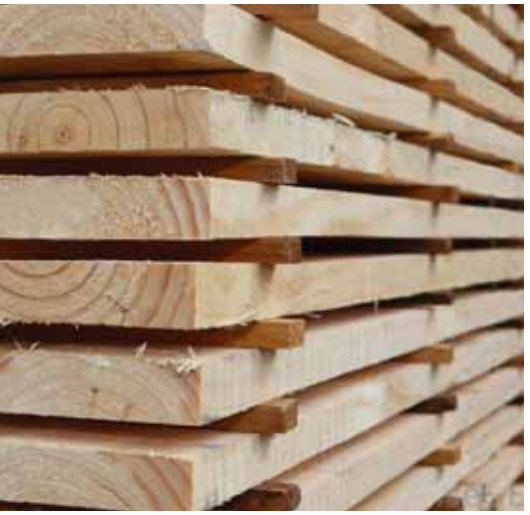
Hey! What's Going On?

Monitoring Drying Conditions



To people with drying experience, it probably goes without saying that the air temperature, air humidity (usually the relative humidity, but sometimes this is expressed as the EMC or the wet-bulb depression), and air velocity through the lumber pile determine how fast lumber is going to dry and what the final quality will be. Did you know that? Or that the "best" environmental conditions vary with the wood moisture content (MC)?

Understand that the previous statements involving temperature, humidity, velocity, and MC apply to any situation where lumber is drying, including when it is stacked at the sawmill, on a truck during transport, waiting to get into the kiln, and during air drying, shed drying, and kiln drying.

Unfortunately, we often put the lumber or other wood products into a drying situation and then ignore what is going on. After a week or month or several months, whatever moisture content and quality results, especially if it is bad, are blamed on "nature"—maybe El Niño or La Niña, or a hot summer, or even a bad kiln operator.

The premise of this article (or maybe the point of this sermon) is that by measuring the drying conditions, we can manage the environmental conditions to achieve the drying quality we want, the desired drying speed, and ultimately our desired profits. Plus, if we monitor drying conditions all the time, we will also learn which conditions to avoid.

Effects of Temperature, RH, EMC and Velocity

Temperature (see chart next page)

We are almost always interested in the hottest temperature. It is heat that weakens wood, causes color change, excessive drying speeds, and so on. Stated another way, the average temperature can be perfect, but a few degrees of heat above the average temperature can result in defects during drying. It is advisable to have a recorder to measure and record the temperature several times every hour (or more often) just in case the conditions vary while no one is watching.

RH, EMC

We are also almost always interested in humidity extremes. That is, when the air is too humid, drying will slow and increase the risk of staining and warp. On the other hand, when the humidity is too dry, the wood can dry too rapidly, increasing internal stress, which leads to checking and splitting in the lumber ends, on the surface and internally. Because the effects of an incorrect RH accumulate (several excursions add together), it is advisable to have a humidity recorder that records the RH or EMC several times an hour or more often.

Velocity

As the air velocity increases, we probably know that a wet item will dry faster. This is true for lumber and other wood products when the wood is quite wet. So, higher airflow, which costs money, does make drying go faster, but hopefully not too fast, as too fast means checking and splitting. It is good to know the velocity at the location where the lumber is drying, but in a kiln, the velocity does not vary substantially hour-to-hour and day-to-day, so, a recording is not necessary.

But as the wood dries, the velocity has a diminishing effect on drying. We usually find that at 20% MC or lower, the velocity has essentially no effect on how fast wood dries. However, the airflow is required for

moving air around in the kiln, to pick heat off the heaters, to make the vents work, and to provide even drying conditions throughout the kiln. So, under 20% MC, we can use low airflow (150 feet per minute = 2 mph) through a load without concern. Airflow can even vary in the kiln at this low MC without any issues for drying. So, we conclude that monitoring, measuring, and controlling airflow in a kiln with low MC lumber is not going to help with quality; in essence, we ignore the fan speed.

Moisture Content

All drying defects, except cup, incorrect final MC, and residual drying stresses (sometimes called case-hardening), are created during the loss of the first 1/3 of moisture content (from the tree's green MC). As many species of wood have around 75% MC green, this means that drying defects are created above 50% MC. These defects are created most often when the wood is dried too fast. This "too fast" can be for an hour, several hours, for a day, or even longer. Fast conditions are caused by excessive temperature, excessively low humidity, and excessive airflow (or combinations of these).

