IR CURING SHOPTALK

Infrared Equipment Division of IHEA

This column is provided to you by members of the Infrared Equipment Division (IRED) of the Industrial Heating Equipment Association (IHEA). The group includes infrared (IR) curing equipment suppliers from throughout North America. We publish the column three times a year to give you the latest information about IR curing techniques and equipment. Contact information is at the end of the column. Most IR manufacturers offer testing for free or for a fee. Any IRED member can assist you in finding solutions to curing problems and best practices for finishing of coatings. This issue's column was submitted by IRED member Michael J. Chapman, Heraeus Noblelight, Portsmouth, R.I.

Gas catalytic IR — 3:1 rule provides key to success

The use of gas catalytic infrared (IR) technology in the finishing, curing, and drying industries has become so well accepted that more and more companies have modified the question "Will it work for me?" to "How soon can we make the change?"

The overall understanding of the advantages of this technology has improved dramatically in recent years, but it is worth reviewing the most quoted rule of thumb relating to gas catalytic IR — the 3:1 rule. In this article, we will review the 3:1 rule and take a close look at a couple of examples that demonstrate why the rule is so often quoted.

What is the 3:1 rule?

Stated simply, the 3:1 rule says that for every 3 minutes it takes to cure a part in a conventional convection oven, it will require only 1 minute in a gas catalytic IR oven. So, for example, parts that normally take 30 minutes to cure conventionally only take 10 minutes in a gas catalytic IR oven. Obviously, it is not exact if applied across a wide range of parts; some take less time (such as thin sheet metal parts) and some take slightly longer (such as heavy, geometrically complex parts). The 3:1 rule is a good place to start when considering the most appropriate curing technology for your parts.

Why is the 3:1 rule so important?

The most obvious answer to this question is that the 3:1 rule demonstrates that less energy is required for gas catalytic IR technology. An additional, sometimes overlooked, fact is that gas catalytic IR ovens have a further level of control not present in convection ovens. This extra level of control is achieved by the use of heating zones and PLC controls. But it does not stop there. A further look into the incidental effects show that for a given track speed, less time in the oven means that a shorter oven is required. The shorter oven means a more efficient use of manufacturing space. Therefore, the opportunity for overall manufacturing cost reduction becomes even more of a reality when using gas catalytic IR technology.

Apart from the smaller plant footprint and energy saving characteristics of gas catalytic IR ovens, the sheer versatility of the technology should also be considered. The ovens can be used for drying, gelling, and curing of powder coated parts with simple or complex geometric shapes. The flexibility to create recipes for the heating profiles of different part sizes, weights, fabrication materials, and coating technologies is a feature that is built into all PLC control systems used on well-designed IR ovens. This feature is incorporated regardless of the oven's size. Two typical types of cure oven systems will be described in the remainder of this article to highlight the versatility of gas catalytic IR oven systems.

Is gas catalytic IR technology always the answer?

IR technology can be an issue when curing powder on very complex geometric parts. The nature of IR means that it will "heat what it sees," thus missing hidden corners and flanges. (Given enough time, however, these areas will be heated by thermal conduction.) Even in these rare cases, the use of a gas catalytic IR pre gel oven directly upstream of a convection oven can result in a considerable reduction in the overall length of the required convection oven.

Example 1: LPG cylinder refurbishment line. The refurbishment line shown in Photos 1, 2, and 3 was created for a major supplier of bottled gas. Production volumes dictated that a line was required that could run continuously if necessary, curing powder on a wide range of refurbished cylinder sizes with varying batch sizes and colors. This line demonstrates how parts with a large thermal mass can be cured far more efficiently in a gas catalytic IR oven than in a convection oven.

PHOTO 1

The refurbishment line's oven design has been optimized to suit the complete range of LPG cylinder sizes.

PHOTO 2

The system is capable of handling high volumes and a continuous flow of product.

How does the 3:1 rule gauge efficiency?

