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NORTH CENTRAL FOREST EXPERIMENT STATION, FOREST SERVICE—U.S. DEPARTMENT OF AGRICULTURE
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COMPRESSION DEBARKING OF STORED WOOD CHIPS

ABSTRACT.--Two 750 ft^3 piles of unbarked chips were stored for 1 year to evaluate the effect of chip storage on the effectiveness of bark-chip separation-segregation methods under study. In processing stored chips suffered more wood loss than fresh chips.

OXFORD: 821:825.71:844. KEY WORDS: *Populus tremuloides*, *Pinus banksiana*, beneficiation, deterioration, temperatures, pulpwood.

Field chipping of whole-trees and subsequent removal of bark from the chip mass is one approach to increasing utilization of our forest resources (Erickson 1971). Field chipping would enable recovery of residue currently left in the forest in the form of tops and limbs and economical harvesting of stands that are marginal or submarginal when present harvesting systems are used. All this depends on the development of a system that could effectively remove bark from the chip mass to make whole-tree chips suitable for papermaking.

Two years of research (Arola and Erickson 1972) plus continued process improvements at the Forest Engineering Lab (FEL) have shown that a system that will remove the bark from a chip mass is technically possible. The bark-chip separation-segregation (BCSS) system currently under development at the FEL utilizes three primary pieces of equipment:

1. A steaming vessel that subjects the chip mass to low pressure steam.
2. A compression debarker where the chip mass is passed between two steel compression rolls set at a small nip spacing and hydraulically loaded to maintain the nip spacing. Bark removal occurs either by the bark adhering to the rolls and being scraped off into the rejects containers, or by the bark being fragmented as it passes between the rolls and screened out of the wood chips as fines.
3. An abrader further fragments the bark particles in the compression debarker output so that it can be screened out of the wood as fines. A rotating drum with swinging hammers (drubber) is currently being used as an abrader.

In an earlier investigation by Arola and Erickson (1972), it was observed that storing the chip mass in plastic bags for a period of time prior to processing improved the bark removal achieved by the BCSS system. Since the effect of chip storage in plastic bags could be similar to the effect of chip storage in large outdoor piles, it was decided to investigate the effect of storage of a chip mass in an outside pile on the BCSS system.

TEST SET-UP

Outside storage of pulpwood chips has been studied extensively, but most of the previous studies dealt with clean chips (i.e. chips with no bark or foliage) (Hajny 1966). Because whole-tree chips always contain bark and foliage (except for the broad-leaved species), it was decided to study two piles, one containing unbarked bolewood chips, and one containing whole-tree chips with foliage.

The two piles were constructed at the Ford Forestry Center of Michigan Technological University near L'Anse, Michigan in November of 1971. One pile consisted of unbarked aspen (*Populus tremuloides*) bolewood chips, and the other whole-tree jack pine (*Pinus banksiana*) chips. The material for the piles was obtained from local logging contractors, and all chipping was done with the 48-inch Morbark

Chip-Pac[1] owned and operated by the Ford Forestry Center. Both piles were built within a week after cutting the trees.

The piles were formed by erecting two levels of snow fence in a 10-foot diameter circle. The chips were heaped to a pile height of approximately 10 feet with each pile containing about 750 ft^3 of chips.

Thermistors were placed in the piles to monitor the pile temperatures in various locations and the surrounding air temperatures (fig. 1). Throughout the storage period, the temperature in each location was recorded three times a week at approximately 3 p.m.

As the piles were being built, three 150-pound samples of each were analyzed for size breakdown, percent of free wood, free bark, bark/wood (wood with bark still attached), foliage, moisture content of the wood and bark, and specific gravity of the wood and bark. After analysis, each sample was run through the BCSS system in two parts. One part was steamed, compression debarked, drubbed, and screened (hereafter referred to as process SCD), while the second part was only compression debarked and screened (hereafter referred to as process C). The output of these runs was analyzed for residual bark content, percent of input bark removed, and wood loss. (Wood loss is any wood removed from the rolls with the bark or fragmented into fines).

Due to the small size of the piles, the piles were not disturbed until a storage time of 1 year was reached. At that time, the piles were broken and a sample taken from the core of each pile. These samples were then analyzed and processed in the same manner as the initial samples.

