DETERMINING YOUR BASELINE MOISTURE PATTERN

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One method that many softwood sawmills use to evaluate kiln performance is to track the moisture distribution of total production over a period of time. Many mills use a commercial in-line moisture detector at the planing mill for this purpose. Others rely on moisture data gathered by the graders in the planing mill. Both methods give a sawmill a general idea of how well they are doing and often form the basis for decisions affecting kiln operation. Even so, three questions remain unanswered. How valuable is this information? How can it be effectively used? What other information will help?

A useful technique is to determine what is referred to as a baseline moisture pattern. This reflects the typical or characteristic moisture distribution pattern for a particular kiln. The main objective of this discussion is to help determine and accurately analyze the top to bottom moisture patterns for kilns.

ESTABLISHING BASELINE MOISTURE PATTERNS FOR YOUR KILN

A kiln operator requires reliable moisture distribution data in order to perform his job effectively. The in-line moisture meter data serves this purpose provided the operator understands its limitations and adjusts accordingly. To do this, he must have information about the typical moisture distribution patterns his kiln produces. I call this information the baseline moisture pattern. It tells you where to expect to find your high moisture content lumber in a given dry kiln.

Kiln operators must have a working knowledge of the moisture patterns inherent in their dry kiln design. This understanding is not limited simply to an awareness of the patterns but also to the processes which create these patterns. In gathering this information, unusual imbalances become apparent and can be addressed intelligently. Although not a practical technique for detecting occasional problems in day-to-day operation, it does give you the information necessary to evaluate sudden changes in kiln performance.

TECHNIQUE

Ten years ago I collected baseline data for a high temperature steam kiln by checking the moisture content of each board in each package of lumber on one kiln cart. Although we gained a great deal of information, the method was tedious and time consuming. For example, we could see how moisture was distributed in each unit, how it varied from top to bottom and from side to side. We illustrated the inverse relationship between air velocity and final moisture content. Figure 1 shows how moisture varied from top to bottom along with accompanying air velocities. It is easy to see that as air velocity decreases, moisture content increases. This inverse relationship is consistent between kilns unless something unusual is occurring.

A simpler technique checks as many boards as possible on every other layer at the breakdown as it is being fed into the planer. This speeds up data collection and brings it within the realm of the operation. Checking every other layer gives time to pause, allowing you to concentrate on the sample layer. It is important to be consistent in your sampling technique. Systematically excluding edge boards skews the data to the high side and introduces bias. Although, by its nature the sampling technique introduces some bias no matter how cautious you may be. By averaging the data for each layer, you can graph your baseline moisture profile. The following outlines the step by step procedure:

- Paint the ends of every other layer before setting it on the infeed to the breakdown.
- As each painted layer slides off the breakdown and onto the landing table, check as many boards as possible with a calibrated resistance moisture meter.
- Needles should be driven into the board approximately eighteen (18) inches from the end.
- Make certain the needles are oriented with the grain and use a block to control depth of penetration.
- Record the data by layer.

If you run an in-line moisture detector or collect moisture data by hand from the grading chain, obtain this information on your test units for later comparison.

Obtaining air velocity data requires loading the kiln as you normally would for a kiln charge. Then proceed with the following steps:

- Turn the fans on, heat off, and close the vents.
- Enter the kiln on the low pressure plenum side and take air velocity readings top to bottom and along the kiln lengths.
- Record this data on a form similar to Table 1.
- Collect information on air loss over and under lumber, around the ends and through the bunk spaces.

This gives you information on where to look for additional gains in drying efficiency.

Figure 2 is an example of how this moisture and air velocity data is put to use. The inverse relationship between airflow and moisture content is again very distinctive. Yet, note the difference when compared to the graph in Figure 1. The high moisture content and low air velocity is at the top rather than the bottom. This kiln is equipped with a plenum baffle system designed to split and direct airflow top to bottom to improve uniformity. It is obvious from this information that some adjustment is in order. Proceed by making an adjustment to the plenum baffles to direct more air into the top and check the moisture profile again. With each adjustment, you should see a change in the profile. Once you determine the plenum baffle position which gives the most uniform moisture content top to bottom, weld them in place. There is no need for further adjustment, and you do not want to risk the baffles being inadvertently moved.

