NORTH CENTRAL FOREST EXPERIMENT STATION

Research Note NC-295

1992 FOLWELL AVE. ST. PAUL, MN 55108 FOREST SERVICE-U.S.D.A.

1983

DETERMINING LIGHT TRANSMITTANCE CHARACTERISTICS OF WOOD AND BARK CHIPS

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ABSTRACT.—Describes computer-assisted testing for measuring light transmittance of wood and bark chips. Electronic interface permitted the computer to collect physical data accurately and efficiently and to analyze and present the data in several tabular and graphical formats.

KEY WORDS: Photosorting, mini computers, computer interfacing, computer graphics, bark-chip segregation.

The bark content of wood chips in the pulping process is a critical factor in determining paper quality. With the advent of whole-tree chippers, the percentage of bark has increased, thus degrading the end product. Reducing the bark content would greatly enhance paper quality.

There are various systems for segregating whole-tree chips; one method being investigated is based on the light transmittance characteristics of wood and bark. Light transmittance is the relative amount of light that penetrates the wood or bark chip, usually measured as a percentage of the incident light.

EXPERIMENTAL APPARATUS

Obtaining statistically valid data on the average light transmittance of bark and wood chips requires the measurement of a large quantity of individual chips. To facilitate accurate and efficient measurements of light transmittance, we developed an experimental setup that used a mini-computer (fig. 1). In addition to the usual data analysis and storage functions, the computer program also performed a self-calibration of the test fixture (lamp, optical detector, and amplifier) at the beginning of each data set and prompted the operator to insert each new chip at the proper time.

The experimental setup comprised an incandescent light source (a quartz-halogen projector lamp), a photometer, an interface amplifier, an analog-to-digital (A/D) converter, and the computer. The lamp, operated from a regulated DC power supply, furnished a constant light level with no 60 hertz ripple. The photometer was a United Detector Technology[1] model 40X. It will respond either linearly or logarithmically to produce a corresponding electrical output of 0 to 50 millivolts. A fixed aperture was placed over the detector to make the sampled area independent of chip size. The logarithmic mode was used here to permit measurements over a wide dynamic range without changing scales. The interface

[1]*The use of trade, firm, or corporation names in this publication is for the information and convenience of the reader. It does not constitute an official endorsement or approval of any product or service by the United States Department of Agriculture to the exclusion of others which may be suitable.*

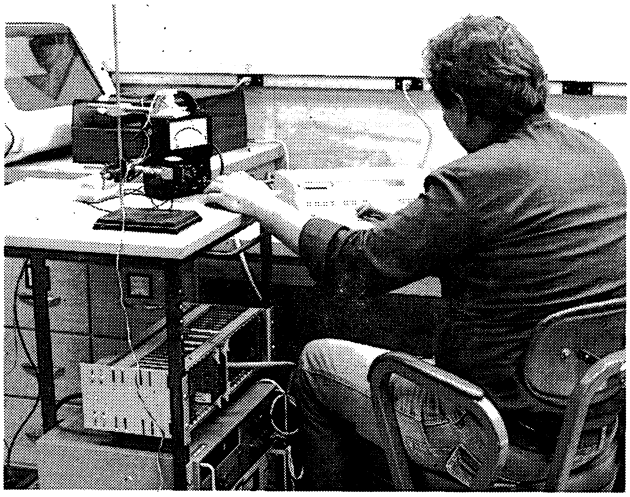

Figure 1.—*Setup for measuring light transmittance.*

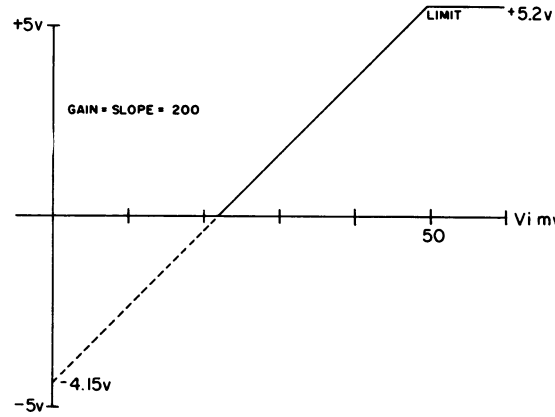

Figure 2.—*Transfer characteristic of photometer interface amplifier.*

amplifier converts the signal produced by the photometer to that required by the A/D converter. The A/D converter in turn feeds the digital signal into a Hewlett Packard 9825A desk-top computer for data manipulation.

