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Finding the CORRECT DRYER for Paper-Pulp Packaging

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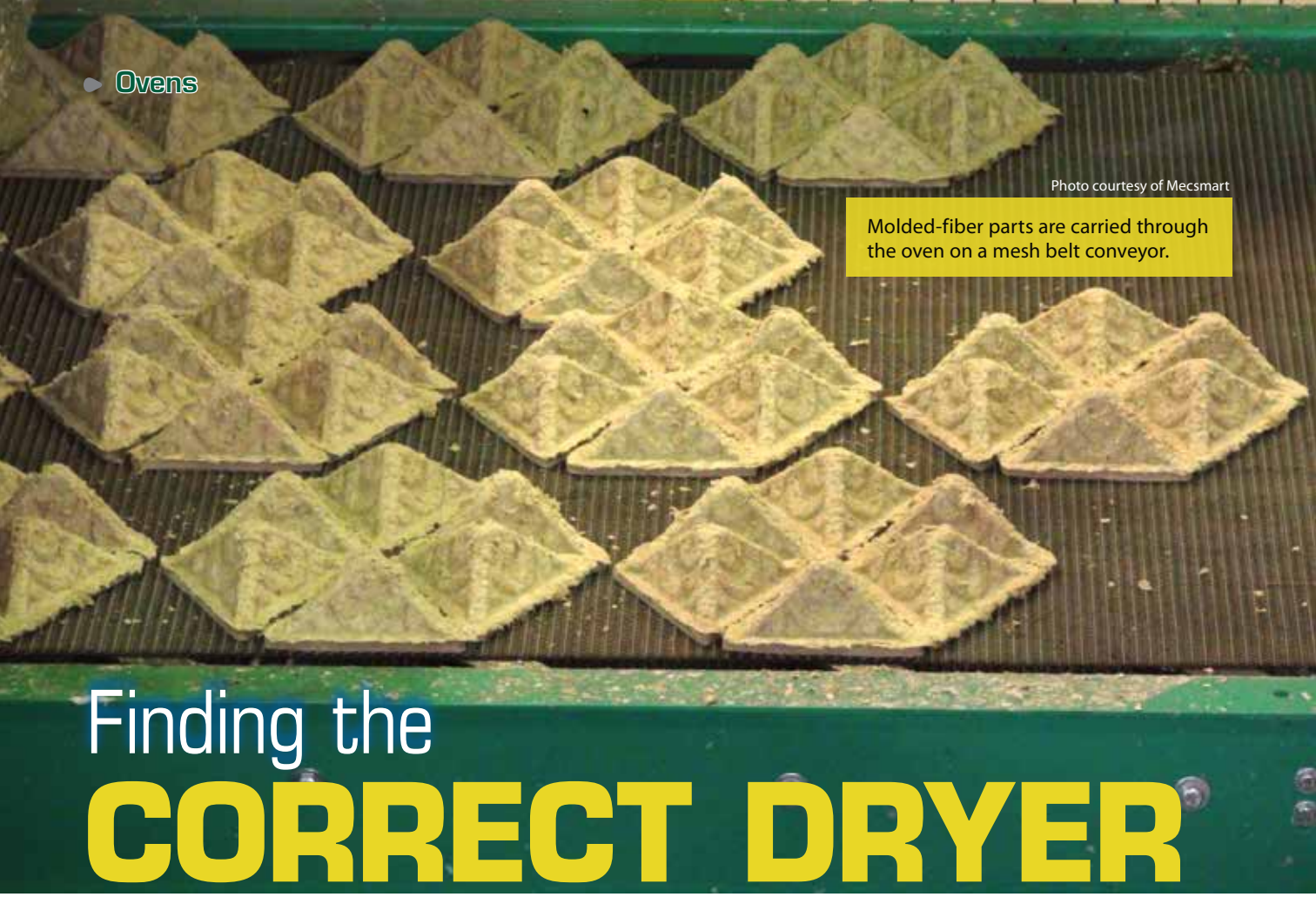

Photo courtesy of Mecsmart

Molded-fiber parts are carried through the oven on a mesh belt conveyor.

Finding the CORRECT DRYER for Paper-Pulp Packaging

Once formed, molded-fiber packaging must be dried in a hot-air convection oven with specific characteristics.

By Mike Grande,
Wisconsin Oven Corp.

Molded paper-pulp packaging material — also referred to as molded fiber — is a fast-growing, environmentally friendly segment of the packaging market. It is manufactured using recycled paper products such as paperboard, newsprint and other post-consumer and post-industrial waste. Molded paper-pulp is used to produce fast-food drink trays, egg cartons and protective packaging for consumer and industrial products as well as disposable plates, bowls, plant trays and clamshell containers, among many others.

Molded paper-pulp is an attractive alternative to foam packaging, expanded polystyrene (EPS) and vacuum-formed PET and PVC. It has gained popularity in recent years because it is made entirely from recycled materials and can be recycled again and again. The raw ingredients are simply paper and water; no binders or additives are required. No wastewater is generated in the manufacturing process because any excess water either evaporates or is returned to the system. For these reasons — and due to its landfill friendliness — paper-pulp packaging is considered a sustainable packaging material.

Molded paper-pulp packaging was invented in 1903 by Martin Keyes, who was awarded a patent for the process. In 1920, additional patents were granted for molded-pulp packaging designed for light bulbs, fruit, radio tubes and other objects. Yet, it was not until the late 1980s, with increased environmental awareness regarding consumer packaging, that the market gained a strong foothold. More recently, molded-pulp packaging with a thin plastic lining — often called "paper bottles" — has been used in wine, beer and some other drink containers.