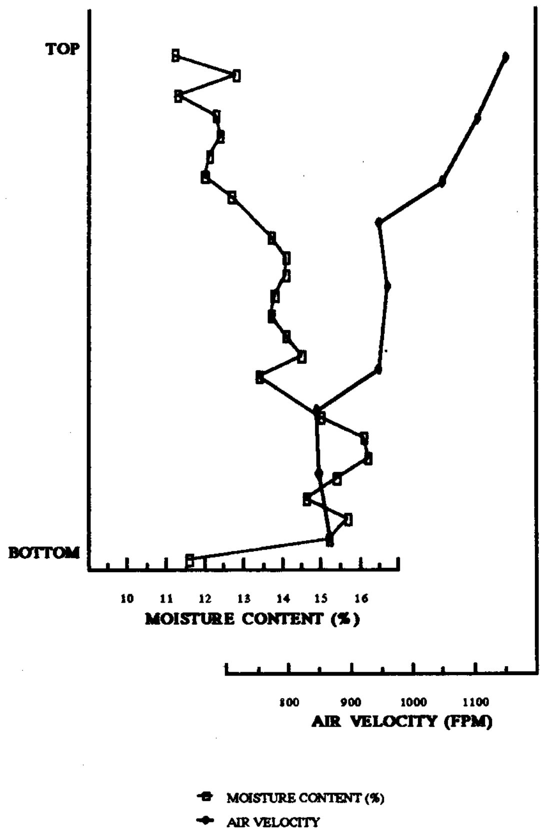

Figure 1. Variation of moisture content and air velocity top to bottom in a double track kiln.

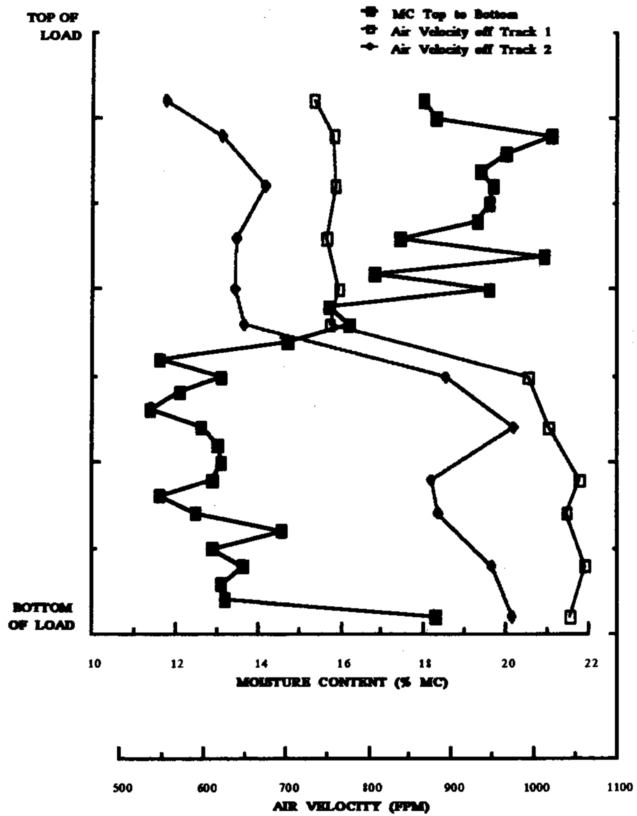

Figure 2. Comparison of air velocity and moisture content top to bottom in kiln #2.