The interface amplifier and the 8-bit A/D converter were designed and assembled by using standard electronic components. The A/D converter has 16 input channels permitting the simultaneous acquisition of a wide variety of electrical signals, although for this application only one channel was used. The photometer output voltage range of interest was 20 to 50 mV. The interface amplifier converts this range to the 0 to 5.2 V input range of the A/D converter as shown in the transfer characteristic (fig. 2). Thus, the input signal was amplified by a factor of 200, then shifted down by about 4.15 V to permit increased A/D resolution in the range of interest. Because the input to the A/D converter must not go below -0.3 V or above +5.4 V under any conditions, the amplifier circuit was also designed to limit at zero and +5.2 V, respectively.

PROCEDURE

Samples of 5/8-inch wood and bark chips of six Lake States species were tested. Included were quaking aspen (*Populus tremuloides),* balsam fir (*Abies balsamea),* jack pine (*Pinus banksiana),* white spruce (*Picea glauca),* sugar maple (*Acer saccharum),* and red pine (*Pinus resinosa).* All species were tested under both green and ovendry conditions. A randomly selected group of 50 bark and 50 wood chips of the desired species was sequentially numbered. All successive measurements were then done in sequence to permit correlation of the various data for each chip. The self-calibration sequence was run once for each group of chips by using a pair of known optical attenuators. The following experimental procedure was then used to create the desired data base:

1. Measure wood or bark chip thickness (to 0.001-inch) and key into computer.
2. Place chip in test fixture and initiate automatic light transmittance measurement (by tapping a switch).
3. Manipulate data and store record (done automatically by computer).
4. Dry chips in oven.
5. Remeasure chip thickness and key into computer.
6. Remeasure light transmittance of dry chip.
7. Manipulate dry data and store record (done automatically).

Once the data are in computer memory, they can be presented in graphs (fig. 3) or tables (table 1).

RESULTS AND CONCLUSIONS

The probability density and distribution functions of the light transmittance (optical density)[2] for two species of green chips is shown in figure 3. The graphs demonstrate the possibility of distinguishing wood from bark in some species by using light transmittance techniques. Aspen demonstrated these qualities best; the other five species showed the same qualities but to a lesser degree (table 1). Jack pine had the least separation of the species measured as also shown in figure 3.

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[2]*Optical density (O.D.) is defined as the common logarithm of the inverse of light transmittance (T). (O.D. =* $\log_{10}\frac{1}{T}$*).*

