DRYING HEMLOCK IN A LAB KILN

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Introduction

Lab kilns are more similar to large kilns than most people think. The main difference is the width of the load. Other differences, such as a high fan speed or large heat coils, can be overcome by adjusting the schedule. The narrow loads in a laboratory kiln can be an advantage if one is interested in looking at the behavior of a wood without the influence of the temperature drop across the load and within-kiln variability. (Figure 1). For example, in one class we have the students weigh the lumber in and out of the small kiln and during the drying cycle they measure airflow and humidity (from dry- and wet-bulb temperatures). They can then compare the actual weight loss of the boards to the amount of water in the exhaust gas to better understand the relationships on the psychrometric chart.

As a part of the undergraduate program, the students dry a 2600 board foot charge of 2x6 hemlock lumber in the lab kiln and measure various thermal and wood properties. The schedule we used last winter is shown in Figure 2. The jumps in the schedule at 5 and 35 hours were not intended to make the wood dry better, but rather to allow the students to see the effect the schedule changes have on drying rate. The actual kiln temperature (Figure 3) followed this closely. The moisture content of the wood was measured two ways, with load cells that weigh the entire load and with an in-kiln moisture meters. The moisture content measured by these methods is shown in Figure 4. Both methods do a good job of predicting the change in moisture content, although they are offset from each other a little.

FIGURE 1. Small laboratory kiln.

FIGURE 2. Schedule for drying.
The slope of the lines in Figure 4 is a measure of the drying rate (the % change in MC per hour). This drying rate is plotted in Figure 5. The load cell data is too noisy to determine the effect of the jumps in the schedule. When the first jump occurred at 4 hours, the meters had not stabilized yet. At the second jump, when the wet-bulb depression was decreased at a constant dry-bulb temperature, there is a slight dip in the drying rate, but you need to look fairly hard to see it. The emc change (4.4 to 5.3%) is fairly small and one would not expect a large change in the rate. Next year maybe we will vary the fan speed and see what happens.

In this lab the students also have an opportunity to measure real lumber and hemlock is an eye opener. As they hand-stacked the lumber, most were amazed that the board weight varied from 40 to 76 lbs. They are likewise rather surprised to plot MC out versus MC in (Figure 6) and learn that the very heavy boards going in are not necessarily the wet ones coming out. This reinforces what we teach in the classroom - sapwood is wet, but is more permeable and dries faster while heartwood is less permeable but starts at a lower moisture content. Then there are the wet pockets. When they see the first 40% reading on the hand-held moisture meter, they assume the meter isn't working. They are even more surprised when they remeasure two inches away, the reading goes back down to 12%.

Shrinkage is another surprising measurement. They all know wood shrinks, but a plot which shows the variability of shrinkage (Figure 7) gives them a feel for the effects of grain

FIGURE 3. Actual temperatures in kiln.

FIGURE 4. Measured moisture contents.

FIGURE 5. Drying rates.
angle, their measuring technique, and the natural variability present in wood. We do a comparison of the average shrinkage to the handbook values and the student are again impressed with how close the values. If all the lumber was perfectly flat sawn, we would expect a the wood to shrink 5.2%. The actual wood shrinkage was 4.8%. This difference, is easily explained because few of the pieces are truly flat sawn. For the same reason, the radial shrinkage value for the lumber is higher than the handbook value.

FIGURE 6. Moisture content out versus moisture content in.

FIGURE 7. Shrinkage. White lines are averages

Lab kilns can also be used to estimate the warp that will occur under different drying schedule. For schedule development, it is a lot less expensive to damage a load of lumber in the kiln in Figure 1 than a 100,000 board foot commercial kiln.

Lab kilns are not good for all purposes. Energy consumption is readily measured in a lab kiln; however, the scale up to a large kiln is not predictable. Subtle changes in lumber grade are probably best detected in a large kiln. The piece count is not great enough in a small kiln to get reliable data unless a large number of charges are run. This creates other problems in handling and storage which affect the results.