Table 1. Sample Air Velocity Data - Velocity in FPM

	Position 1	2	3	4	5	6	Average
Over Top	2290	1880	2070	2020	2200	2050	2085
Top	960	1060	820	1070	940	1050	983
Unit	890	850	1010	1010	1020	1110	981
	1100	940	1140	1110	1260	1100	1108
Bunk	1930	2150	2000	2120	2170	2210	2097
Mid	930	950	1040	1050	1090	1070	1022
Unit	1100	1020	1200	1150	1120	1240	1138
	1070	1000	1100	1090	1250	1260	1128
Bunk	1730	2200	2150	2320	2390	2220	2168
Bot.	1100	1040	970	1100	1120	1250	1097
Unit	1010	1200	1080	1170	1100	1270	1138
	1000	940	1140	1140	1160	1210	1098
Under	1210	1440	1520	1570	1700	1650	1515
Around End	790						1290

Average Through Lumber - 1077 fpm

Close attention to the graph in Figure 2 shows another unusual feature. At the bottom of the load, air velocity is fairly consistent with the layers above it. Yet, observe how the moisture content suddenly jumps at the bottom. At this point, the operator must enter the kiln, and armed with this knowledge, look for a source. We have eliminated airflow as a cause. Something else must be happening. In this case, the center coil steam header blocks heat delivery to the bottom four or five layers. Correction will be difficult and expensive, but it could have been avoided with good kiln design. On the other hand, the mill now knows that they must accept a certain amount of wet lumber as a matter of course. It is built into their kiln until they change it. On the operator side, this knowledge helps avoid hasty reactions when the planer mill complains of wet lumber.

Occasionally you run into something a little unusual. Figure 3 presents data taken from a single track kiln also equipped with a plenum baffle system. We see the typical increase in moisture content as we go top to bottom in the kiln. Yet when we compare this to air velocity, there is a surprising difference. The moisture content appears directly related to air velocity. This points to a serious imbalance in heat delivery.

Sometimes things are not as good as they seem. There has been a recent trend with several mills extending the overhead baffles down past the top few layers of lumber. The lumber is certainly flat in appearance which tells the mill they achieved their goal and the baffle extensions work. They tell their friends. Pretty soon, everyone is doing it. Yet when someone finally looks at how the moisture

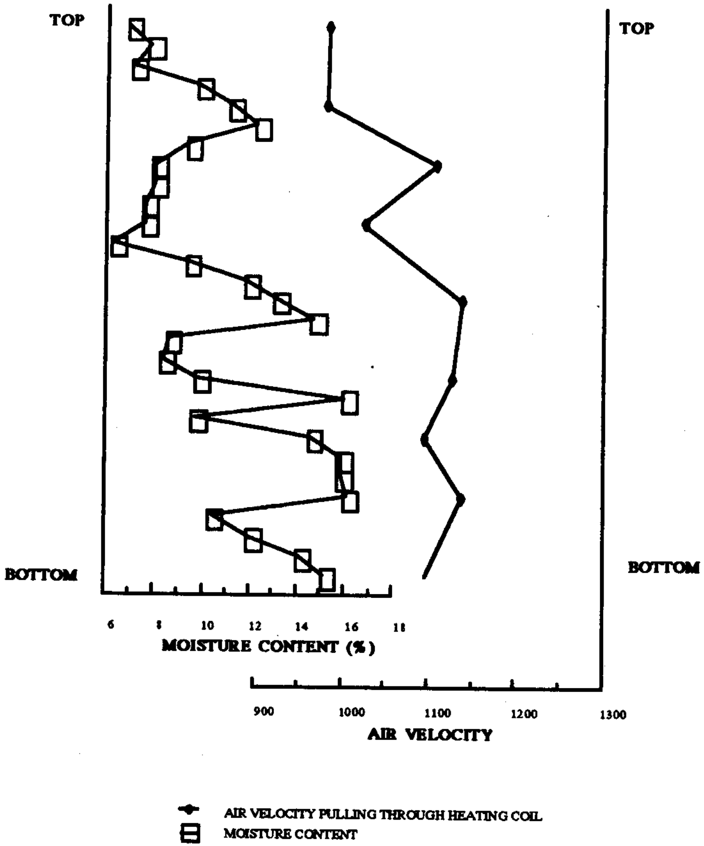

Figure 3. Comparison of moisture content and air velocity top to bottom on one cart.