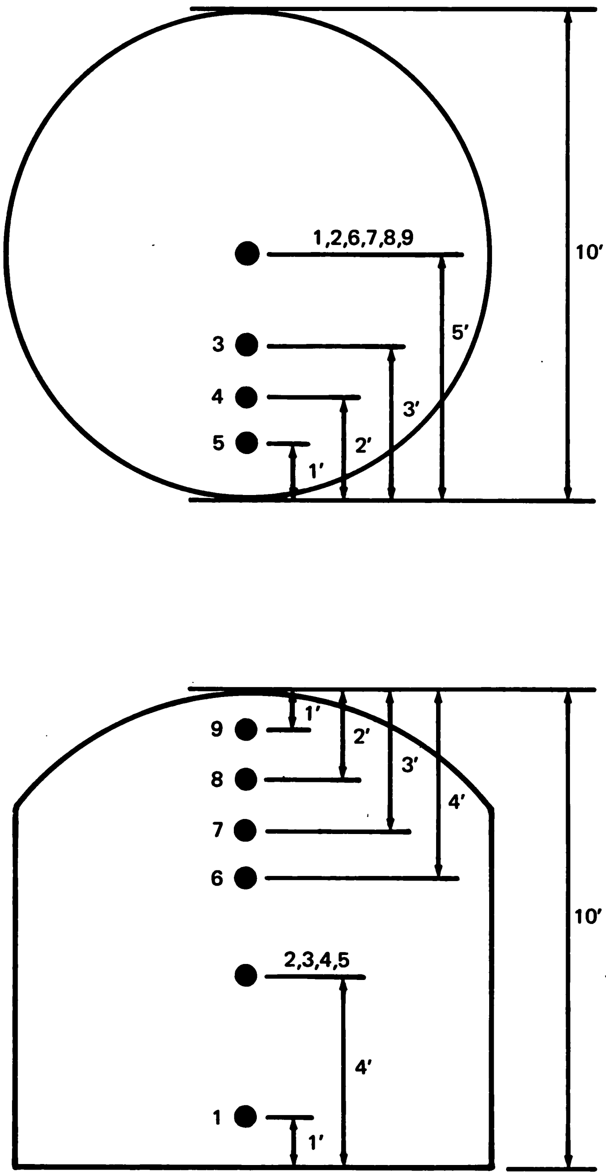

Figure 1.--Top and side views showing placement of thermistors in the chip piles.

RESULTS

The temperature profiles of the two piles were developed using a digital plotter to graph the temperatures observed throughout the storage period.

The center of the pile containing unbarked aspen bolewood chips remained at 32° F for about 10 days and then dropped below freezing following approximately the surrounding air temperature for the duration of the winter season. As the air temperature increased with the onset of spring, the pile temperature increased to 32° F where it remained constant for about 10 days again and then increased rapidly in line with the air temperature. During the summer, the pile center heated up somewhat and then by November fell back down to approximately the air temperature. The periods during which the temperature remained constant at 32° F can be interpreted as the transition periods when the pile center was freezing and thawing. Considering the small pile size, these results are in line with those observed by Erskine and Galganski (1967) in a much larger aspen pile built at approximately the same time of year in Wisconsin.

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

The temperature at the location nearest the exterior of the pile is approximately equal to the air temperature. This effect was observed for all exterior locations in both piles.

The center of the pile containing jack pine whole-tree chips climbed above ambient immediately after formation and remained there for the duration of the winter. After about 6 months storage time, the jack pine pile returned to ambient temperature for the rest of the storage period. This initial rise in the temperature was unexpected, but could possibly be explained by an increased rate of oxidation processes in the pile due to the inclusion of foliage. The mechanism of the initial heat release in a wood chip pile is discussed by Springer and Hajny (1970).

A temperature rise was not expected in the piles during the winter. This warrants further study on the effect of including foliage in a pile before large piles containing foliage are considered.

The significant change in the stored material is the reduction in the bark-wood fraction (table 1). The bark-wood fraction in the aspen decreased from 10 percent to 2 percent, while in the jack pine, the reduction was from 19 percent to 3 percent. Arola and Erickson (1972) concluded that much of the bark remaining in the chip mass after compression debarking is bark that was originally in the bark-wood fraction, so an increased percent of input bark removed should logically follow a reduced input bark-wood fraction.

The wood and the bark taken from the core of the piles after 1 year of storage decreased in moisture content about 50 percent. The exterior portions of both piles were wet and slimy with dark stained chips, while each pile had a core of dry unstained chips (fig. 2).

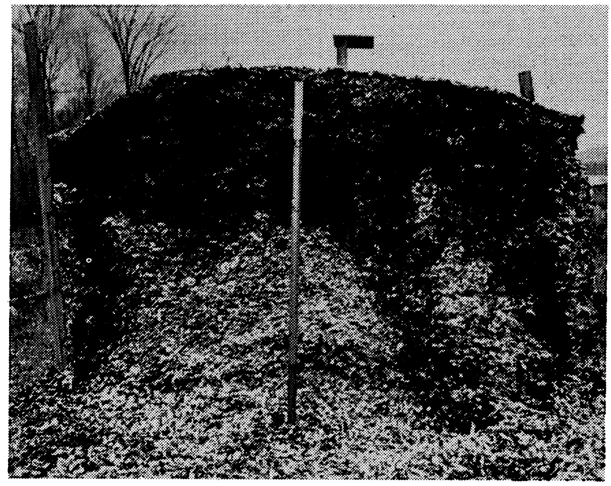

Figure 2.--Cross-section of aspen pile after 1 year of storage.

