process HEATING

FOR MANUFACTURING ENGINEERS WHO USE HEAT PROCESSING EQUIPMENT AND SUPPLIES.

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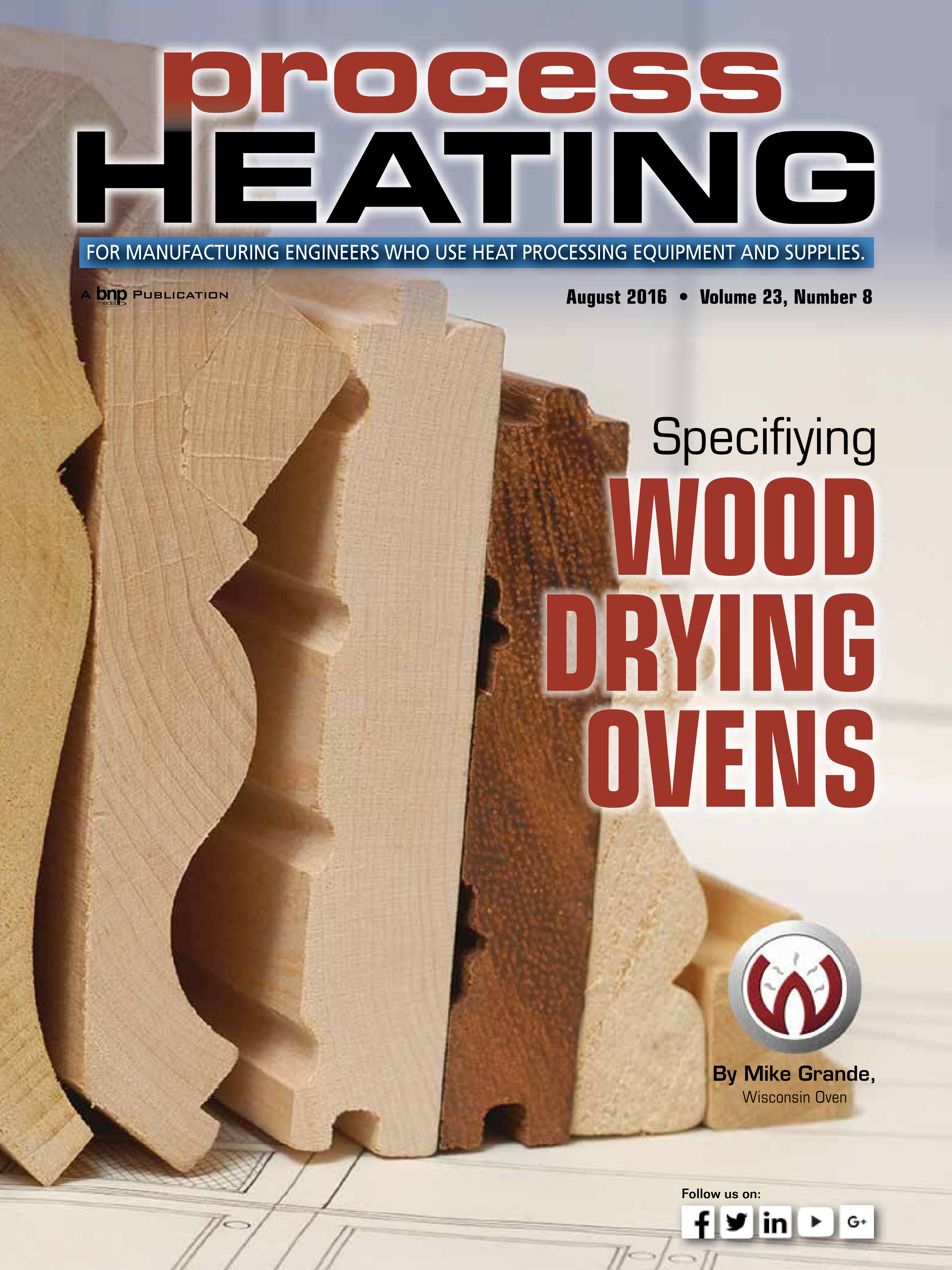

Specifiying WOOD DRYING OVENS

By Mike Grande,
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Ovens

Specifying WOOD DRYING OVENS

Coating and drying the finishes on wood and cement-board siding, moldings and other finish-carpentry trim components prior to installation helps ensure a long life.

By Mike Grande,
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Manufacturers of wood and cement-board trim, siding and other construction materials find it beneficial to prefinish their boards prior to installation. This provides more consistent, uniform coating results and is mandated by the paint manufacturers in order to offer an extended warranty.

Prefinishing consists of applying a paint or primer at the factory rather than after installation at the construction site. Prefinishing requires a wood drying system, consisting of a coater, conveying equipment and a drying oven. The wood drying system can process large panels of wood or cement board, up to 4 by 8 feet, or long boards up to 8 inches wide and 24 feet long.