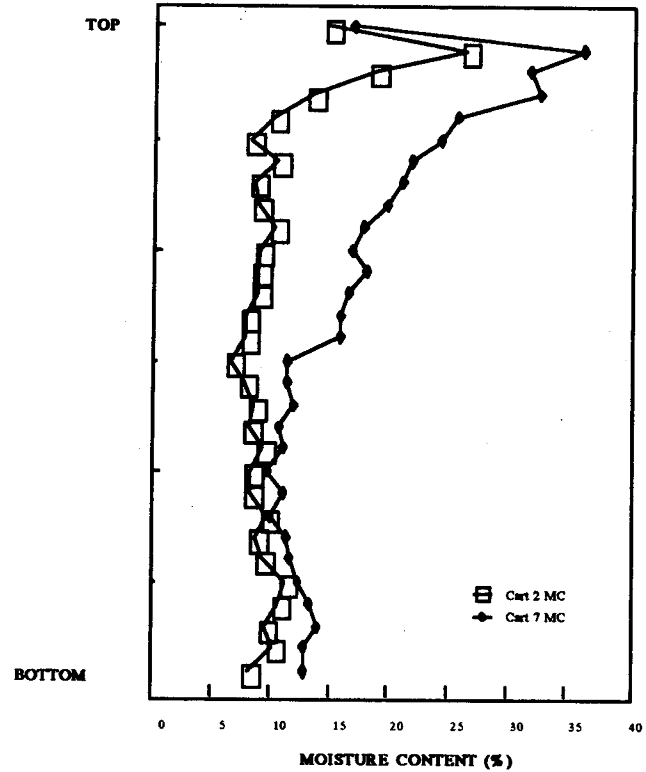

Figure 4. Variation in moisture content top to bottom in carts 2 & 7.

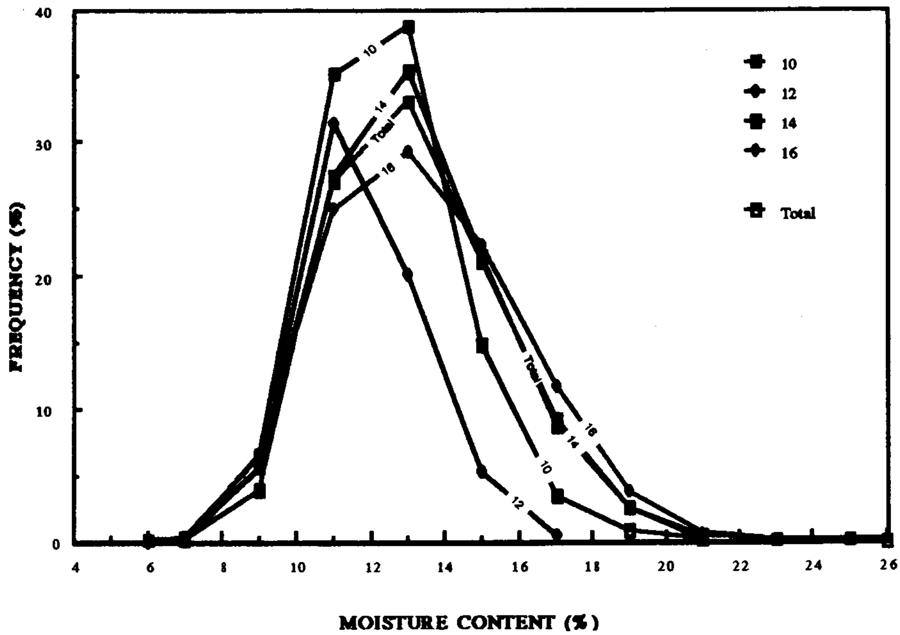

Figure 5. Comparison of moisture distributions from one kiln charge of 2 x 6's data from an in-line moisture detector.

