PRACTICAL TECHNIQUES FOR ACCURATE USE OF A Pin-type Moisture Meter

A moisture meter is likely the second most commonly used instrument in a drying operation. (Can you guess what is #1? Yes! probably temperature probes.) In my job as a consultant and instructor, I often find that the moisture meter is used incorrectly. So, let's look closely at this piece of equipment.

In Theory

The pin-type moisture meter measures the resistance between two needles and the resistance reading is related to moisture content (MC). This relationship was determined back in the 1960s by Bill James at the U.S. Forest Products Lab and is still the basis for our meters today.* The basic data is for 80°F with two needles spaced 1-1/4 inches apart and driven into the wood 5/16 inches deep.

The relationship between resistance and MC (increasing resistance as the wood gets drier) is logarithmic, meaning that the change at high MCs is small but as the wood gets drier, each percent MC change result is as much as 4 times the increase in resistance. The standard calibration for meters for decades has been coastal-grown Douglas fir (Table 1). Note that at 7% MC, R = 22.4 billion ohm. This is so high that conventional ohm meters cannot measure this value; specialized circuitry is required.

What this logarithmic change means is that small variations in R from species to species will not cause large changes in MC, especially at lower MCs. So, the D-F calibration is widely used without corrections for North American species (except southern pine). A few R-values are given for various species (Table 2).

In Practice

▪ **MC Range**. Some practical points. Note that the data only ranges from 7% to 25% MC. As the MC increases over 25%, the resistance change is very small, and at over 28% MC, with liquid water present, the resistance change is erratic with MC changes. At the dry end, the resistance becomes so huge that the meters cannot measure this high resistance accurately. Hence, the accurate functional range for a pin meter is 6.5% MC to 28% MC, no matter who the manufacturer is.

▪ **Pin Type**. Note that pins could be shiny nails; the needles' metallic content is not an issue. Touch the meter pins to the nail-heads. Most pins are only1/4-inch, 1/2-inch or 1-inch long, so with large timbers, the nails can provide a way to measure MC deeper in the wood.

Also, note that the wettest spot along a pin will be the lowest resistance and that wettest spot will be indicated by the meter. This is especially important to

Table 1 Resistance in megohms (R) for coastal DF at low MCs.

MC	7%	8%	9%	10%
R	22,400	4,780	1.660	630

*James, William L. 1988. Electric moisture meters for wood. Gen. Tech. Rep. FPL-GTR-6: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. Madison, WI. (https://www.fpl.fs.fed.us/documnts/fplgtr/fplgtr06.pdf)

Table 2 Resistance in megohm (R) for several species.

MC	Douglas fir	White pine	Sugar maple	Red oak	Walnut
7%	22,400	20,900	72,400	14,400	51,300
10%	630	850	690	630	890
15%	18.6	33.1	16.6	18.2	22.4
20%	2.14	3.31	2.24	2.09	2.14
25%	0.46	0.52	0.60	0.50	0.38

understand as it can cause problems. For example, if dry lumber is exposed to humid weather, such as on a truck driving the load of lumber in the early morning, the surface will pick up a small amount of moisture. So, the meter will read this high surface MC even though the lumber is actually much dryer and the pins are mainly in dry wood.

When surface moisture is present, there are pins available that have insulation along their lengths with only the pointed tips being uninsulated. These pins measure the MC at the tips, so if wet spots exist along the length, they do not influence the tip resistance and the meter reading. However, the insulation will wear off, so frequent pin replacement is required for accurate measurements at any depth.

In fact, with insulated pins, it is possible to measure the MC at any depth. This moisture gradient from surface to core can be useful at times, especially if the wood is to be re-sawn into smaller pieces or will be planed more on one side than the other.

Also, when there is a wet surface, it is important that the nuts or other fasteners for the pins not touch the wet surface; insulated washers are available.

Special note: Older moisture meters were often designed for use with a four-pin probe. The readings with two pins in a four-pin meter are 1/2% to 1% lower.

▪ **Average MC**. Oftentimes, the specifications for lumber require a certain average MC for the piece. That is, the specification does not indicate the surface MC or the core MC, but the overall average. As a rule of thumb, the average MC will be the reading obtained when the pins are driven to a depth of 20% to 25% of the thickness of the lumber. For posts and poles, drive to 1/6 of the diameter.

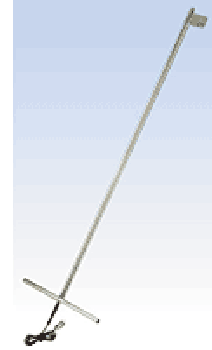
Oftentimes, the specification for kiln drying is that the load be between 6% to 8% MC. A load of 5,000 BF of lumber might have close to 1,000 pieces of lumber, so it is not practical to measure every piece's MC with a pin meter. (It might be more reasonable with a pinless meter. In fact, pinless meters are made that can measure the MC of every piece on a conveyor.) So, when using a pin meter, 30 random pieces can be measured for a load. This average of 30 will be very close to the average if all 1,000 pieces were measured. Plus, if the standard deviation (SD), a mathematical calculation of the variability, of the MC of these 30 pieces is measured (many meters have a button to push that will give this value, or a small handheld calculator can be used), then the MC of the entire load

can be estimated. If one SD is added and is subtracted from the average, these two values indicate the MC range for 2/3 of the load. If two SDs are added and subtracted, this gives the range of 95% of the pieces in the load. If three SDs are used, the range is essentially 100% of the load.

Example: If the average is 7.2% MC and the SD is 0.3, then 3 x SD = 0.9, which means that (7.1 - 0.9 = 6.2% MC) and (7.1 + 0.9 = 8.0% MC), or 6.2% to 8.0% MC is the estimated range for all 1,000 pieces, even though we only measured 30 of them. The key is that the 30 were randomly chosen.

▪ **Hammer Probe**. In order to drive the needles into the wood, many companies have 1/2-inch-long, insulated needles (which will be long enough for the average MC of 5/4 lumber and thinner) installed in a long probe with a movable handle so the pins can be driven into the wood, a measurement taken, and then the pins extracted. (Note that 1-inch pins are common and are fine for 8/4 and thinner but they do tend to bend more easily.)

▪ **T-Probe**. At least one company makes a long skinny probe with needles on the end. This probe can be inserted between the stickers in a load, a handle turned, which drives the needles into the wood, and then pieces within the load can be measured for MC. Although the accuracy is not high, this probe can detect the wetter pieces, such as when air-dried lumber is going into a kiln. The wettest pieces are chosen for samples during the run.



▪ **Temperature Corrections**. The resistance of wood changes with temperature. As a rough rule of thumb, for every 20 degrees the wood is hotter than 80°F, the meter reads 1% MC too high; that is, the wood is drier than indicated. The reverse is true for wood cooler than 80°F.

▪ **Calibration**. Some meters have internal checks for calibration and battery life. For other meters, it is necessary to have a commercial resistor at about 120 megohms that is put across the pins to give a 12% MC reading.

Note that when species corrections are used and temperature corrections are made, the best pin meters are most often within 1/2% MC of the true, oven-dry MC. ■

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