EFFECT OF PRESTEAMING ON SHRINKAGE AND MOISTURE CONTENT DISTRIBUTION OF 4" BY 4" HEMFIR LUMBER

Luiz C. Oliveira
Forintek Canada Corp.
Vancouver B.C.

Stavros Avramidis
University of British Columbia
Vancouver B.C.

INTRODUCTION

Today's increasing processing costs coupled with marketing opportunities offered by higher quality products are definitely influencing the way lumber producers are managing their drying operations. It is now recognized that the drying operation plays a significant role in the financial success of those mills competing in more demanding markets. Thus, many opportunities related to the drying operation are being explored. For example, current kilns are better designed and equipped to carry out new control tasks and gather information. In addition to hardware, several sophisticated drying strategies are now available to attempt to produce a more uniform lumber product and reduce the total drying time.

Many companies are exercising extensive quality control throughout the sawmill and can therefore reduce the incidence of problems that may be aggravated during the drying operation. Occasionally kiln capacity must be added so that the desired throughput can be maintained without affecting quality. Drying schedules used for several years are under review due to a combination of factors including resource changes, processing costs and quality requirements. The use of more controlled drying conditions, by ensuring a narrow wet-bulb depression during the heating up time, is undoubtedly a key factor for achieving certain quality requirements. Stress relief or conditioning treatments usually practiced in hardwood operations are now becoming a normal step during drying of certain softwood products. These changes reflect the importance of the drying operation in today's industry scenario and suggest a number of areas that need to be investigated in greater detail.

For example, in addition to reducing overall drying costs, companies producing lumber that will be remanufactured will have to find ways to minimize the variation of the final moisture content distribution. Large moisture content variations are usually associated with drying stresses and therefore indicate potential risk of degrade developments. The lack of uniformity of the final moisture content is not readily detected by the conventional ways of assessing lumber quality and can be a serious problem at the remanufacturing phase and for the performance of the final product.

The use of low pressure steam before starting drying, that is, presteaming the lumber before removing any moisture, is one area of great interest since past research has shown some benefits with such treatments. Presteaming is not a new idea but in the past the main objective was to find ways to increase drying rates. Today's concerns go beyond than simply fast drying. Due to the value of certain products and their specific applications, quality needs constitute the
main factor in deciding the emphasis on drying schedules.

A pioneer study carried out by Tiemann (1) showed that presteaming affected permeability of certain wood species and consequently had the potential to reduce drying times. Comstock (2) measured permeability of eastern hemlock heartwood and found it to be twice as much when compared to the control specimens. Kozlik (3) found a slight increase in drying rates of presteamed thin sections of sinker heartwood of western hemlock. Simpson (4) presteamed red oak and found a 17-hour reduction in drying time and reduced moisture contents throughout the thickness of the boards. Although the presteaming time varied amongst the studies reviewed in the literature, it was clear that all studies indicated that presteaming contributed to faster drying and in some cases to improved quality.

OBJECTIVES

The objective of the study was to evaluate the effect of presteaming on the drying rates, shrinkage, and within piece final moisture content uniformity of 10.5 cm by 10.5 cm hemfir lumber formed by the mix of two British Columbia softwood species namely, western hemlock (*Tsuga Heterophylla* (Raf.) Sarg.) and amabilis fir (*Abies amabilis* (Dougl.) Forbes).

MATERIALS AND METHODS

Green hemfir lumber pieces, 10.5 cm by 10.5 cm by 4.85 m, were obtained from a local sawmill. The specimens were randomly pulled out from the green chain and pieces containing different amounts of sapwood and heartwood were mixed. A total of four samples, 91 cm long each, were cut from each specimen. All specimens were end-coated with polyvinyl acetate, covered with plastic tarp and stored under sprinklers to minimize moisture loss before drying. Two 3-inch sections cut from each specimen were used to determine initial moisture content by the ovendry method. Basic density based on ratio ovendry weight to green volume was also determined using the moisture content sections. Thus, all specimens were then sorted into two main groups namely, high basic density (HBD) and low basic density (LBD).

All drying runs were carried out in a steam heated laboratory kiln and a total of 48 samples were used in each drying run. The air velocity through the package measured on the exit side was about 2.5 meters per second. Due to the short air path, air flow was not reversed during the drying experiments.

A total of three presteaming treatments, 5, 10 and 20 hours for each density group was carried out. A control run, that is, a drying run without presteaming was also carried out.

