Technology Profile

Value to Wood

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Lumber Drying – Choosing the System That Best Suits Your Needs

Introduction

Whether you are drying 2 x 4 studs or high-quality hard maple for furniture stock, the range of available kiln systems has grown considerably over the past few years. Anyone considering the addition of new drying equipment would be well advised to consider all the options before making a final decision. Some drying systems offer the ability to dry products that were previously impossible to dry properly, or to achieve unprecedented product quality levels. Without considering all options up front, you could end up selecting a system that limits your ability to respond to current or future market opportunities.

Considerations

Selecting the right drying system is even more important for operations which handle specialty products. Generally speaking, specialty products have a higher value than other mill products and have higher drying quality requirements. Another consideration for mills in this line of business is the need to be able to change product lines to meet new market opportunities. This requires that all parts of the operation, including lumber drying, be flexible enough to facilitate re-engineering for the production of new products.

A lot of information must be gathered before you start requesting supplier proposals. The most important consideration is the required quality of the final dried product. This includes all the factors that can affect the performance of a piece of wood in service: final moisture content (MC), moisture uniformity, colour, stress condition, flatness, etc. Once you have determined the level of quality desired for the final product, it is much easier to identify systems that are capable of delivering these requirements. By focusing only on the systems that can meet the level of quality required, you will ensure that you are comparing similar and competing systems when making your final selection.

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Kiln Choices

Heat-and-vent kilns

Heat-and-vent (conventional) dry kilns are the most widely used in lumber drying operations. The majority of kilns in service and currently being sold fall into this broad category. The term "heat-and-vent" aptly describes how these kilns operate. Heat provides the energy to dry the material and venting is regulated to exhaust the moisture extracted from the wood and to control relative humidity levels in the chamber. The kilns that comprise this category feature a broad range of equipment options and can be further sub-divided by feature.

- Operating Temperature
  - Low temperature (generally less than 50°C)
  - Conventional temperature (max. temperature approx. 90°C)
  - High temperature (max. temperature over 100°C)
- Heating System
  - Hot water
  - Steam (low or high pressure)
  - Hot oil
  - Direct-fired
  - In-direct-fired
- Energy Sources
  - Fossil fuels
  - Wood residue
- Loading Arrangement
  - Track loaded
  - Package loaded (also called side-loading)
- Options
  - Steam or water sprays for humidification
  - Variable air flow

Capital investment requirements vary considerably depending to a large extent, on the energy system selected for the kiln. The lowest overall capital investment can be expected with a direct-fired burner, but such a system will require extra supervision at the kiln. On the other hand, a steam system will necessitate extra capital and may require specialized personnel to operate. Wood residue-burning systems may have low fuel costs but are the most expensive from an initial investment point of view. The choice of the optimal energy system depends on many site-specific factors.

Dehumidification kiln

The main advantage associated with dehumidification is the energy saving achieved by using a heat pump. Instead of exhausting hot humid air (like a heat-and-vent kiln), this type of kiln recaptures the heat of vaporization by condensing the air on the cool coils of a heat pump. The energy is captured by the refrigerant system and transferred back to the air stream as dry heat to elevate its temperature. Since their introduction into North America in the late 70's, dehumidification kilns have become widely accepted and offer greater diversity in their operating capacities.

- Operating temperatures (limited by the heat pump and refrigerant used)
  - Low temperature (up to approx. 45°C)
  - Medium temperature (up to approx. 65°C)
  - High temperature (experimental stage)
- Energy sources
  - Mostly electric
  - Supplementary heat from various sources
- Options
  - Steam or water sprays for humidification
  - Variable air flow

Vacuum Kilns

Vacuum kilns dry lumber in a sealed chamber with the drying environment maintained below atmospheric pressure. When drying in such conditions, the lower boiling point of water and greater pressure differentials created between the core and surface of the wood result in much faster drying times. There is a tremendous amount of variability in drying time, depending on the specific type of vacuum kiln, but most achieve drying times that are a small fraction (1/4 to 1/20th) of the time required in a conventional kiln. There are also some advantages from drying wood in an oxygen-free (or oxygen-reduced) atmosphere. Specifically, many of the wood staining mechanisms are partially or fully blocked. The main differentiating feature between vacuum kilns is the manner in which the wood is heated.

