MOISTURE LOSS IN ASPEN LOGGING RESIDUE[1]

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ABSTRACT

Two groups of aspen trees were harvested in northern Minnesota, one in April and one in July. The tops were left to dry in the open to simulate a clearcut harvest. Moisture loss was very rapid for one to two months following cutting and thereafter fluctuated within a narrow range. During the time span of this study, moisture loss of the tops was most influenced by the number of days since harvest and the average temperature for the 30 days preceding chipping. An approximate one-third increase in net heat was noted after only one month of drying in spring or summer.

Keywords: Energy, net heat, *Populus*, harvest, chipping.

INTRODUCTION

It is commonly recognized that drier forest biomass can provide more recoverable heat when burned in properly designed and operated equipment. As a result of this and because of increasing energy costs, the drying rates of logging residue from traditionally harvested forest stands is of considerable interest. Work in this area has shown that drying is initially rapid, but that after a relatively short time, the drying rate becomes negligible and the moisture content of the logging residue begins to fluctuate within a relatively narrow range.

Rogers' (1981) data for loblolly pine (*Pinus taeda* L.) and sweetgum (*Liquidambar styraciflua* L.) felled in November in east Texas indicate rapid drying for the first eight to twelve weeks after harvest. In a Virginia study (Lawrence 1981), the logging residue of seventeen different tree species was monitored for moisture loss. This study showed that three to six months was required before the residue ceased to exhibit a strong drying trend and began to fluctuate within a narrow range. There was considerable variation in moisture loss due to site and tree species for these studies.

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Because of the variation in moisture loss due to species and geographic location and because of the abundance of aspen (*Populus tremuloides* Michx.) in the Lake States, this study was undertaken to determine the approximate time frame for a strong and consistent drying trend in aspen tops remaining after a traditional harvest.

METHODS

Near the end of April 1981, sixteen aspen trees averaging 8.8 inches in diameter at breast height were felled on the Cloquet Forestry Center in northern Minnesota. The merchantable boles up to a 4-inch top diameter were sold to a local paper company, and fourteen tops were left in an open area to simulate drying in a clearcut.

The remaining two tops were chipped in a 10-inch drum chipper. Five chip samples were randomly taken from the chips of each top and placed in sealed plastic bags to prevent moisture loss. The moisture content of each sample was then determined in the laboratory on an oven-dry basis. At approximately one month intervals, through November, two additional tops were selected for chipping and were sampled in the same fashion as previously described.

In July, a new group of ten aspen trees, again averaging 8.8 inches in diameter at breast height, were felled. These trees were chipped and sampled just the same as the trees felled in April, with two additional tops chipped each month through November.

RESULTS

As shown in Fig. 1 the average moisture content of the tops from the April-felled trees dropped for the first three months from an initial moisture content of 99% to 42% at the end of July. However, the tops of the trees felled in July lost moisture for only the first month. They dropped from an average moisture content of 90% initially to 47% at the end of the first month of drying but then moved back to 48% by the end of the second month of drying.

Lawrence (1981) developed species-specific predictive equations for moisture loss in Virginia and reported that initial moisture loss is highly correlated to drying time and temperature. For the data collected in this study, a number of tree-specific variables such as total height, height of top, and specific gravity of top were utilized in conjunction with other factors such as average temperature, precipitation, and drying time in an attempt to determine which factors most influenced moisture content loss of aspen in northern climates. A multiple regression equation shown below was the result:

$$\%MC = 114.35 + (0.00456DT) - (1.005T) - (0.347D) \qquad (1)$$

where: %MC = moisture content of chipped top, oven-dry basis; DT = product of elapsed days since cutting of top and average temperature (°F) for the 30 days immediately preceding chipping; T = average temperature (°F) for the 30 days immediately preceding chipping; and D = elapsed days since cutting of top.

This equation explained 81% of the variation in the moisture content of the chipped tops ($R^2 = 0.81$) and had a standard error of regression equal to 4.76% moisture content. While temperature and time most influenced moisture content, precipitation and tree characteristics did not exert a significant influence.

