips will be widely accepted by the pulp and paper industry.

Only limited success has been attained by a number of experimental chip debarking methods examined in the past--soaking, Vac-sink, air aspiration, air flotation, and compression debarking have been the most effective.[1] Due to the great variation in bark and wood characteristics between and within species, none of these processes has been wholly successful. Clearly, a combination of processes and conditioning treatments must be developed and integrated into a total bark removal system. The "schedule" is likely to change between groups of species having different bark characteristics.

There are two major problems associated with bark removal after chipping: separating bark from wood (breaking apart the bark and wood that remains bonded after chipping) and segregating bark particles from the wood chip mass. Discussed here are several attempts at segregating bark from wood chips for several western species. Compression debarking was the process used[1], supplemented by two conditioning treatments--pre-steaming of the bark-chip mass and post-drubbing.

Conditioning of the bark-chip mass with low pressure steam preceding compression debarking has proven effective in increasing bark removal--particularly with aspen and jack pine processed during the dormant season (fig. 1). The softening of the bark and added moisture are believed to be the major factors causing the bark of certain species to adhere with

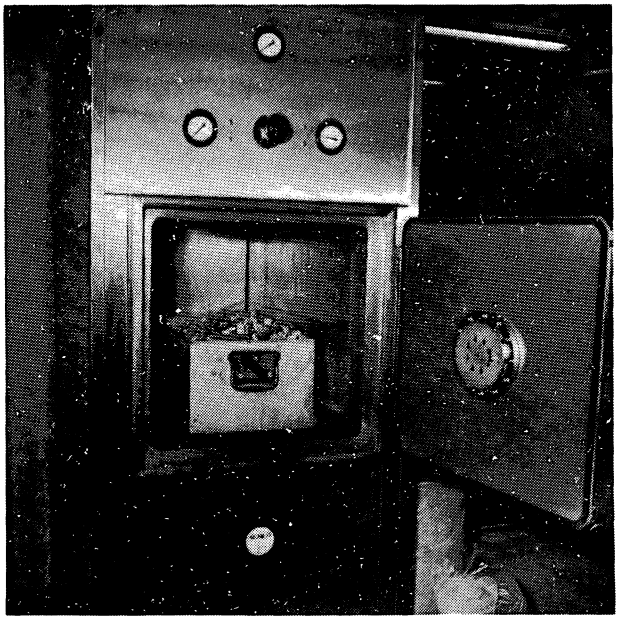

Figure 1.--Low pressure steamer.

[1] *Rodger A. Arola. State-of-the-art and analysis of bark-chip separation-segregation. Unpublished report on file at the North Central Forest Experiment Station, Houghton.*

great tenacity to the compression rolls (thus increased bark removal). Additionally, the pre-steaming loosens the bark-to-wood bond on those chips with bark still adhering after chipping.

The compression debarker features two opposed rotating steel rolls spaced closely together to compress the wood and bark to a size considerably smaller than their free state (fig. 2). The bark is removed by both adherence to the rolls and screening the output which contains fragmentized bark due to the nip action.

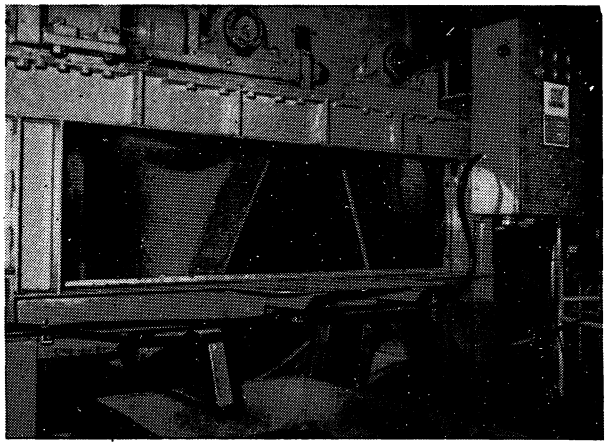

Figure 2.--Compression debarker.

