Sensing Moisture Content Inside The Kiln

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Measuring Moisture Content

- Weight is most accurate:

\[ \text{Moisture Content (\%)} = \frac{\text{Wet weight} - \text{Dry weight}}{\text{Dry weight}} \times 100 \]

- Weight-based MC is unaffected by:
  - Temperature
  - Density/specific gravity of the wood
  - Species properties

- Weight-based MC is accurate at all moisture contents
Using Weight to Measure MC Inside the Kiln

- Weight measurement can be used directly inside the kiln to monitor MC change in the kiln if drying temperatures are less than 85°C.

- For schedules that dry above 85°C, weight can be used to calibrate in-kiln MC measurement systems that are more tolerant of high temperatures, e.g., capacitance or resistance.

Systems for Drying Hardwoods

- Hardwoods are usually dried to a lower and more precise final moisture content

- Because hardwood lumber is often resawn, proper stress relief is critical

- Most hardwood drying schedules use dry bulb temperatures below 85°C.

- Load cells are devices that measure real-time weight change of lumber inside the kiln - change in weight is converted to change in MC by the control computer
About Load Cells

- Strain gauges are the heart of a load cell
- Strain gauges are glued to metal webs inside the cell. As load is applied, movement of the webs is measured by the gauges.
- Load cells are powered with either AC or DC. Their output, in volts, is proportional to the applied load.
- Use of the proper load cell allows a weight from fractional grams to tons to be precisely measured.

In-Kiln, Weight-based Control

- In-kiln, weight-based control has been around since the 1920’s – early systems were mechanical
- Commercial systems on the market today are electronic, all share a common origin to development work done at the Univ. of Tennessee in the early 1990’s
In-Kiln, Weight-based Control

- Weight change is the most accurate way to measure MC inside the kiln
- Most of today’s weight-based systems weigh individual board samples
- Weight-based technology can weigh a much larger percentage of the charge, e.g., one or more kiln cars

Systems for Drying Softwoods

- Possibilities for sensing lumber moisture content inside the kiln:
  - TDAL (Temperature Drop Across the Load)
  - Time at temperature
  - Measurement of an electrical property of wood that is related to MC
- Most modern in-kiln systems use the electrical capacitance of wood as an indicator of lumber MC
In-Kiln Capacitance Systems

- MC readings are strongly influenced by the specific gravity of the wood
- These systems are most accurate when reading MCs between 5 and 25%
- Readings are strongly influenced by the surface MC of boards on which the probes rest
- Best accuracy is obtained during periods of high and constant temperature
- Most electric moisture meter systems have a minimum reading, e.g., 6%. This means that the true MC of lumber with an indicated 6% MC is unknown.

Getting the Most from In-kiln Capacitance Systems

- In-kiln systems find their most common use as a way to end drying at a desired MC. They can also be used to make MC-based changes in conditions during drying.
- Before using a new in-kiln system it should be calibrated to ensure that it reads the MC of local timber correctly. Most in-kiln systems have a calibration procedure recommended by the manufacturer. The procedure should specify not only how to gather comparative MC data but also how to adjust the system if errors are found.
Getting the Most from in-kiln Capacitance Systems

- If an in-line moisture meter is used in the mill, moisture contents from the in-kiln system should be reconciled with the in-line system.

- Before reconciling the two systems, the in-line meter should properly installed and adjusted. The in-line meter should then be calibrated for all products, the most accurate calibration is one that uses oven-dry weight derived MCs.

- OD calibration process:
  - Collect 80 – 100 samples of each product. Use a hand-held meter to select samples equally in 4 MC ranges: below 10%, 10-15%, 15-20%, and over 20%.
  - Within 2 hours of planing read the MC of each sample on the in-line meter.
  - Weigh all samples, oven-dry to a constant weight, re-weigh, and calc. MCs.

Getting the Most from in-kiln Capacitance Systems

- Performing an OD calibration is not a one time event. Calibration checks should be performed semi-annually or when a problem is suspected. It is recommended that all mills purchase an accurate sample oven and scale for OD calibration.
Getting the Most from in-kiln Capacitance Systems

- If an in-line system is not in use, verify MC readings of the in-kiln system against readings from a hand-held moisture meter — this procedure should be described in literature available from the in-kiln meter manufacturer.

- As with an oven-dry calibration, be sure to perform the calibration over the entire range of the meter, from over 20% to less than 10%.

The Effect of Conditioning/Equalization on In-Kiln Readings

- Many modern kilns are equipped with conditioning systems that introduce moisture at the end of drying; steaming baths, live steam injection, and cold water spray are examples of such systems. Introduction of moisture will interfere with the accuracy of in-kiln moisture sensing systems.

- In these kilns it is best to check the MC before conditioning and then run a time-based schedule to end point. Establishing the correct time to end point will be trial and error for the first few charges.
Performance Tips for In-Kiln Systems

- All capacitance systems have recommendations for probe placement and spacing – follow them in every charge.
- If probe cables are uninsulated, be sure they are taut and positioned away from metal objects otherwise shorting could occur as the cables swing in the wind.
- As pitch builds on system components it should be removed - oven cleaner works well.

Questions?