The wood or cement boards are manually loaded onto a powered-roller conveyor that carries them lengthwise through the coater. The coater can be a roll, vacuum, spray type or curtain type. The boards travel through the coater at speeds of 50 to 200 feet per minute. The coating technology used depends on the coating, the characteristics of the boards being processed, and which sides of the boards are to be coated. The coating thickness varies, but 1 to 10 mil thicknesses are common.

Applying the Coating

Roll coaters (figure 1) utilize an applicator roller covered with rubber to transfer the coating to the boards. A metering roller — sometimes called a doctor — is used to regulate the amount of coating applied and thereby the coating thickness. The metering roller is moved further away from the applicator roll to increase the coating thickness and closer to decrease it. An alternative design uses a metering blade in lieu of a roll. Roll coaters can only be used on flat boards without contours or protrusions. Line speeds vary from 30 to 100 feet per minute, and typical coating thickness is approximately 1 mil.

Vacuum coaters work by pumping the coating onto the boards and drawing it off under a controlled vacuum. The vacuum is maintained in the chamber through the use of inlet and outlet cutouts or templates that form a partial seal between the chamber and the boards as they enter and exit. The coating can be applied to all sides of the boards. Vacuum coaters can accommodate three-dimensional shapes such as trim or molding, where the boards have elevated contours, provided the profiles are continuous along the full length. The film thickness is controlled through adjustment of the flow through the pump.

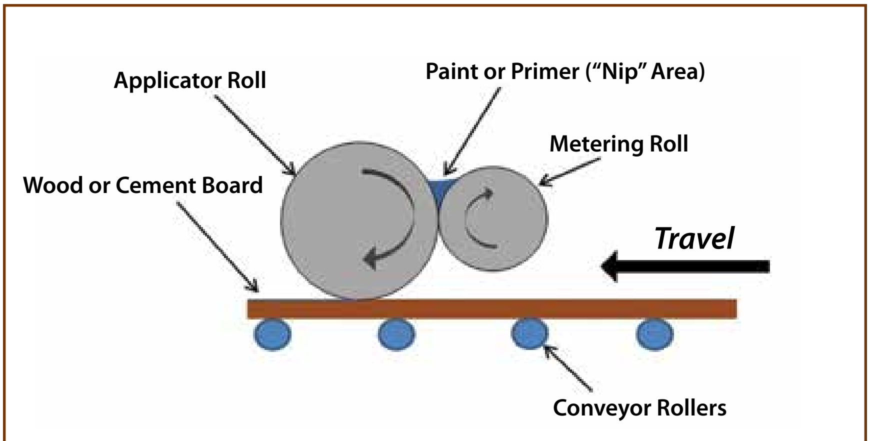

FIGURE 1. Roll coaters utilize an applicator roller covered with rubber to transfer the coating to the boards. A metering roller — sometimes called a doctor — is used to regulate the amount of coating applied and thereby the coating thickness.

Vacuum coaters can apply coatings 0.8 to 4 mils thick at speeds up to 600 feet per minute. The higher line speeds are possible only with lower viscosity coatings.

Spray coating uses conventional spraying technology to coat the boards as they are carried on the conveyor (figure 2). It has the advantage of being able to coat all sides, and it can accommodate raised shapes and profiles on the boards. Depending on the type of spray system and the coating viscosity, the coating thickness can range from 5 to 10 mil.

Curtain coaters pump the paint or primer through a slot nozzle at a controlled rate, after which it falls by gravity onto the boards traveling beneath. The speed of the board conveyor and the pump delivery rate determine the coating thickness. Curtain coaters generally are used to apply thicker coatings.

Prior to drying the coating on the boards, they are transferred onto the oven conveyor using a 90° pop-up-style cross transfer. The preferred style of cross transfer uses a multiple-strand chain conveyor mounted to a vertical lift system. As each board passes a sensor, the chain conveyor rises, lifts the board off the roller conveyor, conveys it sideways above the oven chain conveyor, and sets it down onto the oven conveyor. The boards are now traveling sideways, which reduces the conveyor speed to approximately four to eight feet per minute, significantly reducing the oven length necessary.

Flash-Off and Drying

After the boards are placed onto the oven chain conveyor by the cross-transfer system, they go through a flash-off stage. During flash-off, the boards begin to dry, and the coating releases a portion of the moisture or solvent passively prior to entering the oven. The flash-off period is important because it prevents bubbling or popping that can occur if the paint is force-dried immediately after coating. The flash-off can be open, or it can utilize an exhaust hood to remove solvent fumes. Sometimes, fans are added to the flash-off to encourage evaporation.