Much of the compressed residual bark in the output chips is "extremely friable" and can be broken down into fines by subjecting it to some form of mechanical attrition. For laboratory use a cylindrical tumbler was fabricated with internal impact hammers that beat or "pummel" the bark-chip mass as the drum revolves (fig. 3). We termed this action "drubbing." Following the drubbing, the pulverized bark particles are screened out (less than a 3/16-inch screen size).

ANALYSIS

Test combinations of the compression debarking and drubbing treatment (CD) and steaming, compression debarking, and drubbing (SCD) were made on four classes of material with three to five replications per combination (depending on the available amount of material)(table 1). Because of limited material, the input chips were not classified by size nor analyzed for input wood and bark content. However, the output chips and reject material from the compression debarker were analyzed manually for free wood, free bark, and bark/wood and the input bark content was computed as the sum of the total residual bark in the output plus bark removed.

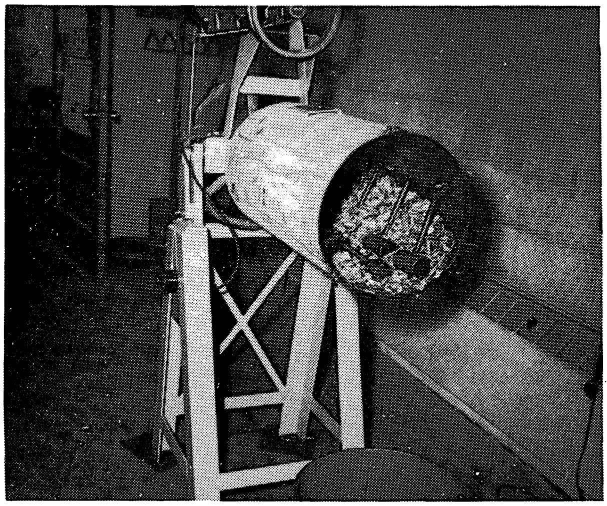

Figure 3.--Impact drubber.

The measures of beneficiation (based on wet weights) of the unbarked wood chips used are defined as follows:

1. Percent input bark =

$$\frac{(\text{Weight of residual bark + weight of bark from rolls + weight of bark in fines})}{(\text{Total input weight})} \times 100$$

2. Percent output bark =

$$\left(\frac{\text{Residual bark weight}}{\text{Total output weight - Weight of fines}}\right) \times 100$$

3. Percent wood loss =

$$\frac{(\text{Weight of wood from rolls + weight of wood in fines})}{(\text{Weight of input wood})} \times 100$$

4. MPY factor =

$$\frac{\text{Percent output bark}}{\text{Percent input bark}}$$

(The MPY factor is a decimal indicator of amount of residual bark in the output mix. An MPY factor of 1.00 indicates zero percent bark removal and an MPY factor of 0.00 indicates 100.0 percent bark removal.)

DISCUSSION

By far the best chip debarking results were obtained with red alder (table 1, fig. 4). More than 90 percent of the input bark was removed. Although wood fiber loss averaged 8.5 percent, methods to reclaim wood lost during processing are being researched to reduce this

Table 1.--Summary of debarking tests on four western species

Chip source	Treatment[1]	Input bark	Output bark	Wood loss	MPY[2]	Weights tested
		percent	percent	percent		pounds
WESTERN HEMLOCK						
Stem only	(SCD)	16.0	4.2	9.9	0.260	233
	(CD)	15.0	3.9	8.7	.259	
Stem, limbs,	(SCD)	16.0	4.1	7.6	.257	226
and foliage	(CD)	15.0	4.3	7.6	.283	
Tops only	(SCD)	20.2	5.5	9.3	.274	262
	(CD)	21.3	5.8	7.6	.272	
Tops, limbs,	(SCD)	26.3	8.9	7.1	.339	221
and foliage	(CD)	25.1	10.3	6.0	.413	
DOUGLAS FIR						
Stem only	(SCD)	14.9	6.9	20.9	.463	208
	(CD)	14.4	5.8	7.7	.401	
Stem, limbs,	(SCD)	17.5	8.1	18.9	.464	218
and foliage	(CD)	15.5	7.9	8.6	.509	
Tops only	(SCD)	16.1	4.9	14.9	.305	196
	(CD)	15.7	4.8	9.1	.309	
Tops, limbs,	(SCD)	20.7	7.0	16.9	.337	231
and foliage	(CD)	21.6	7.9	10.4	.364	
RED ALDER						
Stem only	(SCD)	18.2	1.8	7.6	.099	158
	(CD)	16.9	1.4	9.3	.084	
Stem, limbs,	(SCD)	20.4	1.7	8.1	.082	177
and foliage	(CD)	19.3	1.8	9.6	.094	
BIGLEAF MAPLE						
Stem only	(SCD)	16.4	4.3	20.6	.262	201
	(CD)	15.8	5.8	8.3	.365	