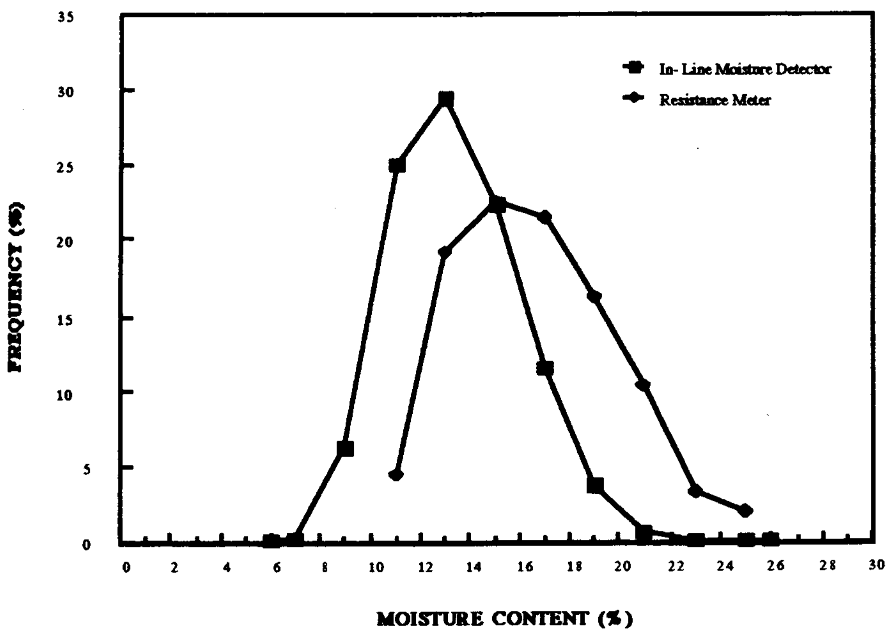

Figure 6. Comparison of test methods resistance vs. in-line moisture detector 2x6-20.

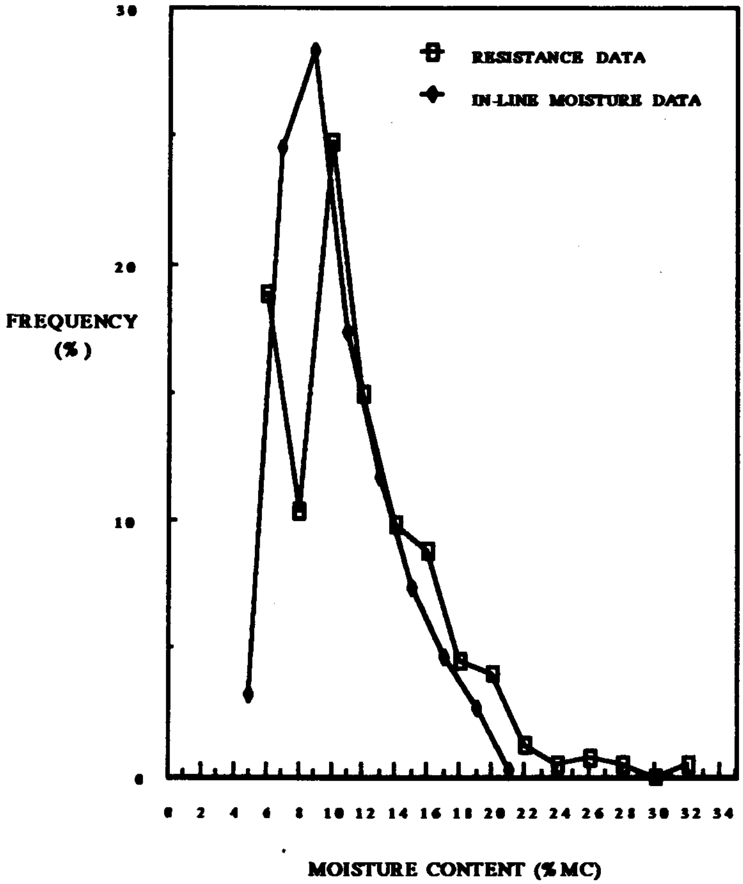

Figure 7. Comparison of moisture distributions.

varies from top to bottom, we discover the trade off. The data in Figure 4 was taken from just such a kiln. Leaving sticks out of the top layers has the same impact.