- Wood Heating Mechanism
  - Partial atmosphere, superheated steam (SSV)
  - Radio-frequency field used to heat solid stack (RFV)
  - Cycling between heating at atmospheric pressure and drying under vacuum
  - Wood in direct contact with heated platens
- Energy Sources
  - Mostly electric
  - Some offer potential to use other energy sources for heat supply (i.e, fossil fuels, wood residue)
- Options
  - Compressive loading for warp control
  - Steam or water sprays for humidification

Kiln Control

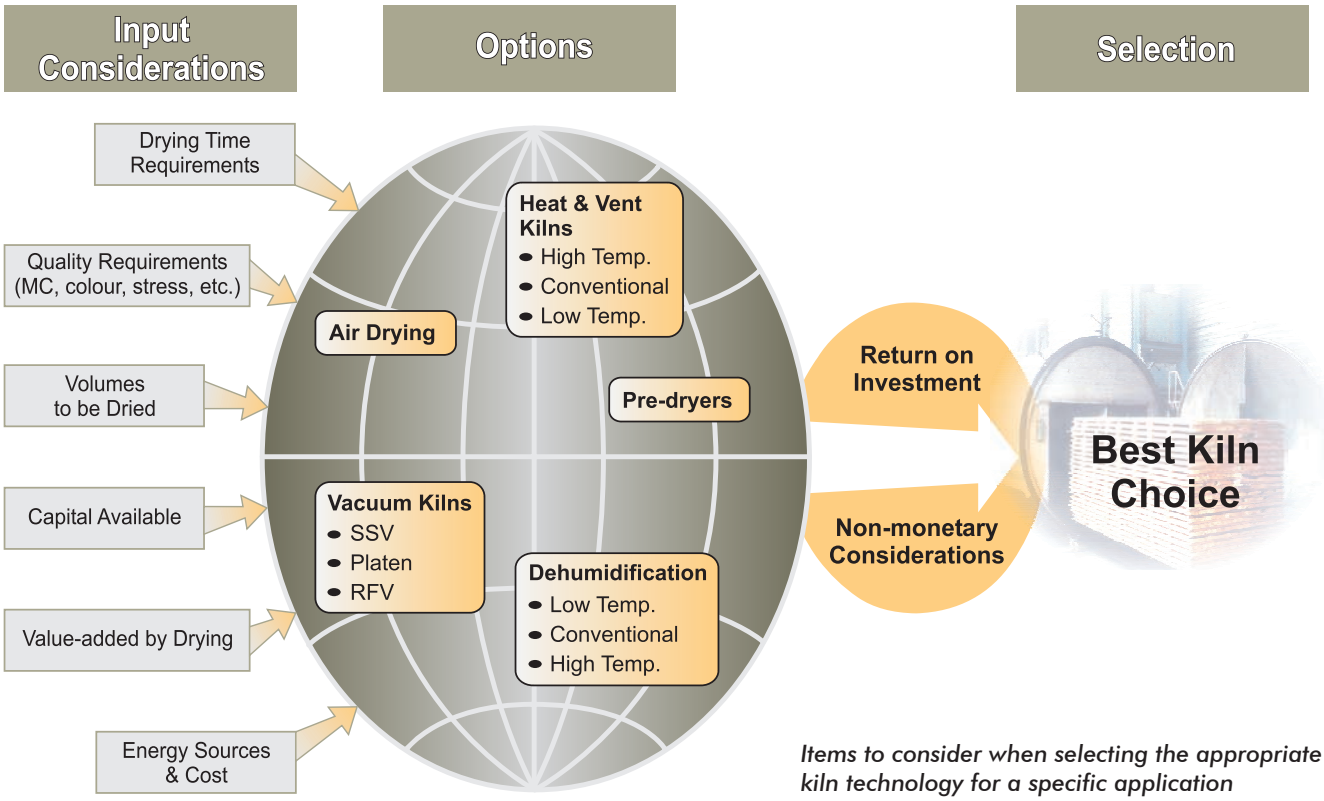
Regardless of the type of drying system chosen, a wide range of kiln control options are available. These options fall under two broad categories: those that are based on controlling the conditions relative to pre-set, time-based schedules, and those that set the conditions based on estimates of the wood's moisture content. Prices vary considerably, depending on the level of automation desired.