[1]SCD - Pre-steaming, compression debarking and drubbing
CD - Compression debarking and drubbing
[2]Amount of residual bark in output mix: 1.00 = 0 percent bark removal; 0.00 = 100 percent bark removal.

figure to less than 5 percent. Pre-steaming made no appreciable difference in bark removal with red alder. Adherence of the red alder bark to the compression rolls and fragmentation of the bark due to the nip action of the rolls followed by screening made it possible to obtain such excellent bark removal.

Western hemlock, Douglas fir, and bigleaf maple did not debark as well as red alder. Bark removal for hemlock and maple ranged between 60 and 75 percent; for Douglas fir it was slightly less. The minor differences in bark removal recorded between CD and SCD runs for hemlock, Douglas fir, and maple should not be considered conclusive due to the limited number of test runs.

Steaming increased wood losses in Douglas fir and maple, in some cases by a factor of 2.5. As with alder, no attempt was made to recover the wood fiber that adhered to the compression rolls. Promising methods to recover this wood fiber are being investigated.

After drubbing, all material was screened through 5/8-inch, 3/8-inch, and 3/16-inch screens; the fines were discarded. Analysis showed that most of the residual bark was concentrated in the material retained on the smallest chip screen size (table 2). Thus, the bark content of chips for pulping can be further reduced by using only the larger chips, but at a sacrifice of additional wood loss.

