STEAM HEATING SYSTEMS IN LUMBER DRY KILNS

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STEAM HEATING SYSTEMS IN LUMBER DRY KILNS

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To obtain uniformly kiln-dried lumber in as short a drying time as possible, the drying conditions throughout the kiln on the enteringair side of the loads should be uniform. This involves not only a well designed, constructed, and maintained building, but the proper design, control, operation, and maintenance of the air-circulating, heating, spraying, and venting systems.

This paper will deal only with steam heating systems of the pipe coil type.

Pipe Coils

There are several types of pipe coils. Those most commonly used in present-day steam-heated kilns are the plain header coil, multiplereturn-bend header coil, single-return-bend header coil, and the booster coil. Of these, the single-return-bend coil and the booster coil are the most common.

Plain-header coils, both horizontal and vertical, are commonly used as heating units. They may be of any length, although short coils are more efficient than long coils and produce more uniform temperatures along the length of the kiln. The coil consists of a number of runs (long pipes) threaded directly into a feed header at one end and attached to short springer pipes of a smaller diameter at the other end. These springer pipes are in turn threaded into the drain header. The springer pipes are usually smaller than the coil pipes to provide flexibility in the springer section, so that the unequal expansion of the runs, as they become heated, will not crack the headers. The coils should be installed with a downward pitch from the feed to the drain header to facilitate the removal of condensate. This pitch is usually 1/8 inch to 1/4 inch per foot of coil length, depending upon the available space.

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Vertical multiple-return-bend header coils are usually located in the supply and return-air ducts of blower-type kilns. They extend across the width of the kiln from track level to the bottom of the air ducts. The coil consists of a supply and a drain header to which a number of pipes running back and forth across the kiln are attached. Generally, there are 20 to 24 runs of pipe per bank. All the pipes pitch downward from feed to drain header to facilitate the removal of condensate. The coils can be constructed of plain or fin pipe.

Header coils with a single return-bend are the most commonly used. They are highly efficient if of the proper size. The coil consists of a feed and drain header and connecting runs of pipe. The feed header is usually located directly above the drain header. The vertical distance between the feed and drain header depends upon the space available. The runs should pitch downward from the feed to the drain header about 1/8 to 1/4 inch per foot of length. These coils can be constructed with 180° elbows or with 90° elbows and connecting nipples.

Vertical coils located between the tracks of multiple-track, forced-circulation kilns are known as booster coils. As the term "booster" implies, these coils replenish the air with an amount of heat equivalent to that it has lost by evaporation of moisture from the preceding load of lumber, so as to reduce the temperature drop across two or more trackloads of lumber.

All pipe coils, regardless of type, can be made of plain or fin pipe of any diameter. Fin pipe is plain piping equipped with thin, circular, metal collars or discs of a larger diameter than the pipe. These are sweated tightly to the pipe at frequent intervals along its length. Fin pipe is said to have 4 to 8 times the heating efficiency of plain pipe of the same diameter. The cost per unit length of fin pipe is greater than that of plain pipe. Because of the increased heating efficiency, however, the total cost of fin-pipe coils may be less than plain-pipe coils, since less pipe is required. Singlereturn-bend header coils frequently have fin pipe in the upper section and plain pipe in the lower section.

Flow of Steam

Steam is fed from the boiler to the dry kiln through supply lines of varying lengths and sizes. From the supply lines it enters the coil feed headers, either by constant or intermittent flow, which is governed by the control system on the kiln. If controlled manually, steam constantly flows into the feed headers; if automatically controlled, it may be either a constant or an intermittent flow depending upon the heat requirements and the size of the heating system. After entering the feed headers, the steam flows through the various runs of pipe in the coil where it is condensed. The condensate flows downward to the drain header, into and through the steam trap, and into the return line to the boiler. All steam supply lines located on the outside of the kiln should be insulated to prevent heat'losses and condensation, which increase steam costs.

Cause and Effects of Air and Water Binding

Air and water are always present in steam. When they are trapped in the heating coils, they seriously affect the flow of steam in the coils and result in an uneven distribution of temperature along the length of the kiln. Air and water binding can be caused by any one or a combination of the following factors: (1) the method of attaching the feed line to the supply header; (2) the coil drainage; (3) the trapping system; and (4) excessive radiation.