Manufacturing Molded Paper-Pulp Packaging

The raw material (paper waste) is dumped into a vat, and warm water at 109 to 149°F (43 to 65°C) is added. The warm water swells the fibers, causing them to break apart. The mixture is stirred thoroughly until the paper fibers are unbound and become a slurry-like pulp.

The pulp is formed into the finished-

packaging shapes using custom-designed one- or two-part molds. The upper mold is lowered into the pulp mixture, and a vacuum is pulled on the rear of the mold to draw the water out while, at the same time, forcing the pulp to conform to the mold's shape. The upper mold then is removed from the vat, and air pressure is used to remove the part from the mold. When two-part molds are used, the upper mold is pressed into the lower mold, which squeezes out excess water, imparts a final shape to the part and creates a smooth finish on the bottom side.

Traditionally, paper-pulp molds have been aluminum or bronze shapes into which a multitude of small passages have been machined to provide porosity through which to draw the vacuum. A stainless steel mesh then is laid on top. More recently, 3-D printing technology is used to produce plastic molds that provide certain advantages — among them, reduced lead time and design flexibility. No matter the type of mold, the suction from the vacuum and the pressure generated by the mold-halves bind the fibers together.

After forming, the wet parts contain approximately 70 to 75 percent water and 25 to 30 percent fiber by weight, and they must be dried. The molded parts are placed onto a conveyor and passed through a hot-air convection drying oven to remove the moisture. After leaving the oven, the final product contains 6 to 8 percent moisture, which is required to prevent breakdown

Molded-fiber parts are removed from the molding machine and placed on the oven conveyor.

and flaking of the material.

After drying, the molded pulp products are trimmed if necessary and can undergo additional processing as required. For example, they can be made waterproof with a spray or dip coating of wax, or printing can be added.

Drying Ovens for Paper-Pulp Packaging

After the shapes exit the molding process, they are passed through a hot-air convection oven or dryer. Because molded paper-pulp products usually are formed at a high production rate, a typical conveyorized paper-pulp dryer must be fairly large to provide sufficient drying time. A 5-to-7-feet wide conveyor and a length of more than 100 feet is common for these units. Typical drying times can range from 6 to 60 minutes, depending upon the thickness of the parts.

Paper-pulp drying ovens use convection technology to evaporate the moisture from the molded parts with heated air. The ovens have pressurized ducts located above (and below if necessary) the parts as they travel through the oven on a conveyor. The air is discharged from the ducts at velocities of 3,000 to 5,000 feet per hour via air nozzles that are located along the width and length of the ducts. The hot air impinges on the wet shapes, using air turbulence to remove the microscopic boundary layer of moisture that continuously forms adjacent to the surface of the shapes during evaporation. Without sufficient impingement, this boundary layer will retard further drying. Steps must be taken to ensure the air velocity is sufficient for drying but not so great as to cause the parts to move or levitate. It is common to use variable-frequency drives (VFDs) on the blower motors to prevent this.

In molded paper-pulp drying applications, it is important that the oven has sufficient heat input to evaporate the high volume of water being processed. It is not unusual, for example, for a dryer to evaporate 3,000 pounds (1,400 kg) per hour of water from molded parts, which is equivalent to 360 gallons (1,360 liters) per hour. For this reason, these ovens normally are gas fired with heat input ratings of several million BTU per hour. Further, pulp dryers usually have several zones of control, meaning the oven is divided in the direction of travel into perhaps three or four separate heating and recirculation systems. A 120-foot (36.5-meter) long oven, for example, might have four 30-foot (9.1-meter) zones, each with its own heating and recirculation system. Each individual zone can be operated at a different temperature, and it is common for the first zone — where the incoming molded parts are the wettest — to be set at a higher temperature. Progressively lower temperatures are used in each successive zone to avoid burning or overdrying the material.

Several conveyor styles are used in molded-pulp drying ovens. The most durable is a chain-edge mesh-style belt. It has two drive chains located on the edges of the conveyor, and a woven mesh belt is suspended between them. The molded parts are carried through the oven on the mesh. This design requires a higher initial investment but has good longevity. Also popular are flat wire belts and Teflon-coated fiberglass. Each style has certain advantages.

Also, it is critical that the oven has sufficient exhaust to remove the moisture-

Most pulp dryers are large, multiple-zone units. After leaving the oven, the final product contains 6 to 8 percent moisture.

This three-zone, gas-fired oven is used for drying molded-fiber packaging. In molded paper-pulp drying applications, it is important that the oven has sufficient heat input to evaporate the high volume of water being processed.

laden air from the heating chamber. If the moisture is not exhausted at a sufficient rate, the environment in the oven will become saturated and will prevent drying of the paper-pulp shapes. In addition, excess moisture can condense on the oven interior and cause rusting of the oven body.

As an energy-saving measure, the hot exhaust air from the oven can be run through a heat exchanger to preheat the water used in the pulp or elsewhere in the factory. A strategy to reduce the exhaust rate — and, therefore, gas consumption — is to include a humidity sensor to detect the moisture level in the oven. Then, the humidity sensor output is used to control the exhaust rate via a variable-frequency drive on the exhaust fan. By properly adjusting the humidity setpoint, the oven will exhaust only the volume of air required to achieve part dryness. Otherwise, the exhaust system must be adjusted to accommodate the highest production rate and will waste energy when the oven is running at lower production.

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The chain-edge mesh-style conveyor belt has two drive chains located on the edges of the conveyor. A woven-mesh belt is suspended between them, making it a durable choice for drying molded pulp-paper packaging.