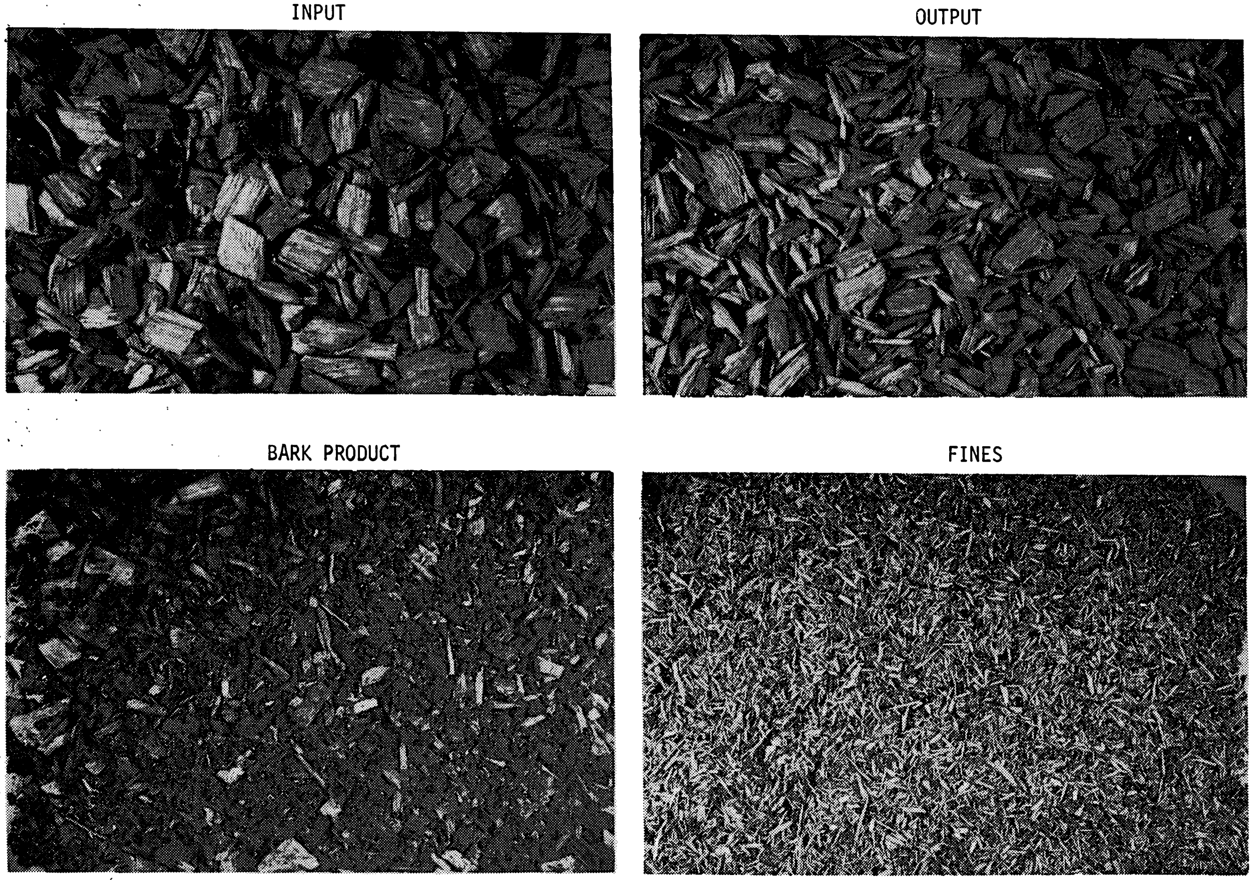

Figure 4.--Red alder processed by steaming, compression debarking, and drubbing.

Table 2.--Output by debarking process and chip size[1]

(In cumulative percent)

Chip size (inches)	Steaming, compression debarking and drubbing				Compression debarking and drubbing			
	Wood content	Bark content	Total output	Wood recovered	Wood content	Bark content	Total output	Wood recovered
RED ALDER (stem, limbs, and foliage)								
5/8+	99.3	0.7	20.1	18.5	99.2	0.8	12.5	11.5
3/8+	99.6	.4	71.2	66.0	99.4	.6	64.3	58.8
3/16+	98.5	1.5	100.0	91.9	98.2	1.8	100.0	90.4
DOUGLAS FIR (stem, limbs, and foliage)								
5/8+	98.2	1.8	14.6	12.7	98.8	1.2	10.5	10.5
3/8+	96.2	3.8	66.5	57.9	96.8	3.2	55.5	53.4
3/16+	91.9	8.1	100.0	82.8	92.0	7.9	100.0	91.4
HEMLOCK (stem, limbs, and foliage)								
5/8+	98.5	1.5	16.4	15.6	97.2	2.8	11.0	10.5
3/8+	97.6	2.4	67.5	64.3	97.3	2.7	59.8	57.3
3/16+	95.4	4.1	100.0	92.4	95.2	4.3	100.0	92.4
BIGLEAF MAPLE (Stem)								
5/8+	99.6	.4	17.5	18.0	99.4	.6	13.1	15.7
3/8+	97.4	2.6	69.7	71.6	97.3	2.7	63.6	72.2
3/16+	95.8	4.2	100.0	81.7	94.2	5.8	100.0	91.7

[1]Processed chips were screened on a Williams classifier into fractions retained on 5/8-, 3/8-, and 3/16-inch round hole screens.

For example, if only the 5/8 size hemlock (process SCD) chips were to be utilized, they would contain only 1.5 percent bark. But this chip size represents less than 16 percent of the total input wood fiber. By adding the 3/8 size chips, the wood fiber would be 64 percent of the input with a total bark content of 2.4 percent. In the same manner the addition of the 3/16 size chips to the mix would increase the bark content to the total output of 4.1 percent with 92 percent wood recovery. If material is "scalped" to increase the level of beneficiation, it should follow that the scalped material be utilized for other products to avoid excessive wastes.

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