Method of Attaching Feed Line to the Supply Header

In almost any type of coil in which the header is fed at one end, air and water binding can be expected. The smaller the coil (in number of pipes), the less will be the tendency for air binding and waterlogging. When steam enters one end of the feed header, it flows rapidly to and through the pipe located nearest to the opposite end of the header, where it condenses. Steam enters the other pipes in progressively smaller amounts and under lower pressures. The condensate, upon reaching the drain header, instead of flowing through the trap, tends to back into the inactive pipes in the coil--those closest to the feed end of the feed header--causing them to become waterlogged and airbound. This reduces the effective radiating surface of the coil, leads to nonuniform temperatures along its length, and may eventually lead to the complete waterlogging of the coil.

When the feed line is attached to the side of the feed header opposite the coil pipes, the steam flows rapidly through the pipe directly opposite the feed line, where it condenses. The condensate, upon reaching the drain header, tends to back up into the outside pipes of the coil causing them to become waterlogged and airbound, thereby reducing coil efficiency.

For best results the feed line should be attached to the side of the feed header at an angle of 90 degrees with the runs. The steam upon entering the header is then dispersed when it contacts the opposite side of the header and tends to flow uniformly through all runs of pipe.

Coil Drainage

Coils should always be installed with a downward pitch from the feed to the drain header so as to facilitate the removal of condensate. If this is not done, the coils may become airbound and waterlogged, and nonuniform temperatures will result along their length. This pitch should never be less than 1/8 inch per foot, and preferably more.

Trapping System

The trapping system should be designed to remove all the condensate from the heating coils rapidly. If the trapping system fails, or is improperly designed, water will either remain in the coils or be drawn into the coils from the discharge line whenever a vacuum is created in the coils during cooling periods.

If the water condensed from cooling steam is allowed to remain in the heating coils of the kiln, the coils will become waterlogged and will fail to supply heat because fresh steam cannot enter. The easiest way to remove the condensate is by means of a valve at the lowest point of line. By opening this valve, the condensate can be blown directly into the atmosphere or to the return line. This practice, however, results in a large loss of steam and increases steam costs. On the other hand, a steam trap that returns the condensate to the boiler results in the utilization of nearly all the heat in the steam. Such traps also release trapped air mixed with the steam. Thus they prevent air binding and the subsequent loss of heating efficiency.

No matter what type of trap is used it must be large enough to take care of all the condensate. A trap that is too small is continuously dumping and is subject to rapid wear, thus requiring frequent repair or replacement.

Traps should be so located that they can be easily inspected. It is desirable to install a trap below the heating unit being drained, so that gravity will assist in the flow of condensate. Steam binding in the drain line connecting the heating unit and the trap can be eliminated by installing a vent line in this drain line. Each coil should be individually trapped, and every precuation taken to insure top operating efficiency by installing check valves, dirt pockets, or strainers. Trap operation should be checked frequently.

Excessive Radiation

One of the most common causes of nonuniform drying conditions in a dry kiln is excessive radiation. This not only produces excessive variations in dry-bulb temperatures along the length of the kiln but results in large temperature cycles--20° F. or more--at certain stages of drying. Sufficient radiation must be provided to carry the peak heating load, which usually occurs in the initial stages of drying, the warm-up period. The higher the initial temperatures, the greater the amount of heat required to obtain these temperatures as rapidly as possible. When the desired drying conditions have been reached, however, radiation should be cut down. Excessive radiation is costly and should be eliminated. There are two ways by which excessive radiation in a dry kiln can be spotted. If the recorder is in good condition--no loose linkage-and the recorded dry-bulb temperature line is jagged or wide instead of smooth and narrow, excessive radiation is indicated. Another indication is a short "on" period and a long "off" period when under automatic control.

The most economical drying is obtained in an automatically controlled steam-heated dry kiln when steam is flowing through the coils 100 percent of the operating time. This condition, of course, is impossible to attain during all stages of drying. It can, however, be closely approached by flexible control of radiation.

Many dry kilns have two large main heating coils with hand valves on both feed and drain ends so that either one can be shut off to reduce radiation. This is good, but not good enough. More flexible control is necessary.

