STEAM PRESSURE CONTROLLERS AND THEIR OPERATION

By

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All of us connected with the lumber drying industry are aware that the three basic factors of kiln drying are temperature, humidity or equilibrium moisture content, and circulation. These factors must be established and controlled when setting up drying conditions within a kiln chamber for a particular species, grade and thickness.

All of us, whether we are using steam or the direct products of combustion from an oil or gas burner, are using the basic principle of pressure controllers when we throttle or modulate the amount of steam or fuel going to the burners.

Pressure controllers are actually volume controllers, and by controlling volume we, in turn, can control temperatures.

Most modern kilns, irrespective of manufacture, are called upon for a wide heat load variation. This heat load variation is reflected not only from the beginning to the end of a particular charge, but is also increased by the heat load variations that exist from one charge to the other. For example, not only do we have a higher heat load demand at the beginning of a kiln run than at the end of a kiln run, but a wide heat load variation exists in the drying of white fir studs and in the drying of hardwood lumber.

Each kiln must, therefore, be designed for its maximum heat load demand. This is accomplished by having properly sized feed connections, diaphragm valves, heating coils and traps to handle the maximum demand. What are we going to do when the heat load is low and we do not require full utilization of the pipe coils within the kiln?

Many operators have been using the principle of pressure or volume control by turning off certain heating coils or throttling the hand valves to the coils. This can be done, but in many cases operators either do not have the time to adjust several hand valves on each kiln when they have several kilns in a battery, or they fail to open the hand valves wide open at the beginning of a new charge thereby increasing the length of the kiln schedule.

I am certain we all agree, it would be far simpler to have an instrument located next to our master recorder controller which would allow us to vary the pressure or volume of steam within a kiln by the simple setting of a dial. This can be accomplished by the use of a steam pressure controller.

To properly operate and take full advantage of steam pressure control, we must understand the basic principle of pressure or volume control. Next we are interested in what a pressure controller can do for us in a dry kiln.

Let us assume we have a single track kiln designed for operation on 100 psi steam and equipped with 1,680 lineal feet of 1" steel fin pipe. This amount of 1" steel fin pipe contains a total cubic volume of 10.03 cubic feet (Footnote #1: See Addenda 1 for detailed calculations and extract from steam tables). From a steam handbook we find 1 pound of 100 psi steam occupies 3.9 cubic feet per pound. Thus in any one instant we can get 2.57 pounds of 100 psi steam into the heating coils.

Now let us assume that due to the drying conditions within the kiln and the velocity of the 100 psi steam, we can fill this cubic volume of 10.03 cubic feet 30 times per minute. Thus by calculation these coils would handle 4,626 pounds of steam in one hour.

Then let us use this same size kiln and operate with 60 psi steam which, according to a steam table, has a volume of 5.9 cubic feet per pound. (Footnote #1) For comparison only, let us assume we are operating under the same drying conditions and the same steam velocities. Therefore, we can fill the available pipe volume of 10.03 cubic feet with 5.9 cubic feet 1.7 times or get 1.7 pounds of steam to the coils at one instant. Since we are using the same drying conditions, we will fill this pipe volume 30 times, or in one hour we would be able to use 3,060 pounds of steam.

Prior to comparing these two volumes, we must remember that we obtained this 60 psi steam by passing 100 psi steam through a reducing valve. In passing the 100 psi steam through a reducing valve, we did not utilize or destroy any of the heat that was contained in the 100 psi steam. Therefore, we have the same amount of heat per pound of steam at 60 psi as we did at 100 psi. We did, however, change the volume of the steam and, therefore, we have less heat per cubic inch or cubic foot, or volume.

Comparing the 4,626 pounds at 100 psi to the 3,060 pounds at 60 psi proves we have materially reduced the amount of heat available within the kiln.

Control of the pressures or the volumes, as we have just outlined, can be done with the simple setting of one dial. We do not have to remember which hand valves have been throttled or closed, and we are approaching the ideal method of handling steam flow into a dry kiln.

I am sure you will all agree that having steam going into the heating coils in a continuous flow gives a better chance to maintain even temperatures throughout the kiln and reduces maintenance of the heating coil equipment.

It must be remembered that changing steam pressure through a reducing valve does not change the heat per pound but does change the heat content per unit of volume.

Since there is a given amount of volume in any set of pipe coils, our available space for steam is a constant. Changing the volume of a given pound of steam only allows so many pounds to be placed in the constant available space. It is this volume control that we are utilizing with steam pressure regulators in dry kilns. With a pressure controller on a kiln, an operator may vary the pounds of steam being utilized because he is able to change 100 psi steam at 3.9 cubic feet per pound to any desired cubic footage per pound up to approximately 25 cubic feet per pound which is the space occupied by one pound of steam at 1 psi.

