Specifying an Oven for Drying and Curing Processes

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Manufacturing trends have moved finishing to a just-in-time, rapid-change curing process. Find out if combining convection with an infrared booster is right for the drying or curing step in your operation.

Figure 1. The oven should have a clean, smooth insulated floor. Locating the hot air supply ductwork in the ceiling eliminates the problem of parts falling off and damaging the ductwork.

Selecting an oven for drying or curing is not as easy a task today as it was 20 years ago. Today's engineer, who is charged with upgrading the company's finishing or other curing needs, has a much larger selection from which to choose, and production needs are usually much more complex, too.

In the 1970s and 1980s, the most common type of drying/curing meth-od was the convection oven, and this style of oven matched the manufacturing style of that era. Then, companies operated with much larger inventories of parts in process and finished goods in inventory. They had the ability to set up the production process for a certain product and run only that product, or another product with almost the same curing requirements, for several shifts -- or even days at a time -- without changes.

When parts constructed out of heavier (or lighter) material were to be cured, changes to the oven temperature or conveyor line speed, or both, were needed to get the proper finish on those series of parts, which had different cure requirements. There were even cases where product curing changes were so different that separate curing lines -- and sometimes different ovens altogether -- were required to be able to finish all of the product.

Current manufacturing trends, however, usually require the manufacturer to run its factory with less inventory of parts in process and feed its various assembly lines different product at the same time. This trend has required the finishing process to evolve into a rapid-change curing process. With the introduction of programmable logic, PLC-controlled systems now can manage the entire finishing process, including curing the product, pretreatment and conveyor, along with the application equipment. Finishing lines operate in today's manufacturing environment as a just-in-time (JIT) process.

There are multiple cure styles, including convection, infrared and a combination of the two. A straight convection oven is best suited to cure parts that do not vary much in material thickness -- for example, a family of parts that vary in thickness from 18 to 14 gauge or 14 to 10 gauge. If the material thickness varies more than that, then you should vary the oven temperatures so that overcuring of thinner parts or undercuring of thicker parts does not occur.

The convection oven has been and still is the mainstay for curing today. Of course, this does not mean all convection ovens are designed specifically for your process application, and not all are designed equally. A good convection oven will meet several design standards for proper curing of finished product. It should be designed for very uniform temperatures along the conveyor path: From the operational setpoint of the oven, it should not vary more than +/-10^{o}F from the beginning to the end of the oven and +/-5^{o}F from the bottom to the of the top profile opening. The oven should have a clean and smooth insulated floor (figure 1). All the supply ductwork for delivering the heated air should be in the ceiling, which helps eliminate any problem of parts falling off and damaging the ductwork. The exhaust should be controllable so as to have a large exhaust for purging the oven at startup and then an automatic lower exhaust rate for when the oven is operational, thus reducing the energy cost to operate the oven.

Advanced Methods

Figure 2. Modern manufacturing trends demand a highly flexible curing system that can handle a range of product sizes on the same curing line. Here, a light gauge part exits the oven's infrared booster while a heavy part enters it (left). Heavier items can be run down the finishing line at the same production rate as lighter items (right).

If your product does vary in material thickness -- for example, 16 gauge to 0.375" metal plate -- and your production requirements are driving you to more JIT manufacturing methods, there have been advances made in the last several years to curing and drying ovens. One is the addition of a PLC-controlled system that can change operational setpoints quickly and automatically. Another one is the addition of an efficient, fast-response infrared booster to the front of a convection oven. When infrared boosters are added in conjunction with the PLC, it provides the following advantages:

- Curing cycle can be varied automatically on the parts -- even from part to part -- to match specific curing needs.
- Parts with larger variance in material thickness can be run through the same oven at the same time. Parts no longer need to be sent through in batches.

Presently, there are oven systems that are handling parts on the line next to each other that vary in material thickness from 20-gauge material to 1" thick parts (figure 2). In this production case, the powder paint system is run at a constant line speed and convection oven temperature, only varying the infrared boost while supplying four different assembly lines with totally different products. The design param-eters for this line include 1 min of an infrared boost and 20 min of convection heat at 350°F (177°C).

In another production example, a customer running heavy construction equipment down the line can vary the powder cure requirement automatically, so that a 3,500 lb part can be cured with material thickness up to 3.5". At the same time, on the same line, small parts are cured for the same piece of equipment. In this case, the oven uses 3 min of infrared boost with 25 min of convection heat at 400°F (204°C). Again, the adjustment is made automatically to the infrared boost by the PLC, and neither the line speed nor the convection oven temperature varies from part to part.

The combination of infrared and convection can greatly increase your production rate and process flexibility. Heavier items can be moved down the finishing line at the same production rate as lighter items (figure 3). If properly controlled, you can intermix the parts to produce several different products at the same time and not have a large inventory of parts in production.

Design Assignments

These systems require the manufacturing engineer to complete some homework to get a system that will work properly for the plant's production requirements. Some of the more critical points to consider include:

Type of System Control (PLC or Manual). Keep in mind that manual operation requires more personnel to constantly adjust the system. Over time, the operator may become complacent and cut corners, causing inconsistently cured parts to be produced.

Convection Oven Design. The convection oven will have to be built to at least the minimum of the standards described earlier to ensure uniform results from that portion of the curing process.

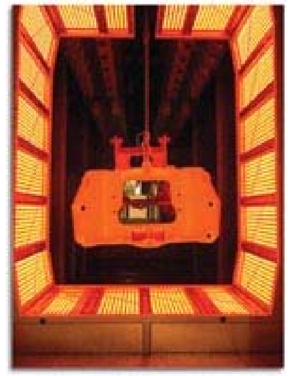

Figure 3. Combination infrared/convection ovens can increase production and process flexibility. If properly controlled, parts can be intermixed to produce several different products at the same time.

Selection of the Infrared Booster. The selection of the infrared booster is critical as there are many sources of boosters and some are not suitable for specific production requirements.

One of the first design specifications you need to determine is the length of response time needed to change the intensity of the infrared booster as well as the length of time it takes to start up the booster if the line is shut down for a few minutes. If changes need to be made to meet system cure requirements from part to part, then the booster has to be able to provide startup and change intensities in a matter of a few seconds.

Today's advances in electronics, which allow better control of the process, allow parts to be cured with a better finish than was ever possible in the past.