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3 Industrial Processes, 3 Industrial Ovens

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3 INDUSTRIAL PROCESSES, 3 INDUSTRIAL OVENS

Plastic processing, molded pulp and paper products and foundries have special oven requirements. Tailoring an oven to its industrial application allows it to deliver precise heating.

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This article will examine how and why ovens play a crucial role in three common industrial applications: plastics, pulp and paper, and foundries.

Plastic Processing

When plastic is molded or machined, internal stresses are induced. These residual stresses can cause localized weakness, reduced resistance to wear and chemicals, and other undesirable physical properties.

To relieve these residual stresses, plastics are annealed, or stress relieved. Also referred to as tempering, annealing typically is done in a convection oven at temperatures of 180 to 300°F (82 to 149°C). This involves bringing the plastic to a temperature just above its glass transition softening temperature, holding it there for a period of time and then cooling it slowly. Plastic annealing can be done in either batch or conveyor ovens. The temperature uniformity of the oven is critical, and the temperature must be held within a tolerance of ±5 or ±10°F (2.8 to 5.5°C).

Plastic annealing ovens often use vertical conveyors that carry the parts up and then back down, reducing the footprint of the equipment. Vertical ovens operate in an indexing manner, meaning the parts are loaded on a tray that is attached to conveyor chains. The tray stops during loading and then indexes vertically, one position at a time. After reaching the top, the conveyor indexes the tray of parts back down. They can either be unloaded at the other end of the oven or carried back to the entrance for unloading. Examples of annealed plastic parts are automotive taillights, plastic housings, composite lumber and safety glasses.

Extruded plastic shapes also are annealed to remove residual stresses. During the process of extrusion, the material is compressed while passing through the die and then begins to harden immediately, remaining in a highly stressed state. This can result in cracking, warping, shrinkage or other dimensional inconsistencies. Unannealed composite plastic lumber, for example, will shrink over time, even after installation, and gaps will appear in the finished product such as an outdoor deck.

Another approach is to normalize the material when it first leaves the extruder in continuous billet form prior to additional processing. An oven is located at the exit of the extruder and normalizes the billet for a period of time – perhaps for 60 minutes at 190°F (88°C). Normalizing is similar to annealing but, because the material is already at elevated temperature when leaving the extruder, the oven merely has to maintain the plastic billet at a uniform elevated temperature, then slowly cool it, while the temperature distribution in the billet becomes even (normal). Billet normalizing is done on a continuous basis, and the ovens use a conveyor to convey the continuous billet at the same speed as it leaves the extruder.

Molded Pulp and Paper Products

Molded paper pulp products are made from recycled newsprint and other paper. Commonly, they are used as packaging and can be custom formed to fit nearly any product. Examples are fast-food drink holders, egg cartons, fruit trays, paper plates and bowls, and protective packaging for countless household and industrial products. They are popular products because it is considered environmentally sustainable. Molded paper pulp products are made from recycled paper and can be recycled again after use. Molded pulp products can be made water resistant with a coating of wax. Another approach is to use wax-imbedded raw material such as recycled fast-food ketchup cups. For many applications, molded pulp is less expensive than expanded polystyrene or other plastics and foams.

The process of manufacturing molded paper pulp products involves creating a fibrous slurry made of shredded paper and water. The slurry is thoroughly mixed until consistent and then vacuum formed in a mold made with a fine wire mesh or plastic. As the vacuum is drawn through the rear of the mold, the slurry is drawn onto the mesh and much of the water is removed through

Plastic annealing ovens often use vertical conveyors to reduce the footprint of the equipment.

the vacuum system. What remains in the mold is a final shape that is roughly 25 percent paper and 75 percent water. The shape then is dried in an oven for 20 to 60 minutes at temperatures between 300 and 450°F (149 and 232°C). After exiting the oven, the parts are complete and ready for packaging.

The ovens are usually conveyorized and have multiple zones of control. Because molded paper pulp products are produced at a high production rate, a typical conveyorized paper pulp dryer has a 5' wide conveyor and is 60 to 80' long in order to provide sufficient drying time.

In molded paper pulp drying applications, it is important that the oven have sufficient heat input to evaporate the high volume of water being processed. For this reason, these ovens are usually gas fired, with heat inputs of several million BTU per hour. It is also critical that the oven has sufficient exhaust to remove the moisture-laden air from the heating chamber. If the moisture is not exhausted at a sufficient rate, the environment in the oven will become too moist and will retard drying of the formed paper pulp shapes.

Heat recovery can help improve the energy efficiency of the process. For instance, the hot exhaust air can be run through a heat exchanger to preheat water used elsewhere in the factory. Another strategy to reduce energy use is to include a humidity sensor to sense the moisture level in the oven and use its output 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

Most of the sand core drying ovens used in foundries are conveyorized.

Molded paper pulp products are used in packaging for countless household and industrial products.

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.

Foundry Applications

Foundries use sand casting, also known as sand mold casting, which is a metal casting process, to make parts out of aluminum, steel and other metals. Examples are engine blocks, automotive steering components and transmission housings, among others.

During casting, molten metal is poured into molds made of a special sand-like material – hence the term sand casting. The metal is allowed to cool and the part is removed. More than 70 percent of all metal-casted parts are produced via a sand casting process. The process also incorporates sand cores, which are sand shapes used to produce internal cavities in the molded part.

After sand molds and cores are formed, they are coated with a refractory wash – also known as a mold wash or core wash – before being used in the casting process. The wash is a water- or solvent-based liquid or slurry suspension of zircon, magnesite talc or graphite solids. It is applied by spraying or by dunking of the mold into the wash. The wash provides a better surface finish on the casting and protects the sand in the mold from the heat and erosive action of the molten metal as it enters the mold cavity.

After the wash is applied, the molds and cores are dried in an oven prior to use in the casting process. The process evaporates the water or solvent, leaving the zircon, magnesite talc or graphite. The ovens are called sand core dryers, mold dryers or core drying ovens. They operate at 200 to 400°F (93 to 204°C) and dry the cores or molds in 10 to 30 minutes. The temperature and drying time are dependent upon the mold size, sand porosity and the efficiency of the oven delivering the heat. By designing the oven for tight temperature uniformity, high air velocity (velocities greater than 5,000 ft/min are common) and good end seals to prevent hot air loss, a lower oven temperature can be used. This results in reduced energy use and lower operating costs.

Sand molds and cores are destroyed after casting during the process of removing the molded part. As a result, a typical foundry uses a large number of them, which requires significant drying capacity. Therefore, most of the core dryers used in foundries are conveyorized, meaning they use a conveyor to carry the cores and molds through the oven. It is common for a cooler to be located after the oven to cool the sand molds for handling.

Sand core dryers use high-velocity air nozzles to improve energy efficiency by allowing a reduced oven temperature.

In conclusion, despite the needs of these various ovens, it is easy to see that selecting the proper oven for each individual application is crucial. An experienced oven manufacturer, familiar with your industry, will be able to assist you in selecting the best oven for your application.

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