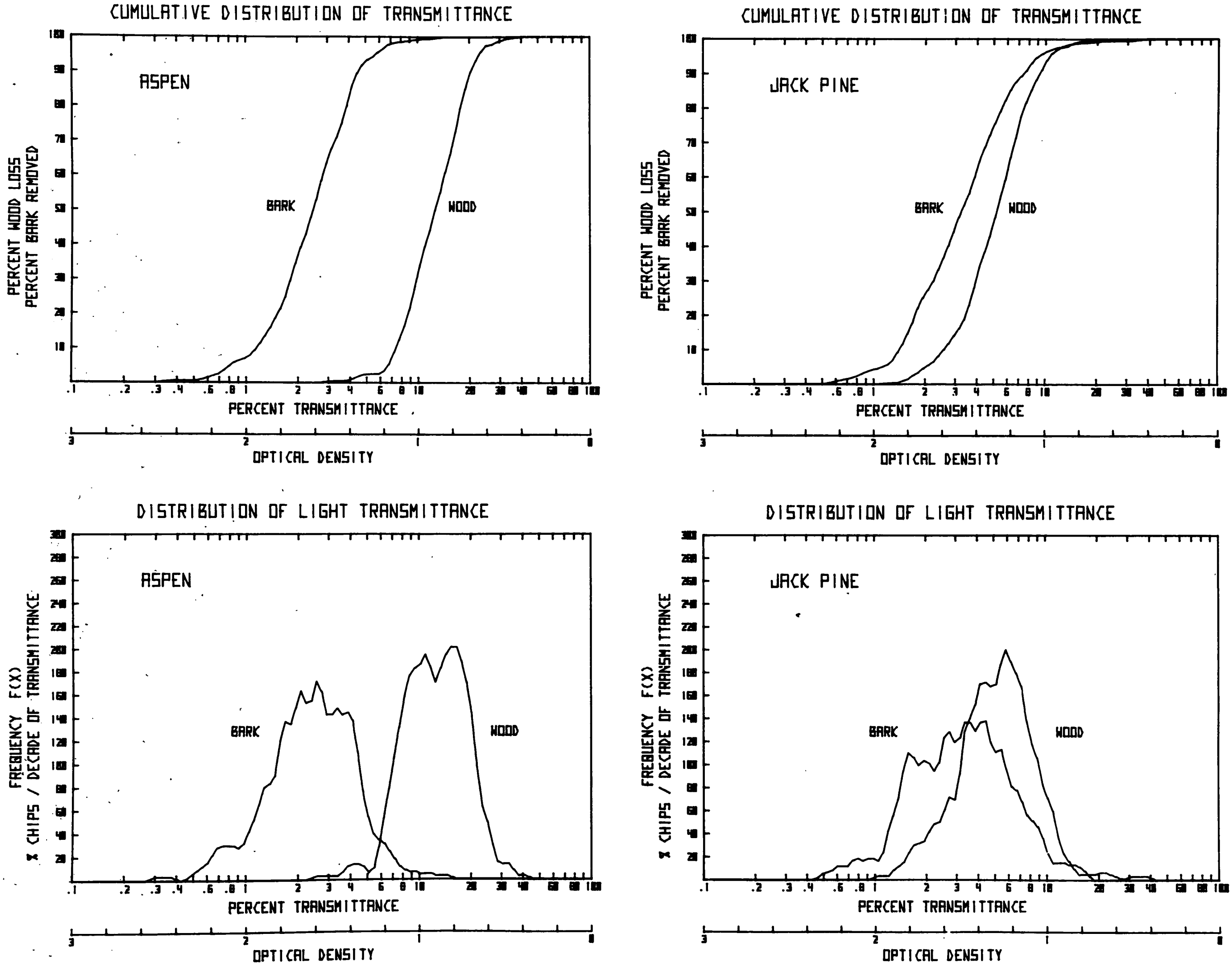

Figure 3.—*Computer graphs of light transmittance of aspen and jack pine.*

For those species with nearly disjoint transmittance distributions, electronic differentiation of a low or high light level passing through each chip can be used to actuate a mechanism to segregate bark and wood (Sturos and Brumm 1978), with the optimum sorting threshold being selected for each species.

Using the computer in this project helped us create an accurate data base. Because of the large quantity of chips required, manually keying the data into the computer would probably have introduced some errors and would have required a more highly trained operator than we used. It also would have required more time to collect the desired data. The present system can readily be modified for making other automatic measurements by simply altering the amplifier circuit.

LITERATURE CITED

Sturos, John A.; Brumm, Douglas B. Segregating wood and bark chips by photosorting. Res. Pap. NC-164. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station; 1978. 6 p.

Table 1.—*Computer tables of six Lake States species tested*

		THICKNESS (IN)		% TRANSMITTANCE	
		GREEN	DRY	GREEN	DRY
ASPEN					
WOOD	MEAN	.132	.123	13.48	4.55
	ST.DEV.	.032	.030	5.40	1.74
BARK	MEAN	.184	.141	2.79	1.64
	ST.DEV.	.063	.052	1.65	0.78
BALSAM FIR					
WOOD	MEAN	.124	.118	12.46	5.98
	ST.DEV.	.032	.031	7.75	2.31
BARK	MEAN	.203	.171	3.97	3.31
	ST.DEV.	.076	.071	1.71	1.40
MAPLE					
WOOD	MEAN	.139	.130	4.04	2.39
	ST.DEV.	.038	.038	1.82	0.95
BARK	MEAN	.123	.104	2.47	3.27
	ST.DEV.	.028	.026	1.27	1.19
JACK PINE					
WOOD	MEAN	.149	.143	5.72	3.92
	ST.DEV.	.048	.047	2.95	1.81
BARK	MEAN	.112	.080	4.05	3.38
	ST.DEV.	.040	.038	3.41	2.87
RED PINE					
WOOD	MEAN	.141	.137	13.52	4.03
	ST.DEV.	.042	.037	7.64	1.96
BARK	MEAN	.084	.064	7.71	5.29
	ST.DEV.	.041	.037	4.79	4.55
WHITE SPRUCE					
WOOD	MEAN	.120	.119	4.79	3.67
	ST.DEV.	.034	.035	2.07	1.43
BARK	MEAN	.167	.092	2.18	2.45
	ST.DEV.	.028	.025	1.08	1.14

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