PROPER CONVEYOR OVEN DESIGN

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Increases Manufacturing Productivity

These small design points can have large impacts on conveyor oven efficiency.

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As users of industrial conveyor ovens, you likely want to increase productivity by finding the best match between your manufacturing process and the oven. In pursuit of this goal, certain factors must be considered and decisions must be made if oven designers and manufacturers are to be successful in helping oven users achieve their goals. This article aims to shed light on design points that seem small but often have a large impact on oven design.

Operating Temperature Affects Oven Design

Operating temperature is an area that is often a source of unexpected adjustments. The two most common operating temperature ranges where unexpected adjustments are needed are low temperature (less than 150°F [65°C]) processes and those in the 450 to 600°F (232 to 315°C) range.

In a typical conveyor oven, the heat source will be infrared, infra-air (a combination of infrared and internal recirculating airflow), and electric or gas hot air convection. The choice of heat type is first based upon the substrate and the heat source that best matches it.

Perhaps surprising to some, low-temperature processes – less than 150°F – present challenges when selecting the heater type. In this temperature range, both infrared and gas heat sources struggle to effectively operate. Infrared heat sources do not produce infrared waves as needed to provide true infrared heat. Most gas heat source designs will struggle to operate at this low of a temperature. Typically, the operating temperature must be approximately 200°F (93°C) or higher to be a good fit for gas. Thus, electric hot air convection is almost always the preferred heat source in this temperature range.

Processes with an operating range between 450 to 600°F present a different set of challenges. While all three primary heat sources can appropriately heat at these temperatures, many common materials and parts have temperature thresholds that are also in this range. If proper design adjustments are not made for an oven operating in this temperature range, premature wear and parts failure will occur.
Oven Opening Height

Properly sizing the oven opening height is key to ensuring the heat source is the proper distance from the substrate and to providing an oven chamber that has an even temperature balance. Inherently, the taller the opening, the more challenging it is to have a truly balanced oven chamber and to heat the substrate equally.

When working to ensure that the heat source is the proper distance from the substrate, many process-specific factors must be considered. However, if this evaluation is not done, it hinders the heating or drying process and ultimately decreases productivity and efficiency.

The more noticeable impact comes in the area of increased oven price. Most manufacturers have some form of standard opening heights. If this standard opening height is a good fit for your product or substrate, costs can be minimized. However, if a different height is needed, the oven price can jump significantly. When a custom height is required, a series of other needs are triggered as well. New CAD models and prints must be created, material quantities changed and special-order parts required, to name a few.

Product Mass and Weight Influence Oven Design

The mass and weight of a product are important factors in oven design, particularly for heat input and belt selection.

For instance, suppose that a stainless steel part is preheated to 300°F (149°C) prior to a gasket being installed. Assume that the part is 8 by 8 by 8” with some contours and shape, and it weighs 10 lb. The tendency is to think that only the outside layer of the part can be heated, but the entire mass usually must be heated to ensure 300°F because the stainless steel mass acts as a heat sink. Proper design in this area is compounded by heating the part within a predetermined amount of time.

In any process heating application, the oven must be able to provide ample heat input as needed for the mass being heated. While other factors must be taken into account when determining proper heat input, the mass and weight of the part, as well as how well any particular material will accept heat (specific heat value), should be the initial considerations.

High Operating Temperature Considerations

Processes with an operating range between 450 to 600°F (232 to 315°C) present some challenges because many common materials and parts have temperature thresholds that are in this range. Common materials and parts that must be closely evaluated include:

- Belt material.
- Sheet metal.
- Electronic components that are exposed to heat (direct or residual).
- Bearings.
- Insulation.
Belt Considerations

In industrial ovens and dryers, two common types of belt material used are: fiberglass woven or wire mesh. All belt systems have a natural total weight limit. Fiber mesh belts have a lower weight capacity, typically in the area of 1 lb/ft². Stainless steel wire belts can carry much more weight, typically to about 10 lb/ft².

For a specific product, it is easy enough to determine if the total belt load exceeds the total load capacity of the belt material. The more difficult design point to work around is the area of weight distribution. Fiber belts are not designed for focused weight distribution. Though wire belts are better able to handle focused weighted points, there are still weight distribution concerns. It is possible to have a belt that can handle the total load yet wear prematurely because the links are not able to handle focused distributions of weight. Premature wear leads to early belt replacement.

The choice between fiberglass-woven or wire-mesh belts is typically a function of the belt-load capacity or of the rigidity of the belt material. While these decision factors are most common, they are not the only factors to make a large impact on the process.

One key to balanced temperature in a heating chamber is even and consistent airflow. Not only does the shape and mass of a product impact airflow, but the belt also plays a significant role. The more solid the belt, the more the airflow is restricted. The more the airflow is restricted, the more difficult it is to have balanced temperature profile in the oven chamber.

Most fundamentally, the air must have room to move around the mass of the product. For example, if a product is relatively flat but has a footprint that covers a significant portion of the belt, a belt that allows air to easily pass through it in the space between each item must be selected. The belt type must include consideration for its impedance of airflow and be considered in conjunction with process requirements for the appropriate level of truly balanced temperatures inside the oven. An additional consider-
Two common belt materials — woven fiberglass and wire mesh — are used in conveyor ovens. The structural differences between the two belt materials affect airflow and air balance within the oven.

The consistent message received from conveyor oven users is the need for increased productivity. This can be in the form of higher throughput, higher quality, decreased labor or less energy consumption. The key to achieving higher productivity via a conveyor oven is in carefully evaluating all process details and oven design points. With a quality evaluation and discussion between you and your oven company, the goal of higher productivity can be reached.

While oven concept and design can be a fairly straightforward process, it is often not as simple as it seems.

Byron Stokes is the director of sales and marketing for Hix Ovens, a company of Hix Corp., Pittsburg, Kan. For more information, call 800-835-0606 or visit www.ovens-dryers.com.

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