

PROGRESS OF HEAT PUMP DEHUMIDIFIER

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In the early 70's, dehumidifiers were sold underpowered and this gave them a reputation of slow drying times. Since the late 70's, some manufacturers size them to give the fastest drying times possible. Because of this, most hardwoods and some softwoods can now be damaged and the method of operating the equipment becomes responsible for the quality of the lumber and the cost of energy.

To operate dehumidifiers efficiently, we must evaluate what the lumber needs and what the equipment needs in order to obtain the best results.

The quality of the lumber dried by dehumidification comes from the low temperatures at which it is dried. Since lumber is stronger at low temperatures, it can resist the shrinkage forces better, thus producing less checks, warps, bows, crooks, etc.

Refrigeration equipment loses efficiency if it works in a broad range of temperatures. Wet bulb temperature variations affect directly the performance of the equipment, so a narrow range of variation in wet bulb conditions will increase the amount of water extracted by a given H.P., reducing the energy cost.

With these requirements in mind, let's see if it is possible to efficiently operate a dehumidifier with a recorder-controller. Since this usually involves a step schedule, fixed conditions of wet bulb and dry bulb are set. Because the heat pump constantly produces a small amount of excess heat, to maintain a fixed dry bulb condition, venting must occur. This is not desirable since that energy is lost, and when the dry bulb must be increased, a large amount of heat is needed instantaneously to obtain the desired condition.

The heat pump cannot produce this heat instantaneously, so expensive auxiliary heating is needed to increase the dry bulb. If the temperature was increased gradually, then, the heat produced by the heat pump could be used, eliminating the use of auxiliary heating, which substantially lowers the energy cost. The wet bulb is also changed by steps and this does not favor efficient water extraction, since the evaporator can only operate efficiently in a small range of wet bulb temperature. Decreasing the air volume over the evaporator does help, but not significantly. Since efficiency decreases, to maintain the depression, venting will often be needed and, again, an instantaneous energy demand will be created to heat the make-up air, bringing the expensive auxiliary heat on line once more to maintain set conditions. As you can see, step conditions are unfavorable toward achieving low energy costs.

Instead of improving their water extraction capabilities at low relative humidity, some manufacturers now raise the operating temperature of the equipment. As we noted at the beginning, dehumidifiers produce a high quality of lumber because of the low temperature at which they can dry the lumber. If dehumidifiers follow a conventional step schedule, the lumber quality will not be better than in a conventional kiln. Once more, we defy the purpose since shrinkage will be increased and quality will be affected.

Advertisement for dehumidifiers claims the buildings can be made of wood, metal, etc., which lowers capital cost. If temperatures are increased to 180°F, then a much more expensive, less insulated aluminum kiln building must be used, or else the wood or prefab metal building will deteriorate very rapidly due to the high vapor pressures and corrosive properties of the condensates of the walls and ceiling. Having less insulation, a conventional kiln building, even new, will have to see its insulation upgraded to R20 from the outside, again adding more cost to the installation.

Because of their low HP when they were first introduced, the equipment was working 100% of the time. With the introduction of larger heat pumps control methods had to be devised. How then should we operate a dehumidifier?

One method is to use a fixed wet bulb as low as possible to keep the lumber strong. Then, gradually increase the dry bulb temperature with the help of the heat pump. Then, only one wet bulb thermostat is needed to control the equipment (since it is fixed) and a cycling on/off timer on the compressor will easily control the drying rate of the lumber. This method is simple for the operator, the lumber is as strong as possible for maximum quality, and the equipment functions at its maximum efficiency, thus the minimum energy cost. Those are the basic reasons to purchase a heat pump dehumidifier in the first place!

Using this method is so efficient that, if the building is well insulated, not only will the dry bulb rise without the help of auxiliary heating, but the wet bulb will also tend to rise. Since maximum water extraction occurs in a narrow range of wet bulb temperature, this excess heat, or what is left after rising the temperature inside the kiln, can be vented and with it the water it contains. Instead of using auxiliary heat, only the excess heat from the heat pump is used to increase the temperature inside the kiln, and the venting is not used to create a depression, but only to maintain a fixed wet bulb temperature.

The second method involves using a control to maintain the compressor at full load. To do this, one must be drying softwoods that cannot be damaged, or in other words, where the lumber can release more water than the dehumidifier can absorb. This method increases water extraction by 5 to 10% and does not need the intervention of the operator. When the motor reaches full load, which is usually caused by higher than desired wet bulb condition, a power vent is activated to lower the temperature inside the drying chamber. When the excess heat is vented, it also carries moisture from the chamber to the outside, which helps the drying rate. Once the motor is back at 97% of its full load, the venting stops. This maintains the equipment at its maximum water extraction rate.

As you can see, steps controls are definitely not the way to operate the dehumidifier efficiently, and other ways of control have already been used successfully and are much more efficient, using less energy, maintaining the equipment at maximum water extraction while producing the highest quality of lumber possible.

Regarding progress of the equipment, improvements on water extraction per HP is now very limited since the theoretical maximums have almost been reached.

The next developments in dehumidifiers will be to look at alternate ways of driving the compressors. Already a heat pump driven either by a natural gas turbine or a reciprocal engine is on the drawing board. With some luck, one should be operating at a major lumber company on the West coast within six to seven months.

This new approach is aimed mainly at large softwood producers where limited electrical power is available or where the average cost per kilowatt hour exceeds 0.06¢. Compared with a normal gas fired kiln, these engines will cut gas requirement by 2.5 times per 1,000 board feet.

As you can realize, after the major impact on the hardwood drying industries, many softwoods producers are increasingly considering dehumidification since raw material prices, and yield, combined with quality are now becoming as important, if not more, than production. Low energy costs, high quality and ease of operation and maintenance are the reasons why we are now seeing more heat pumps in operation on the West coast. With the involvement of the major lumber companies, dehumidification has progressed enormously in the last five years, and future refinements will increase the appeal of dehumidification as an alternate to conventional kilns, especially on the West coast.