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KILN DRYING LUMBER TRENDS AND RELATED MOISTURE ISSUES

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The moisture content of lumber before and after treatment is a concern for producers and end users of preservative-treated wood. The producer is concerned with attaining an initial moisture content that will not hinder the uptake of water-borne preservatives. The end user is mostly concerned with obtaining wood at a moisture content that will minimize problems due to shrinkage and warpage in service. This presentation was prepared to cover four main subject areas with regard to lumber drying:

- Basic principles of lumber drying
- Drying equipment
- Drying procedures
- Pre and post-drying of treated wood

There are many reasons why solid-wood must be dried before end use, but the four most relevant reasons with regard to treated wood are:

- To provide a dimensionally stable material which can be cut or turned to exact dimensions
- To eliminate warping, splitting and checking of products in use
- To prepare for future treatment
- To reduce the weight of lumber and thereby minimize shipping and handling costs

The most important consideration in designing a kiln facility or deciding how to operate a kiln is to define the drying objectives for the final product. This entails developing a list of specifications for the final moisture content (MC) properties and physical quality required in the final product. For example, if you are drying 2-inch dimension lumber, a fairly basic kiln operated on time schedules should suffice. On the other hand, if you are drying hardwood lumber that is to be used in furniture construction, a kiln with additional components will be required and the method of operating it will be quite different. With regard to moisture content you will need to be able to specify the following:

- What average MC is required
- What variation around the average is acceptable
- What is the level of tolerance with regard to wet pockets
- What level of MC uniformity is required throughout the cross section

With regard to physical quality of the lumber you will need to be able to state the level of tolerance toward various drying defects such as warpage, checking, collapse, and stain. All of these aspects of final MC and lumber quality will need to be determined through close liaison with the users of the dried wood whether they be subsequent manufacturing operations in your mill, a purchaser who will further manufacture the material, or the end user of the product.

As in wood treating, a good understanding of wood structure and anatomy is required in order to dry lumber properly. In addition, the basic principles of wood moisture relations need to be understood. These topics are all well covered in numerous dry kiln operator manuals including; 1. Kiln Operator's Manual for Eastern Canada (Cech and Pfaff, 1980), 2. Kiln Operator's Handbook for Western Canada (Mackay and Oliveira, 1989), and 3. U.S. Dry Kiln Operator's Manual (Simpson, 1991).

Shrinkage is either directly or indirectly the cause of a number of wood-drying defects. Fast drying at the ends or along the surface of a board will cause splits or checks to develop. Splits are the result of drying one portion of the board well below the fibre saturation point and initiating shrinkage while nearby locations are still above it. Warpage is the result of differential shrinkage between one face or edge of a board versus the opposing face or edge. Differential shrinkage may result from different grain directions on opposing faces or be the result of the presence of juvenile wood or reaction wood. These "non-normal" wood fibres shrink considerably more in the longitudinal direction and are often the cause of crook, twist, or bow in dried lumber.

Collapse is a drying defect that tends to occur more frequently when drying lumber that has been treated with a water-borne preservative. In untreated, green wood it typically develops in low-density woods with a very high initial moisture content. The high levels of fluid added to wood during the treatment process is the reason for the higher incidence of this defect in treated wood. Collapse occurs at the very early stages of drying and can be avoided or minimised by incorporating a slow initial drying step. This could be a lower temperature, higher humidity step at the start of the kiln drying cycle or an air-drying treatment before placing the material in the kiln. Another possible reason for the increased incidence of collapse in treated wood is the weakening effect that some preservatives may have on wood fibre. Aside from collapse, there are no other inherent reasons why treated wood should develop more or less defects during drying than untreated wood.

All major types of drying systems could be applied to the drying of treated wood. This includes conventional (heat and vent), dehumidification, and vacuum drying systems. As with any intended application, it is the site-specific economic parameters that will determine the equipment best suited to the job but there are some general statements that can be made. For bulk drying of commodity items such as construction grade lumber, a heat and vent kiln with a residue or fossil-fueled burner will likely be the most economical alternative. As product value rises and/or the need to preserve quality increases, other drying systems should considered.