The efficiency described by the 3:1 rule is achieved in part because 80 percent of the energy contained in natural gas is converted into medium- to long-wavelength infrared energy that is easily absorbed by the powder coated surface of the cylinder, resulting in a rapid rise in surface temperature. The IR from catalytic heaters is radiated in a hemisphere from thousands of catalytic reaction sites on the surface of the emitter. This long-wave IR is absorbed by whatever is directly in its path. Any IR that misses its target is reflected by the internal galvanized oven surface, providing multiple absorption opportunities at multiple angles of attack. Since IR travels at the speed of light, this is a rapid process and one that is repeated hundreds of thousands of times during the part's dwell time in the oven.

In the LPG cylinder refurbishment line example, one of the key elements of heating with IR is that the complete mass of the LPG cylinder does not need to be brought up to the cure temperature of the powder. Since certain areas of the cylinder have different mass profiles, the multi-zoned oven allows for extra IR heat flux to selectively heat the areas having a high mass, such as in the collars and bases of the LPG tanks. Zoning from top to bottom of the part and entrance to exit within the oven is the key to obtaining good heating profiles for specific parts.

PHOTO 3

Small-sized LPG cylinders can also be cured in the same oven.

In the case of the LPG product range, the changes that are required in the thermal profile need to be taken into consideration because of the differences in the overall height and mass of each type of LPG cylinder. The overall heating profile along the length of the oven will remain broadly similar — maximum heat output initially in the oven to achieve curing temperature, then hold and maintain to achieve cure.

Example 2: Small part manufacturing plant. Supplying the TV and theatre industry with powder coated rigging, suspension, and lifting equipment is a demanding business. Customers tend to hold less stock, but still require fast response time from suppliers. As a result, maintaining supplier loyalty becomes a real challenge. Recently, just such a company decided to discontinue using an outside vendor for powder coating, and instead installed a gas catalytic IR oven along with a conveyor and powder application booth specifically designed to meet their requirements. The catalytic oven was chosen because of its ability to cure a wide range of part weights, sizes, and geometries. The 3:1 rule showed that there was not enough available space for a conventional oven, so a small footprint, energy-efficient gas catalytic IR oven was decided upon. See Photos 4 and 5.

In operation, the company found that despite the wide range of products that required powder coating, it could respond to customers' needs in a way it never could have imagined. Small batches and responsive changes in recipes have resulted in lead times being reduced to a point where rush custom jobs can be completed in hours instead of days. The ultimate advantage that the company has gained by bringing its powder coating in-house is that they can offer a "while you wait" service for the occasional, but ever present, emergency job. The new gas catalytic IR oven is ensuring customer retention is not only maintained but improved in this very competitive marketplace.

This system differs from the LPG tank example because, due to the wide range of parts, sizes, and materials, the true flexibility of creating recipes can really be highlighted. The selection of a new recipe requires a new thermal profile to be active in only about 1 minute. The fundamentals of the technology remain the same, but the true versatility of quick and reactive changes to the volume and mix of parts using the PLC controls are clearly exemplified.

Final rule of thumb

The 3:1 rule is always a good place to start when comparing the available technology, and it is an easy way to demonstrate the underlying efficiencies that accrue from using the technology. The initial capital cost may be slightly more for gas catalytic IR technology, but factor in the long-term, year-on-year savings on energy and running costs and the argument is compelling. Plus, don't forget to consider the improved response times, greater capacity, improved quality, and better customer satisfaction. When you weigh all of these factors, the need to have gas catalytic IR technology in your process becomes imperative. **PC**

PHOTO 4

This relatively small, two-section gas catalytic IR oven is suitable for handling a high mix of varied but relatively small components.

PHOTO 5

These are typical parts that are cured in the small part manufacturing plant's oven.

For more information or to submit a question, contact Anne Goyer, executive director of IRED, at 859/356-1575; anne@goyermgt.com; http://www.ihea.org/?page=IRED.

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