Controlling steam pressures will help to remedy poor control of drybulb temperatures caused by excessive radiation. The best solution, however, is to install a number of smaller coils that can be cut on or off by hand valves when necessary. A few kilns have been examined in which one run of 1-inch plain pipe has furnished enough heat to carry kiln temperatures to 130° F. under certain operating pressures. How many times, however, do you find kilns with such small coils? As a rule, the smallest steam coil will be one containing two runs or more of 1-1/2-inch or 2-inch fin pipe.

The cost of installing several small coils will be greater than the cost of fewer large coils since additional feed and drain lines, hand valves, and traps will be required. The additional cost, however, will probably be more than offset by the savings resulting from better and faster drying.

Two statements have been made at various times against the use of flexible radiation. One is that most kiln operators are so busy, particularly at large kiln installations, that they do not have time to open and close valves during the drying cycle. The other is that the operator will forget to close or open valves when necessary, thereby offsetting the benefits that can be derived from flexible radiation. It would seem, however, that an operator who really wants to do a good job of drying at lowest cost would find the time and would not forget to open and close valves when necessary.

Control of Steam Pressures

Control of steam pressures within reasonable limits is also very important in order to obtain good, fast drying. Even well designed, flexible heating systems will not give the desired results if steam pressures vary considerably. This is true under any operating pressure, but particularly when using low-pressure steam. A number of kiln owners reported that their kilns had insufficient radiation because temperatures fall below those desired at certain stages of drying, especially in the initial and final stages. In most of these cases it was found that at times the steam pressure was down to zero or at 1 or 2 pounds. On a few kilns operated on highpressure steam of 75 to 100 pounds the pressure varied by as much as plus or minus 50 pounds. Naturally, the drying suffered as a result.

At one plant the kilns had insufficient radiation when operating under low-pressure steam. Later it was found that the heating system had been designed for steam pressures of 100 pounds. After several months of operation, the management had decided to reduce pressures to about 5 to 8 pounds because they had heard lower pressures resulted in faster and better drying. An increase in pressure solved this problem.

A good pressure gage and reducing valve should be installed on each kiln. The reducing valve should be installed ahead of the automatically operated heating valve. The pressure gauge should be installed on the low-pressure side of the reducing valve. The reducing valve will not control minimum pressures, but it will control maximum pressures.

Main Feed Lines

The main feed line from the boiler to the kiln must be large enough to supply enough steam to the kilns. Two plants recently reported that dry kiln temperatures above 130° F. could not be obtained at any time during drying. Both plants had kilns of the natural-circulation type, 4 at one and 6 at the other. Each kiln was literally paved with heating coils, but in each case steam was being supplied from the boiler through a 1-1/2inch diameter feed line. Obviously, this was too small. A larger feed line corrected this trouble.

Occasionally long uninsulated steam feed lines are used between the boiler and the kilns. This results in a tremendous temperature and pressure drop of the steam and increased steam costs. All main steam feed lines should be well insulated.

Maintenance of Heating Systems

All equipment must be properly maintained to secure best performance and maximum life. Heating systems are no exception. Regular maintenance will cut down the number of major repair jobs and will keep the kiln in production.

All kiln operators should inspect their kilns regularly using a check list to reduce inspection time and minimize the possibility of overlooking important items. Such a list has been prepared by Mr. Harvey Smith of the California Forest and Range Experiment Station, Berkeley, Calif. This list can be obtained from that Station or from the Forest Products Laboratory, Madison, Wis., upon request. Many operators keep a limited supply of spare parts and items on hand for emergencies, a practice that should be adopted at all plants. The cost is small in comparison to the savings that may result through their use in preventing costly shutdowns.

Heating Systems in New Kilns

In general, the steam heating systems in new and modified kilns are well designed. There is, however, still a tendency to install a few large coils instead of a larger number of smaller coils. One reason for this appears to be the initial cost of the kiln. As previously stated, the cost of installing a larger number of small coils with necessary feed and drain lines, valves, and traps will be greater than installing a heating system composed of fewer coils. Naturally, management wants to buy dry kilns as cheaply as possible. However, the little additional cost for flexible control of radiation will probably more than pay for itself in a short time through good drying at low cost.

Every kiln operator wants to obtain properly dried lumber at the lowest cost. One way to do this is to obtain flexible control of well designed steam heating systems and to operate and maintain them properly at all times.