With this principle of the pressure controllers behind us, it takes little explanation on my part to show the application available on a dry kiln. The installation of pressure controllers is a relatively simple job and usually consists of installing a diaphragm valve ahead of the main control heat diaphragm valve or at the take-off from the steam main for each kiln.

Pressure controllers can be secured from several different manufacturers, and the manufacturer will advise the best method of installing the equipment. Their recommendations should be followed for maximum efficiency of the equipment.

Let us assume we have now installed a pressure controller on the above-mentioned kiln. The next question is, "How are we going to set it?" When the kiln has first been charged with lumber, we want to bring the temperature up rapidly. Therefore, the pressure controller can be set wide open. As soon as the kiln comes up to heat, the pressure controller can be reduced. The lowest pressure used should be the pressure that will maintain the desired dry bulb temperature on the recording controlling instrument and have the heat valves open 85% or more of the time.

Some operators have found from experience that a definite dry bulb setting for a given drying schedule will call for a definite setting on the pressure controllers. Other operators use the rule of thumb as stated above--simply using the lowest pressure setting that will maintain the desired dry bulb temperature and have the heat valves open 85% or more of the time.

As operating personnel, what can this pressure controller do to help me? Some of the answers are as follows:

1. It simplifies our work. With the above pressure controller installed next to the temperature and humidity controller, we can control the pressure to the kiln to give a thin dry bulb line without having to hand throttle feed connection hand valves. Nor, do we have to remember which of the many hand valves we have previously throttled or closed.

2. It permits us to work towards the end of a continuous steam flow to the coils and to a more uniform heat distribution throughout the length of the kiln.

3. It reduces the maintenance by eliminating the wire drawing or wearing of the valves and seats of hand valves.

4. It reduces the maintenance by having a continual steam pressure on the traps, thus preventing water from laying in the coils and causing pipe deterioration.

5. It will save some steam, but it will only save that steam that has been wasted by an over-feed condition in the kiln, or the steam that is wasted because the boilers are fighting to keep up with the kilns. This may be a little hard to visualize, but many times 5 or 6 kilns in a battery call for steam simultaneously, thus throwing a heavy demand on the boiler. This heavy demand quickly registers in the boiler room, and the fireman tries to compensate by adding fuel to

the boilers. The demand at the kilns suddenly drops off when the kilns reach the desired dry bulb setting. Due to the increased fuel in the boiler, the pressure continues to build up and the safety valves let go. It is this wasted steam that the pressure controllers will save by helping to eliminate these peak demands.

We know it takes so many pounds of steam or units of heat to evaporate water from lumber. A steam pressure controller will not change this basic figure. It will, however, help conserve heat if properly operated.

In this day of high stumpage costs, high manufacturing costs and competitive materials in the lumber field, it is the responsibility of all of us to produce the best product we can at the lowest possible cost to our employers. Steam pressure controllers will help do this.

Steam pressure controllers are manufactured with indicating and controlling devices as well as recording and controlling devices. A simple one pen recording and controlling instrument will allow the operator to know and control the actual pressures used on a particular kiln. A two-pen recording and controlling pressure controller will give the operator a record of the steam available in the steam main and that pressure actually used on a particular kiln. A three-pen instrument would allow the operator to obtain a record of:

Pressure available for a kiln
Pressure used in feed connections
Actual pressure at the traps.

It is only through the knowledge of what is actually going on within the kiln that we are able to improve the quality of stock being dried and reduce drying costs.

Steam pressure controllers, like our modern temperature and humidity recorder controllers, will only do the work requested of them. It is up to the operating personnel to know the limitations, the applications and how to interpret the records obtained from these instruments. An analysis of the records obtained from these instruments is fundamental in their proper use.

There are many cases when the installation of steam pressure controllers have actually allowed an additional kiln to be installed without enlarging the boiler plant. There are other cases where the installation of steam pressure controllers have materially reduced the boiler load, and consequently, the fuel consumption within the boilers.

Are you taking advantage of the principle of steam pressure controllers? If not, why not?

ADDENDA NO. 1

1. Calculations of volume of 1,680 feet of 1" pipe:

$$\frac{.86 \text{ square inches of inside area} \times 1680 \text{ feet of pipe} \times 12\text{" to the foot}}{1728 \text{ cubic inches per cubic foot}} =$$

Equals 10.03 cubic feet within 1680 feet of 1" pipe

2. Extract from Saturated Steam Table:

Material	Pressure	Temp. °F.	Total Heat Btu/lb	Volume Cu.Ft./lb
Water	0 Psi gauge	212	180	.02
Steam	0 Psi	212	1150.2	26.80
Steam	10 Psi	237	1159.5	16.9
Steam	60 Psi	307	1181.0	5.87
Steam	100 Psi	337	1188.9	3.9