Regardless of the type of drying system chosen, there are some considerations which should be kept in mind when specifying the equipment. Most water-borne preservatives increase the potential for oxidation of metal surfaces. Therefore, wherever possible specify components made from non-corrosive metals such as aluminum or stainless steel. Depending on the type of preservative being used, even aluminum may not be a good choice. This will increase the initial cost of the kiln but will ensure a good service life with minimal maintenance.

A second consideration in specifying a kiln is the quantity of liquid that must be removed during the drying process. The initial drying of treated lumber will quickly release large quantities of water in the form of water vapour which must be removed from the system. Most standard kilns are not designed to handle such a fast drying rate. If the system does not have the capacity to remove water at the same rate it exits the wood, relative humidity will build up in the drying chamber and drying times will be extended. It is recommended that this topic be raised with any potential kiln supplier and any necessary changes made. It is easier to make these changes at the design stage than after the fact. If you are using an existing kiln, you will soon realise if this is a problem if you cannot maintain the set-point conditions at the early stages. If this is the case, you will need to install additional vents on a heat-and-vent kiln. On dehumidification or vacuum systems it is much more difficult and costly to install additional moisture extraction capacity.

In heat and vent or dehumidification kilns, drying time and kiln performance can be improved by using a high-level of airflow. Typically, this will be in the same range as recommended for drying of green, softwood lumber. At temperatures up to 180° F. (82° C.), an exiting airflow of 600 to 800 feet per minute (fpm) is recommended. At higher temperatures an airflow level of 800 to 1200 fpm is recommended. A consideration in specifying the airflow is the width of the load. In general, the wider the load, the greater the demand for a high airflow.

Air drying is a valid option for drying of treated lumber. If done properly, some very good drying results can be attained in many areas of the country. There are some obvious seasonal limitations but 8 to 9 months of good drying can be achieved in many regions. The following points should be kept in mind when setting up an air drying yard for treated lumber:

- Keep lots of space between packages i.e. a minimum of 1 to 2-feet between adjacent packages
- Place no more than 5 to 7 packages (based on 4-foot width) between roadways
- Keep bottom packages well up from the ground level (ideally 12 to 18-9inches above the ground)
- Situate and orient the yard in a manner to take full advantage of prevailing winds
- Use pile covers to protect upper packages from sun and rain damage

Following these points will help achieve the fastest and best drying results for your region. Other than in humid maritime regions, you should be able to achieve a final moisture content of 12% or less in a good air-drying yard.

Lumber piling is as critical when drying treated lumber as it is in drying green lumber. For heat and vent or dehumidification drying, the wood should be placed on stickers with a minimum thickness of ¾inch (19 mm). These stickers should be placed no more than 2-feet apart for 2-inch softwood lumber and must be well aligned vertically. Similarly, it is important that supporting bunks used between packages be well aligned and of uniform thickness. All of the basics of lumber piling are well covered in the kiln manuals referenced earlier.

One of the most difficult aspects of any drying operation is the determination of when the targeted final moisture content has been achieved. Moisture meters are used extensively for this purpose when drying commodity grade softwood lumber. These instruments are also the preferred tool for evaluating final MC in treated lumber however there are some unknowns to be addressed. There is very little information on the effect of wood preservatives on meter readings. This is true for both DC-resistance type meters and RF-based (dielectric) type meters. It is believed that both meter types will provide a rough indication of MC in treated wood. Some research on the effect of preservatives on meter readings is required before more reliable measurements can be obtained.

Whether you are drying green lumber to prepare it for treatment or treated lumber to prepare it for the end user, all of the basics of lumber drying need to be understood. Drying schedules exist (in the literature) for green lumber, however, there are no such "textbook" schedules for the re-drying of treated lumber. As in many softwood drying operations, the drying schedules tend to be developed over time and are designed to respond to the characteristics of the material being dried and the specific kilns being used. For this reason, there is no substitute for an experienced and knowledgeable kiln operator. To assist in the area of operator training, Forintek offers a number of services including kiln operator courses, in-house training programs, kiln manuals, a correspondence course, and a computer-based training package.

References

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