Here, I must caution the kiln operator. Do not judge the results of kiln modifications solely on appearance alone. There are several techniques which flatten top layers of lumber. When you consider appearances alone, these techniques seem to work very well. Top layers are flat. They are also very often wet.

IN-LINE MOISTURE DETECTORS vs RESISTANCE MOISTURE METERS

Now that we have our baseline moisture profile, we need to examine how this information relates to information gathered from in-line moisture detectors or at the grading station. If we collect this information while we are generating our moisture profile, then the rest is easy. Simply graph both sets of data as a percentage of the sample population for comparison. Otherwise, we have to collect comparison data in a separate run of material.

Let's look at the type of information we might obtain from an in-line moisture detector. Figure 5 compares the moisture distributions of each length of lumber contained in one kiln charge to the moisture distribution of the entire charge. This is a total moisture sample collected with a commercial in-line moisture detector. It is interesting to note that the basic curves for each of the lumber lengths are remarkably similar, only their peaks shift. When the total population is considered, we see that combining the total data tends to average out the frequency of high and low moisture contents. Aside from general ideas about overall trends in kiln performance, it is difficult to draw specific conclusions from this information. The data can mean almost anything.

Let's take this a step further. Figure 6 compares the total population of the data collected from the in-line moisture detector on the 2 x 6-20's in the previous example to a partial sample collected from the same lumber with a hand held resistance meter. The resistance meter data was gathered by omitting the edge boards which tends to exclude low moisture content places. Even so, the resistance data detected 61 more boards above 19% MC even though the in-line meter had a sample size six times larger (3,613 pcs vs. 613 pcs).

A later test designed to compare the in-line meter vs. the resistance meter without excluding the low moisture content pieces produced the graph in Figure 7. Again, the data is remarkably dissimilar with a significant portion of the moisture content data missing at the high and low ends from the in-line measurements.

What these examples suggest is that while we may use the in-line moisture meter data to track changes in overall trends, it may not tell us all we need to know. There seems to be a tendency for this equipment to ignore high and low moisture content pieces in the sample. If we rely on it as a sole source of information for managing our kilns, we may have a problem. Remember, the grading agencies use the resistance meter as their standard. It is up to the individual mill to determine how this information relates to their situation.

WHAT IS THE POINT?

There are several . . . . .

1. Determining your baseline moisture pattern helps you discover the cause of

wide moisture variations. It gives you the information you need to take corrective measures.

2. Knowing your baseline moisture pattern helps avoid the consequences of overreacting to drying complaints.

3. Understanding your baseline moisture pattern helps you function as a more effective kiln operator. You control your drying operation rather than letting it control you.

4. Simply tracking overall moisture distributions over time does not tell you everything you need to know. However, once you determine your baseline moisture pattern, overall moisture distributions can be monitored for shifts in patterns or performance. Once alerted to a change, you can look closer for a cause.

5. Changing your baseline moisture pattern requires changes in the way the kiln dries lumber. These changes may be simple or complex. The baseline gives you a snapshot of how your kiln performs and conveys information on how to improve its performance. You are able to identify the easy and often inexpensive improvement options and implement them. It gives you the ammunition you need to push for more extensive modifications.

6. If you operate an in-line moisture detector, the moisture distributions generated from your baseline data gives you an easy check on meter performance and accuracy.

7. Making changes to your kiln without investigating the true impact of those changes may mean that something unexpected and unwanted goes unnoticed, until too late.