The total weight of the charge in each drying run was monitored throughout the drying process. A target moisture content of 15% was chosen and the lumber followed a drying schedule developed Avramidis and Mackay (5).

At the end of each drying run all specimens were visually examined for surface and end checks and then cut into three equal length segments to find the presence of internal checking. Two sections of 3 cm each in thickness each were sawed from each drying sample. One of the sections was used for shell and core moisture content determination and the other sample was used for determination of the average final moisture content. An additional ten samples from each drying run were used for evaluation of internal stress (casehardening) levels by the prong test.
RESULTS

Lumber with basic densities varying between 263.3 and 355.8 kg/m³ (16.4 to 22.2 lb/ft³) represented the low basic density group whereas lumber with densities varying between 355.9 and 491.0 kg/m³ (22.2 to 30.7 lb/ft³) represented the high basic density group.

Figure 1 illustrates distributions of the initial moisture content for each basic density group. As shown, a wide distribution was observed for both groups. In the low basic density group, approximately 50% of the lumber had initial moisture content below 52%. For the higher density group, about 50% of the lumber had initially a moisture content below 57%. This wide spread for both groups represents actual values normally found in industrial operations.

Figure 2 represents the distribution of the final moisture content for both low and high basic density groups according to the presteaming time. Each individual box represents 80% of the data and the whiskers indicate fifth percentile, that is, 5% of data was found above the upper whisker and 5% of the data was found below the lower whisker. The line within each box represents the median value.

The upper part of Figure 2 illustrates the distributions for low basic density group. As the graph suggests the distribution is essentially the same for all presteaming treatments including the control (no presteaming). In all cases, the final moisture content for 80% of the lumber varied between 11 and 19%. The median value for all treatments was around 15%. The lower graph in Figure 2 illustrates the final moisture content distributions for the high basic density group. Similar distributions were again obtained for all treatments and the median value was also around 15%. Thus, presteaming treatments did not seem to affect the final moisture content distributions either low or high basic density groups.

Figure 3 illustrates distributions for moisture content differences between core and shell. The difference between core and shell moisture contents is particularly important when assessing lumber that will be remanufactured because it can represent potential risk of degrade development. For the low basic density group presteaming times of 5 and 10 hours did not affect the difference between core and shell moisture content. On the other hand, a presteaming time of 20 hours significantly reduced the difference in moisture content between core and shell. In general, as illustrated by Figure 3, the longer the presteaming time the narrower was the difference between core and shell moisture contents for the lumber in the high basic density group. In addition to the significant reduction of the difference between core and shell moisture contents with longer presteaming times, the interval in which the differences occurred was also decreased, that is, lower median moisture content values were obtained with longer presteaming periods. The results show that presteaming can effectively reduce the variation of moisture content within a piece of wood and by that result in products with better dimensional stability.
Figure 1. Initial moisture content distributions for the low (A) and high (B) basic density groupings. Note different x-axis scales for upper and lower graphs.
Figure 2. Final moisture content distributions for the low (A) and high (B) basic density groupings.
Figure 3. Moisture content gradients for the low (left) and high (right) basic density groupings. The gradient is defined as the core moisture content minus the shell moisture content.

Figure 4 illustrates the distributions for the total shrinkage obtained in each treatment. In general, shrinkage increased as the presteaming time increased. Apparently larger variations between the lowest and the highest shrinkage values were observed for the high basic density group. The highest shrinkage values for this group though coincided with those for the low basic density group. These results are important when establishing optimum green sizes for lumber that will be presteamed.

Figure 4. Shrinkage for the low (left) and high (right) basic density groupings. The shrinkage is from green to 15% moisture content.
SUMMARY

In summary, presteaming of 4x4 hemfir lumber did not seem to affect drying times and average final moisture content distribution. On the other hand, presteaming, especially the 20-hour treatment, significantly reduced the moisture content difference between core and shell for the low basic density group. For the high basic density group, the presteaming time had a greater influence on the moisture content gradient. Shrinkage was also affected by presteaming and tended to be higher for longer presteaming periods.

The results of this study suggest that there are very specific benefits when carrying out presteaming treatments. It seems that presteaming treatments may be of great value when uniformity throughout the thickness of the lumber is required as for remanufacturing operations. Since presteaming represents additional kiln residence time, it is important to carefully evaluate processing costs as well as investment in hardware against the added value to the final product. It is also important to note that presteaming results may be different depending on the drying schedule and therefore additional research is recommended to determine the effects of presteaming for slower drying schedules.

REFERENCES