After flash-off, the boards enter the drying oven (dryer). The wood dryer oven uses high velocity convection air at temperatures of 180 to 350°F (82 to 177°C) to impinge on the boards, quickly drying the coating. Heated air is delivered through a fully enclosed, pressurized supply duct located above the boards and below if necessary. The ducts have tapered nozzles that impinge the air directly onto the surface of the boards while traveling on the chain conveyor. Because the air is traveling at 4,000 to 5,000 feet per minute when exiting the nozzles, it creates turbulence on the surface of the coating, which wipes away the boundary layer of moisture (or solvent) that would otherwise form on the coating surface. This boundary layer must be continuously removed; otherwise, it will retard drying.

The drying oven typically is heated by natural gas although propane gas or electric heat can be used. Forced convection may be favored over infrared technology because it uses less energy. Also, forced convection provides consistent drying even if the line speed or product-mix changes. Forced convection technology allows drying of water-based and solvent-based coatings of all thicknesses.

For longer dryers, multiple heating zones are used. Each zone has its own in-

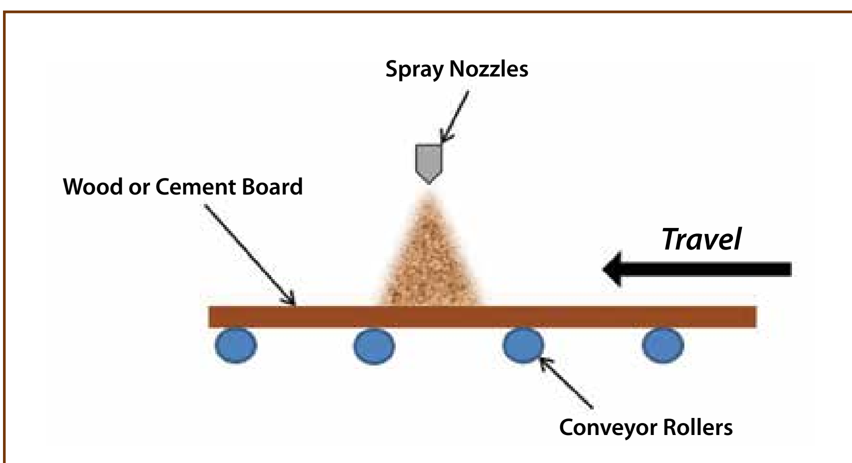

FIGURE 2. Spray coating uses conventional spraying technology to coat the boards as they are carried on the conveyor.

