USE OF THERMOCOUPLES IN MEASURING TEMPERATURE—HUMIDITY CONDITIONS IN COMMERCIAL DRY KILNS

By William Brubaker, California Redwood Association

One prerequisite for successfully operating a dry kiln is an adequate instrument with which to control temperature-humidity conditions within the kiln. The instrument should be able to hold, reasonably well, conditions in the kiln as desired by the kiln operator. Kiln controlling instruments are intricate and expensive, but are of little value if not in proper calibration. It is highly impractical, if not impossible, to calibrate kiln instruments to the exact degree, the same as it is senseless to dry lumber in commercial kilns following time schedules which specify temperature changes at an exact minute of the day. But the fact still stands, kiln instruments must be kept in adequate calibration to be utilized to their maximum advantage.

Two procedures are commonly followed in calibrating kiln instruments —1.) immersing the controller bulbs in boiling water and adjusting the instrument to respond accordingly to this temperature, and 2.) placing hygrometers near the controller bulbs while the kiln is in operation and adjusting the instrument to respond accordingly to wet and dry bulb temperatures read on hygrometers.

In late summer of 1958, the California Redwood Association began investigating the feasibility of using a potentiometer with thermocouples in measuring tempertature-humidity conditions in commercial dry kilns.

Tests were made with a portable instrument-pack consisting of a potentiometer, a jack-box with 12 outlets, a 12-position selector switch, dry-cell batteries, and spools of thermocouple wires, all contained in a luggage case. Readings taken with the instrument were compared with readings of hygrometers, the recording-controlling kiln instruments, and, in one instance, an Anemotherm. The tests were made in dry kilns at five different redwood mills.

At each kiln in which tests were conducted, thermocouples were mounted approximately 1/2 to 1 inch away from each dry bulb, and one thermocouple was inserted inside the wet bulb wick between the wick and the bulb. Thermocouple leads were strung to the potentiometer unit which was set up in the kiln instrument and control room.

Before taking temperature readings with the potentiometer, the following information was recorded on a worksheet designed for the tests: the date and time of day the readings were made, direction of air circulation in the kiln, and kiln instrument set-temperatures and recorded-temperatures.

Temperatures were recorded once for each thermocouple; following this group of readings, information was recorded as to whether or not the heating, damper, and spray valves were open. This procedure was re-

peated in the same order until at least twenty readings were obtained for each thermocouple. The 100 to 125 readings thus taken required 20 to 25 minutes and were numerous and rapid enough to ensure temperature measurements throughout a complete cyclic operation. Subsequent readings were made in the same manner each day until the charge was pulled from the kiln, providing numerous readings under a variety of temperature and humidity conditions.

Temperature readings of each thermocouple were averaged daily. The following data was compiled at the end of the kiln run for each series of readings: the date and time of the readings; time elapsed; the number of readings taken for each thermocouple; the direction of air circulation in the kiln at the time of the readings; kiln instrument set-temperatures and recorded-temperatures; temperatures taken by other means (hygrometer, etc.) for comparison; and the average, the low, and the high temperatures for each thermocouple.

This information provides the kiln operator with a complete record of his kiln instrument's operation. Functioning of the kiln's temperature-humidity controlling components can be checked closely on the daily records.

The use of thermocouples for measuring temperature-humidity conditions within a kiln offers the following advantages to the dry kiln operator:

1. Quick response to changes in temperatures.

2. High and low temperatures can be read during the temperature cycle.

3. Temperatures can be read rapidly, thus requiring a minimum of the kiln operator's time.

4. Both wet and dry bulb temperatures can be read; also, the thermocouples can be placed in "hot spots" for measurement of temperatures other than those of the controller bulbs.

5. Temperatures can be read directly in the kiln instrument room, eliminating the necessity of the operator's entering the kiln, and, also, the disturbance of internal conditions resulting from opening the kiln doors. Temperature measurements can be made during exceptionally high temperatures and humidities when other methods are either dangerous, impractical, or impossible.

6, If enough readings are taken, the kiln operator can observe the cylic operation of the kiln by recording temperatures and the opening and closing of vents, heating coil valves, and spray lines.

The following precautions must be taken to ensure maximum accuracy

when measuring thermocouple temperatures with a potentiometer:

1. Thermocouples should be shielded against radiation from spray lines and heating coils.

2. The potentiometer, when moved to new surroundings, should be allowed to stand until its internal temperature is in equilibrium with surrounding conditions.

3. Air circulation, especiaaly cold and hot drafts, around the potentiometer and jack-box should be eliminated. Variations in temperature of these units will cause false readings.

Provided the above precautions are taken, temperature readings with a potentiometer and thermocouple will be accurate within 1 degree F.

The procedure for making the readings is simple for either a number of readings or just a few. With thermocouples permanently installed in dry kilns, the operator can make quick daily temperature checks with a portable potentiometer, requiring only a few minutes of his day for each kiln.

A very satisfactory portable potentiometer unit, such as the one used in these tests, can be assembled with equipment costing $290. Cost of nylon-covered thermocouple wire is 8 cents or 10 cents a foot depending upon wire quality. A 36' X 66' double-track kiln can be wired with one thermocouple at each of five controller bulbs for a materials-cost of $32 to $40; this allows for enough wire so that the thermocouples are not restricted to placement only at the controller bulbs.

These tests demonstrated that the use of thermocouples saves time and simplifies the task of measuring kiln temperature-humidity conditions, and also, of calibrating kiln instruments. Thermocouples respond very rapidly to temperature changes. Measurements of temperatures with thermocouples offers several advantages over other methods commonly used, and when carried out properly, will furnish the kiln operator with accurate and reliable data.