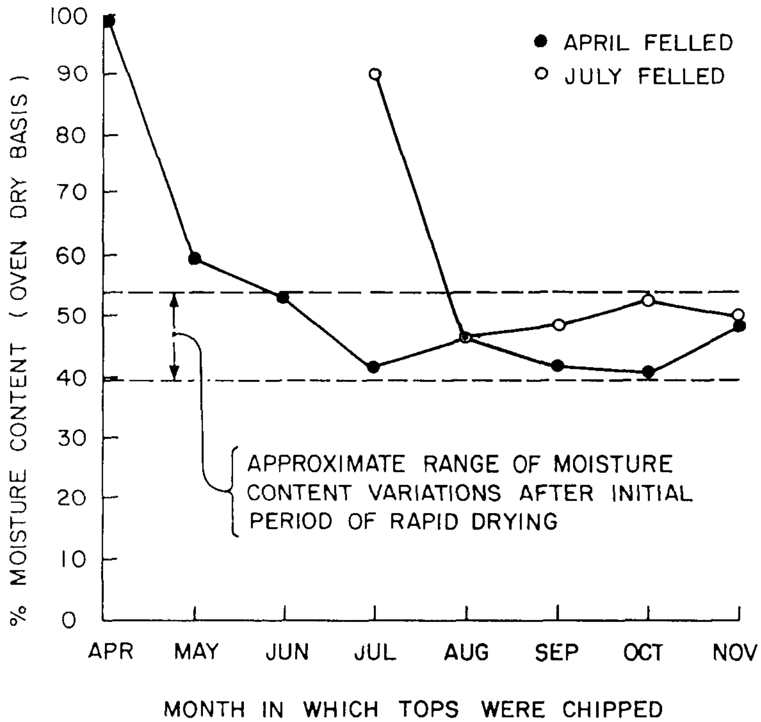

FIG. 1. Changes in moisture content of field dried aspen tops between April and November in northern Minnesota.

The potential application of the data from this study can be illustrated by examining Fig. 1. Two hand-fitted dashed lines are used on Fig. 1 to approximate the range of the moisture content variations after the cessation of a strong drying trend. The moisture content of both groups of tops moved within the range of

TABLE 1. *Average moisture content and net heat changes for aspen tops which were field dried and chipped.*

Month of sampling	Average temperature 30 days prior to chipping[1] (°F)	Precipitation 10 days prior to chipping[1] (inches)	April group		July group	
			Average moisture content (oven-dry basis)	Net heat[2] (Btu's/ pound)	Average moisture content (oven-dry basis)	Net heat[2] (BTU's/ pound)
April			99%	3,674		
May	50.4	0.24	59%	4,901		
June	60.1	1.83	53%	5,140		
July	66.4	0.97	42%	5,631	90%	3,905
August	65.4	0.97	47%	5,399	47%	5,399
September	55.8	1.56	42%	5,631	48%	5,354
October	41.7	0.32	41%	5,679	53%	5,140
November	35.1	0.79	48%	5,354	50%	5,267

[1] Data from climatological observation station on the University of Minnesota's Cloquet Forestry Center.
[2] Calculated using the equation adapted from Elliott (1980).

$$\text{Net heat} = 8{,}500\left[1 - \frac{MC}{100 + MC}\right] - 1{,}200\left[\frac{MC}{100 + MC}\right].$$

these two lines in one or two months after felling. This range of moisture content suggests the partial limit to natural drying.

By calculating the change in net heat values with the formula adapted from Elliott (1980) below, it is possible to estimate the increase in recoverable heat due to the strong initial drying trend.

$$\text{Net Heat} = \text{HHV}\left[1 - \frac{\text{MC}}{100 + \text{MC}}\right] - 1{,}200\left[\frac{\text{MC}}{100 + \text{MC}}\right] \qquad (2)$$

where: MC = % moisture content, oven-dry basis; and HHV = higher heating value, 8,500 Btu/lb.

Table 1 shows the average moisture content and net heat for each month's sample of tops. Only one month after felling, the net heat per pound from the two groups of tops had increased 33% and 38%, respectively.

CONCLUSIONS

For the spring- and summer-felled aspen in this study, a strong drying trend of the residual tops takes place only for a relatively short time after harvest. Average temperature for the 30 days prior to chipping and the total elapsed days since the initial harvest were the factors most influencing drying rate. If harvesting operations could allow for a delay of 30 to 60 days before processing of top material, a considerable increase in net heat is possible.

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