This loss of moisture indicates that the piles used in this study were too small; such a moisture loss would not be expected in a large industrial pile.

A loss in specific gravity is frequently used as a measure of wood substance loss in storage experiments (Hajny 1966). The aspen wood chips decreased 12 percent for 1 year of storage, while the jack pine wood lost 11 percent. These losses exceed those reported by Erskine and Galganski (1967) for 1 year of storage of clean aspen chips.

From the compression debarking tests, the significant quantity for both aspen and jack

Table 1.--Sample analysis of fresh and stored wood chips

Species and condition	Sample analysis (Percent of random mix)[1]				Moisture content[2] (Percent)		Specific gravity[3]	
	Free wood	Free bark	Bark/wood	Foliage	Wood	Bark	Wood	Bark
Aspen								
Fresh	78	12	10	0	51	49	0.364	0.511
Stored	86	12	2	0	27	26	.320	.498
Jack pine								
Fresh	70	8	19	4	52	60	0.360	0.286
Stored	89	6	3	2	26	31	.320	.421

[1]All chips that will pass through a screen with 1-1/8" round openings, but will be retained on a screen with 3/16" round openings.

[2]Moisture content expressed as ((green wt. - dry wt.) / (green wt.)) x 100.

[3]Specific gravity expressed as oven dry wt./green volume.

pine is the enormous increase in wood loss that occurred with the stored chips (table 2). The percent wood loss for the stored chips ranged from 35 percent for jack pine processed through the SCD process to 79 percent for the aspen run through the C process. For the fresh chips, the maximum wood loss was 9 percent for jack pine run through the C process.

Table 2.--BCSS results for fresh and stored chips

(In percent)

Process	Species and condition	Input bark	Output bark	Bark removed	Wood loss	Input foliage	Output foliage
SCD	ASPEN						
	Fresh	13	3	83	6	--	--
	Stored	15	2	95	45	--	--
C	ASPEN						
	Fresh	17	9	54	6	--	--
	Stored	15	3	96	79	--	--
SCD	JACK PINE						
	Fresh	14	5	69	9	2	1
	Stored	11	6	68	39	2	0.00
C	JACK PINE						
	Fresh	14	8	51	9	4	3
	Stored	10	6	72	52	1	*

*Less than 0.5 percent.

Arola and Erickson (1972) observed that bag-stored chips in which moisture had transferred from the wood to the bark had a higher rate of bark removal and wood loss than fresh chips. Considering the reduced moisture content of the stored chips, the results of this study would support that finding. However, if the moisture content were the only significant variable, it would be reasonable to suspect that adding moisture to the stored material by steaming the chip mass would decrease bark removal and wood loss to the level of the fresh chips. This did not happen, however, so something else must be involved. The stored chips had become "spongy" and had lost the resilience of the fresh chips. The "spongy" nature of the stored material probably enabled it to conform to the shape of the compression rolls as it passed between them and thus had a greater tendency to adhere to the rolls and be scraped off into the rejects containers. One result of the material's tendency to adhere to the rolls was a buildup of material on the compression rolls. In a production facility, a continuing buildup of material on the compression rolls could create serious problems with the compression debarker.

CONCLUSIONS

The long term storage of whole-tree chips prior to compression debarking did not have the hoped-for effect of improving the results of the BCSS system. The results of this study on two small piles cannot be considered conclusive, but long term storage appears to decrease the effectiveness of the BCSS system.

On the basis of this study, it would seem that whole-tree chips should be processed in a hot operation, i.e., processed as they are received, and the clean chips stored if storage is necessary.

LITERATURE CITED

Arola, Rodger A. and Erickson, John R. 1972. Compression debarking of wood chips. USDA For. Serv. Res. Pap. NC-85, 11 p., illus.

Erickson, John R. 1971. Bark-chip segregation: a key to whole-tree utilization. For. Prod. J. 21(9): 111-113.

Erskine, W. C. and Galganski, R. T. 1967. Effects of outdoor storage in chip form on northern aspen pulped by the sulfite process. TAPPI. 50(10): 477-482.

Hajny, G. J. 1966. Outside storage of pulpwood chips. TAPPI. 49(10): 97A-105A.

Springer, E. L. and Hajny, G. J. 1970. Spontaneous heating in piled wood chips. I. Initial mechanism. TAPPI. 53(1): 85-86.

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