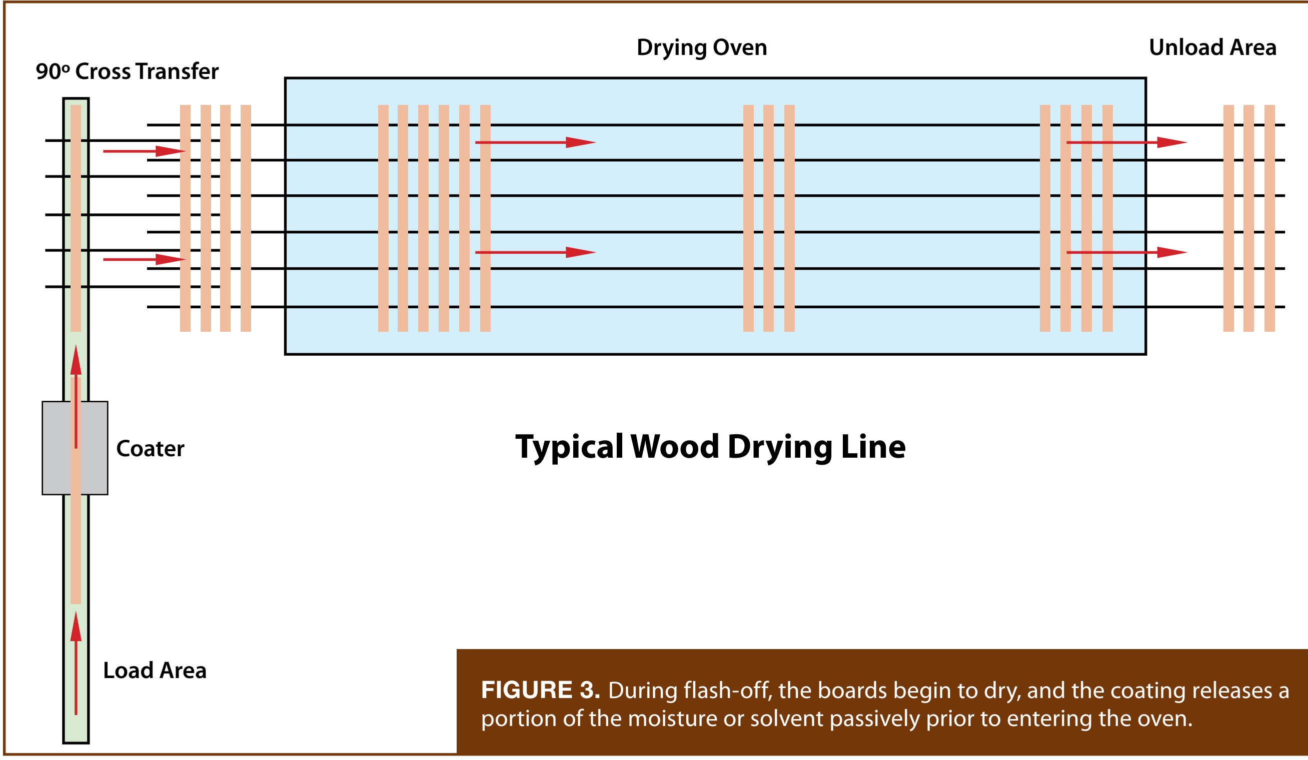

FIGURE 3. During flash-off, the boards begin to dry, and the coating releases a portion of the moisture or solvent passively prior to entering the oven.

dependent heating and recirculation system as well as its own separate temperature control. This allows the first zone to be set at a lower temperature to slowly start the drying process. The subsequent zones can be set at a higher temperature to quickly complete the drying process and ensure the coating reaches the specified temperature.

If only the top of the boards are coated, the dryer can be designed to deliver air in a top-down airflow configuration. If both the top and bottom of the boards are coated, the dryer will have both top and bottom ducts. The dryer is designed as a fully enclosed unit and typically includes 4" of insulation, with a sheet-metal interior and exterior to contain the insulation. In addition to the heating and air recirculation system, an exhaust blower is included to remove the moisture (or solvents) and the products of combustion generated by the burner.

The wood dryer utilizes a multiple-strand chain conveyor (figure 4) to carry the boards through the heating chamber. The chains are located on 12" to 24" centers across the width, so each board only makes contact with the chains at two to four places. This reduced contact between the boards, and the conveyor minimizes blockage of the bottom supply air when a bottom-up airflow pattern is used. It also reduces marring or disturbing of the coating on the bottom of the boards in those cases when the boards are coated on the bottom. The chain conveyor typically includes replaceable wear strips under the chains to provide long life and ease of service. After exiting the oven, an extended length of conveyor is provided to cool the boards, or a cooling system can be provided.

Optional features such as takeaway conveyors, fume-capture hoods, Ethernet communication, low NO_x burners and PLC integration can augment the drying system. The wood dryer can be designed with the heating/recirculation system on the top of the equipment, reducing the floorspace requirements of the system.

Post-Drying Operations

After exiting the oven, it is necessary to cool the boards. If the boards exit the system too hot, the coating will remain tacky, and the boards will stick together when stacked. Failing to cool the boards also can lead to them sticking to the packaging when wrapped for shipment.

Cooling. Cooling can sometimes be achieved naturally as the boards are carried on the exit conveyor after leaving the oven. The conveyor can be designed with extra length to provide sufficient cooling time. When the time available on the exit conveyor is not sufficient to cool the boards, simple cooling fans can be mounted above the exit conveyor to provide forced cooling. For thicker boards running through the oven at higher temperatures, the boards have a greater mass

FIGURE 4. Some wood-drying ovens use a multiple-strand chain conveyor system.

and exit the oven at a higher temperature. In this case, cooling fans may not be sufficient to bring the boards down to the proper temperature, and a high capacity cooling system is required. High capacity cooling systems use several large fans (four or five 50-hp fans, for example) to deliver the cooling air through a duct system using high velocity nozzles. The air impinges onto the boards at velocities of 4,000 to 6,000 feet per minute.

It is important to note that an optimized drying oven design will result in reduced board temperatures exiting the oven, thereby reducing the board cooling requirements. This is achieved by delivering the heated air to the boards at higher velocities through a carefully engineered oven-duct and air-nozzle arrangement. This design allows the oven to be operated at a reduced temperature and still achieve satisfactory drying of the boards. In contrast, a poorly designed oven will require a higher operating temperature to dry the boards, resulting in higher exiting board temperatures, necessitating greater cooling capacity.

Preheating. To ensure consistent drying of paint or primer, the boards must enter the coater at a consistent temperature. In cold weather climates, this can be a problem if the boards are stored in an unheated warehouse or are delivered from a different facility by truck. In either of these cases, the boards might be too cold to ensure proper adhesion and other properties. To prevent this problem, the boards can be run through a preheat oven prior to coating. The preheat oven is similar in design to the drying oven, using heated air delivered to the top and bottom of the boards via a forced convection system. Because the requirement for preheating is weather-dependent, the preheat oven is turned off when not required, and the boards are carried through the system on the oven conveyor, making a bypass conveyor system unnecessary.

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