Temperature

Temperature is measured with a thermometer. In drying, this is also called a dry-bulb. Today, these measurements are made with a sensor that varies resistance at different temperatures. The sensor most often is a thermistor or a resistance temperature detector (RTD), and often using a platinum wire that changes resistance with temperature. We want a range of 50°F to 200°F, with an accuracy of + or -1°F and a resolution of 0.1°F. (Resolution means that we can read the temperature to 0.1°F. Accuracy means that the reading we obtain is within 1°F of the true, actual temperature.)

Humidity

Relative humidity is measured with a moisture meter. The desired range is 5% RH to 99% RH, the accuracy is ±3% RH, and the resolution is 1% RH.

Several companies sell a fancy stainless steel or aluminum clamp that holds a small wafer of wood. The MC of the wafer is measured using resistance, in the same manner that is used for a wood moisture meter. The recorded MC is adjusted for temperature and wood species, and thereby provides the EMC of the air.

Some drying operations, including kilns, use a regular dry-bulb temperature sensor that is covered with a wet muslin cloth or wick. This is called a wet-bulb. The water should be distilled water, and the airflow should be around 600 fpm. Many reservoir devices are available to keep the wick wet for a day or longer. When the dry-bulb and wet-bulb temperatures are known, the RH and EMC can be obtained from a chart or table.

Velocity

As most drying operations do not have control of air velocity through the pile (never turn off one fan to drop the velocity), we typically do not check the velocity very often. Further, as much of the lumber that we dry is already air-dried, it is not useful to measure air

Summary of Effects of Temperature, RH, and Velocity on Drying

Role of Temperature When the temperature rises

a) lumber dries faster, which in turn means brighter, flatter lumber with more risk of checking
b) lumber dries more uniformly throughout the kiln
c) lumber develops darker (usually browner) colors
d) lumber is weaker, and therefore lumber is more prone to checking and splitting
e) lumber is weaker, and therefore lumber is more prone to warping unless stacking is precise
f) insects and fungi are less active above 100°F and are killed above 130°F

Role of Relative Humidity When the humidity drops

a) lumber dries faster, which in turn means brighter, flatter lumber with more risk of checking
b) lumber dries more uniformly throughout the kiln
c) lumber develops lighter colors
d) lumber is stronger, and therefore less prone to warping
e) lumber is stronger, and therefore less prone to checking and splitting

Role of Velocity When the velocity is increased

a) above 40% MC, lumber dries faster, which in turn means brighter, flatter lumber with more risk of checking
b) below 20% MC, velocity has very little effect on the drying rate
c) lumber dries more uniformly throughout the kiln

velocity at low MCs. An anemometer with a small fan blade will give an average reading, but this is not as useful as the measurement between the stickers. The cost of a reasonable unit is over $200. Perhaps it is better to see if you can borrow a unit for a day from an air-conditioning/heating repair shop if you really need to get the airflow. Generally, the unit should measure velocities between 25 to 600 feet-per-minute with a resolution and accuracy of about 25 fpm.

MC

In past issues of this magazine, we have thoroughly covered how to use both the pinless- and pin-type moisture meters, and the measurement techniques using wet weight and oven dry weight.

Data Logger

A data Logger is a device that measures and records the environmental conditions. In most lumber drying cases, we would consider a handheld data logger with remote probes for temperature and RH. This could be used in a kiln for spot checks now and then; the sensors are inside the kiln and the data logger is outside in a controlled environment. Data is downloaded to a computer through the USB port. The cost varies from $30 to $500, depending on the durability and options. The big advantage of such units is that they can be used to check temperature and RH at almost any location in the kiln.

Recorder-Controller

When drying in a kiln or other chamber—including a fan shed—something is needed to determine if the fans should be on, if heat is needed, and if the RH is too high or low. Such devices often include a data logger and a hook-up to a computer (or the old-fashioned style has a chart with pens to record the data on paper). In addition, the controller part of the instrument turns on or off various switches, pumps, vents, etc., to achieve the desired temperature and RH. Such a device is certainly essential for kilns over 5,000 BF and is also desirable for smaller kilns. It is best to buy one from a supplier of kiln equipment, although sometimes a DIY person can make a system. The deluxe systems also estimate wood MC, have troubleshooting features, control fans, have wireless sensors, and allow dial-up phone connections. ■

Gene Wengert, Professor Emeritus, University of Wisconsin-Madison, is President of The Wood Doctor's Rx, LLC, in Bishop, Georgia.