Other Options

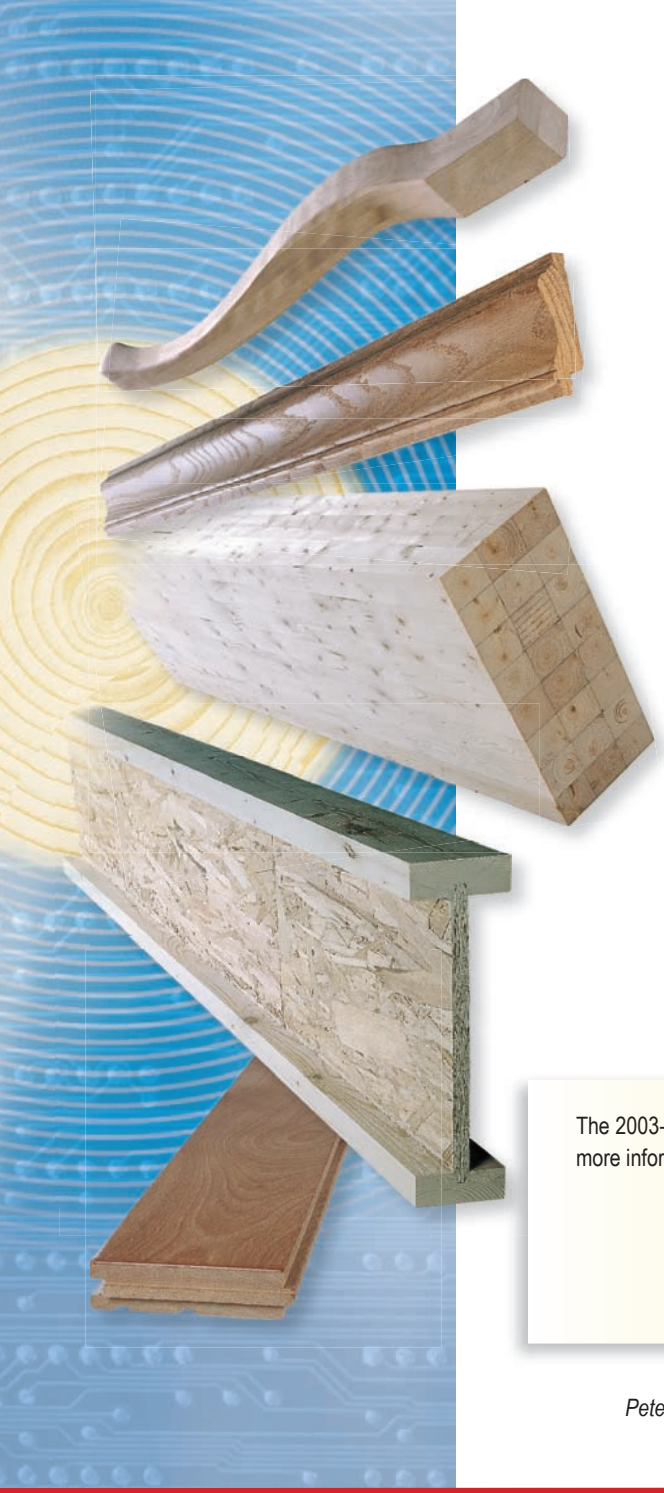
Air drying is still a viable alternative for some operations. However, due to the uncertainties with respect to drying time and final product quality, air drying systems are generally not considered when dealing with high-value products. Predryers are large volume drying chambers designed to supplement the drying capacity of an operation. Wood is dried down to about the fibre saturation point (25 to 30% MC) at a low temperature (usually less than 40°C) before final drying in a faster drying system. Such systems help preserve product quality but only work well in situations involving large volumes of similar material.

Where to Start

The flow chart below provides some detail on the input considerations that must be taken into account when considering the acquisition of a drying system. Start by listing your data for the items listed on the left side of the diagram. This will give you a basis to discuss your operation with potential kiln suppliers. Identify which kiln types can potentially do the job you have in mind and request price estimates. Keep in mind that most kiln types can dry lumber to the required level of quality provided they are fitted with the right options and operated correctly. On this basis, the final decision on kiln type is usually dictated by the economics of the specific application. With this in mind, it is important to ensure that you have accurate data



Items to consider when selecting the appropriate kiln technology for a specific application



on expected drying times, capital costs, energy costs, and other operating costs. In some situations, non-monetary considerations may influence the final decision. One example might be access to certain markets based on a brighter colour of the wood achieved in vacuum drying.

Environmental issues do not currently play a role in kiln selection in Canada, however that may change. With regard to the energy sources used, the use of wood residue or fossil fuels result in different repercussions. With regard to kiln emissions, certain systems (such as dehumidification and vacuum) lend themselves well to containment and treatment of all emissions.

Conclusion

Forintek staff can provide more detail on all of the items discussed in this Profile or assist you with a site-specific review of your drying options. When drying high-value products, it is prudent to take some time to ensure that you select the drying system best suited to your current and expected future needs.

The 2003-2004 ***Value to Wood*** research program includes various projects related to lumber drying. For more information, visit www.valuetowood.ca (Research and Development).

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*This **Technology Profile** has been edited by*
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*Ce **Profil technologique** est également disponible en français.*

Value to Wood

As part of the ***Value to Wood*** program, funded by Natural Resources Canada, Forintek's Industry Advisors are providing technical services to value-added wood product manufacturers in all regions of Canada. If you need information on any technical issue related to wood product manufacturing, you can:

- Send a request via *valuetowood.ca* (Help Desk).
- Contact a *Value to Wood* co-ordinator at one of the following locations:

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