

WHY CONTROLS?

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When one hears the word "control" we immediately think of restriction. Some controls are restrictive. Some controls make possible the impossible. Without exotic controls our spacemen would never have reached the moon. Our electronic industry would not be turning out wrist watch radios or hand-held calculators.

So, with the drying of lumber. Each species of wood possesses a unique structure. Removing moisture requires different conditions in the surrounding air for each species. A skilled technician could stand and face gauges during the drying cycle. But it would be expensive. Therefore, we use special equipment to control the drying environment.

The variables in drying are temperature and humidity. Drying rate increases directly with temperature and air mass passing over the lumber. Drying rate varies inversely with humidity and board thickness. Air movement is generally fixed and of course thickness is based on the lumber to be dried. So we control drying by temperature increase or decrease and humidity decrease or increase.

One of the most reliable and accurate measures of humidity is the rate of evaporation of water from a wetted surface. Humid air passing over a wet surface will not evaporate water as fast as dry air will evaporate it. When water evaporates it absorbs vast quantities of heat. It cools its environment as it evaporates. The amount of cooling is a measure of the humidity. If a thermometer is covered with a wetted wick the reading will fall when air is blown over the wick. The amount of fall is proportional to humidity and quantity of air that passes over the wick. Experiments have shown that velocities of 600 f.p.m. will safely provide the maximum cooling for any normal humidity. Charts and tables have been prepared that will indicate the humidity for each relationship of thermometer dry and thermometer with wetted wick. In drying lumber the wetted wick thermometer is called wet bulb and the dry thermometer is called dry bulb.

Most tables for dry kiln use have not only the relative humidity shown but also the figure that is termed equilibrium moisture content. This name is given to a humidity state which an object that can absorb or give up moisture will ultimately reach if kept in this wet and dry bulb situation for an indefinite time. The USDA Dry Kiln Handbook #188 on page 11 presents a table in which the equilibrium moisture contents are shown in italics below the corresponding relative humidity. You will note that the differences between wet bulb and dry bulb is shown as wet bulb depression. This is the term commonly used in developing schedules.

It is easy to see that a wet bulb depression that would not dry lumber below 20% M.C. is difficult to develop unless the control mechanism is both accurate and precise. If one is drying

oak at 100 degrees F. a 20% M.C. may be produced in the lumber to be dried with a two degree wet bulb depression. This condition will permit only 1/3 the total shrinkage of the surface area while the interior is at a high M.C. and not yet shrinking. If the depression is 8 or 10 degrees with green oak lumber, the surface will split.

To dry with such a close depression requires an accurate controller. Temperature wet and dry is and has been controlled to date with a system that functions on what is called vapor pressure. A volatile liquid substance gives off a portion of itself as a vapor at a rate that is governed by the ambient pressure and temperature. If some of this liquid is enclosed, a pressure gauge of proper range connected to the enclosure, and heat is applied to the enclosure, the needle on the gauge will rise. After a time it will level off. The pressure reading is called vapor pressure. Its reading may be calibrated in the figures of a temperature scale. If the container is connected to a very small tube, the gauge may be placed on the opposite end and the reading can be observed at a remote point. A pen may be attached to the needle of the pressure gauge and its reading on a chart will provide a record of the temperature the bulb is exposed to.

Such instruments are rugged and simple to manufacture. They do have a fault. At the lower end of the scale their movement is somewhat insensitive and inaccurate.

A more modern instrument is one that measures current flowing through a resistant circuit. Instead of being transmitted by vapor pressure the signals may be electric. A resistance which varies predictably with temperature produces an imbalance in an electrical measuring circuit and will record and control to the set point.

In either case -- vapor pressure or resistance variation -- the energy to operate valves or vents is usually through varied pneumatic pressure. Movement is produced in a shaft from the force transmitted from a flexible sheet called a diaphragm. A spring of predetermined resistance pushes the force developed from the air signal. The higher the air pressure the more the movement.

An instrument with full response from no air pressure to full air pressure signal during a temperature change of one degree F. is often referred to as "on-off" control. Conversely one in which the air pressure changes three pounds for each degree F. is called modulating. With the proper amount of modulation (change in air pressure per degree F.) a chart recording of temperature under control will be a smooth circle. With insufficient modulation the chart line will be a saw tooth shape. With excess modulation and improper reset the line will deviate from the desired level.

Obviously then, a control instrument with an adjustable modulating characteristic is desirable.

An instrument, no matter how sophisticated in design, will not continue to provide control if it is neglected. Its case must be air tight. It must be open only for servicing. Its pneumatic supply must be clean and dry. The source should be exclusively for instrumentation. A plant air compressor normally passes on to the discharge a certain amount of its lubricant. If there is any contaminate, especially oil vapor, it must be filtered before admission into the controller.

While instruments normally remain in calibration they should be periodically checked. A rough, simple procedure is to remove the wet bulb wick, close kiln door, turn off heat and allow fans to run for ten minutes. The wet and dry bulbs should read approximately the same.

For more careful and precise calibration a precision thermometer and a bucket with water may be employed. The bulb, of which calibration is desired, is placed in the heated water and the thermometer placed adjoining it. The contents are stirred until both instrument and calibrating thermometer are stable. Several readings from lower to upper scale are desirable.

If an accurate potentiometer is available the thermocouples may be taped to the bulb while it is in place in the kiln and readings compared while the kiln is in operation. If the bucket method is employed with a vapor pressure system the reading should be made at the normal position of the bulb in relation to that of the instrument. Any variation in elevation will slightly affect the instrument reading and control point.