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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 Mike Chapman, Vulcan Catalytic Systems, Portsmouth, R.I.; telephone 401/683-2070; e-mail [mchapman@vulcan-mdf.com].

IR technology: The finishing solution for lean manufacturing

As the manufacturing base in the US slowly restores itself from the effects of a global recession, the traditional ways of producing and routing parts through the various manufacturing steps are coming under close scrutiny from the fundamentals of the lean manufacturing concept. While production rates remain below the levels that were the norm prior to 2006-2007, existing finishing equipment is often found to be oversized, overpowered, aged, and unequipped to handle the reduced volume, new part configuration, and multiple color changes.

The lean manufacturing concept aims to reduce idle time, which is one of the eight lean wastes, between manufacturing processes as they shorten the point of order to delivery time for a given product. Lean manufacturing also aims to reduce the amount of finished stocks held and to only manufacture and coat the part at the 'pull' of the customer. Lean also aims at pursuing an economical batch size of one. A number of 'lean thinkers' have also added a ninth waste, namely, energy—a key part of powder coating.

In reality, this means that batch sizes are reducing as manufacturers start to apply lean techniques. The old concept of a continuous finishing line, with a conventional, low (7 percent to 15 percent) efficiency, convection oven, blasting away now looks decidedly wasteful and non-green. A conventional oven must be heated to fill its interior cavity as well as to bring interior surfaces of the oven to the desired temperature, a costly expenditure of energy. Infrared (IR) ovens, on the other hand, target heating the coated part surface and affecting a cure without the mass of the part reaching the curing temperature.

A new approach needed to meet the lean concept

A new approach is required for powder coating these varying batch sizes with multiple color and texture choices that addresses the needs of lean enterprises. Over the past year, a number of powder coating lines have

Figure 1

Processing long parts in a powder coating system focused on lean manufacturing

been installed to address those concerns mentioned previously. These lines are powered with gas catalytic IR ovens and a novel approach to conveying parts through the lines. The main advantages of these lines over traditional lines are lower capital investment, a smaller plant footprint, long-part capability (Figure 1), lower utility costs, and increased production throughput. The lines also achieve all the lean goals and drive manufacturing costs down.

The key to the process is to separate the part washing, IR drying, and powder coating from the catalytic IR curing process. This is shown in Figure 2. Two distinct powered loops are connected by staging areas. Once the parts are washed, they join the first powered loop that dries the parts via an IR oven. Then the parts pass through a powder coating booth and into the first staging area. The line speed is adjustable from batch to batch to adequately powder coat the part with handguns or automatic guns. Once coated, these parts can remain in the staging area awaiting the catalytic IR cure section. Note: For small batches, the oven can remain off until all the coating is finished. Then, using a reduced labor force, the oven is turned on, and the parts cycle through the IR oven. The line speed through the IR oven will depend on the part weight, geometry, and material. A very basic system is shown in Figure 3 with a powder booth and IR oven. The pretreatment is completed off line.

FIGURE 2

Lean manufacturing powder coating system

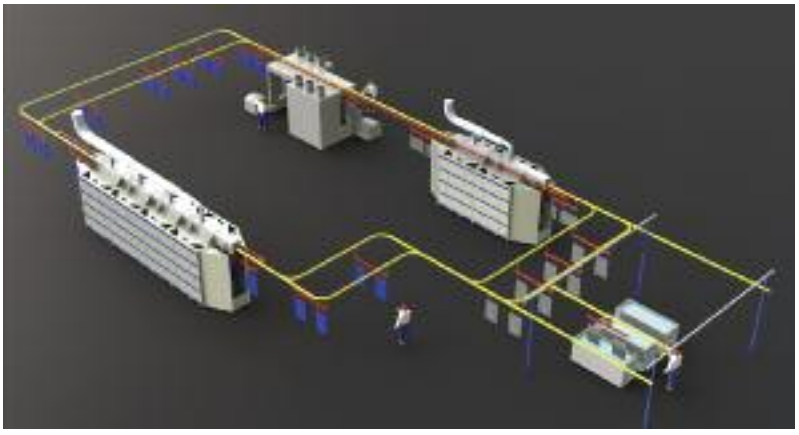
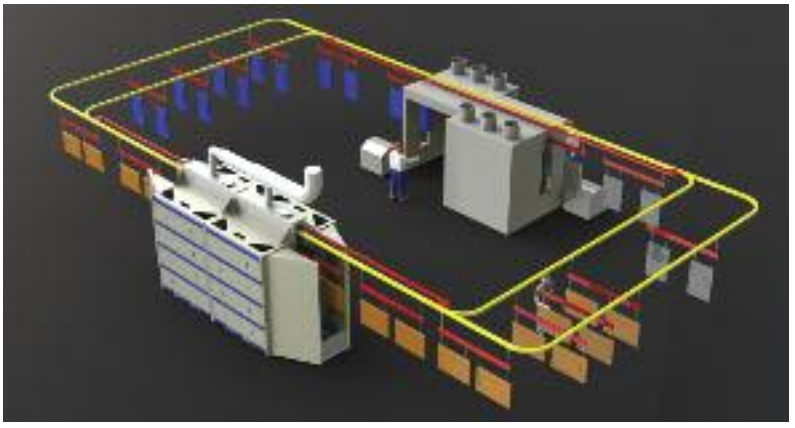


FIGURE 3

Basic system with powder booth and IR oven



In Figure 4, the portable stepladder requires 12 minutes of dwell time to cure. The line speed is set at 1 foot per minute in a two-section, eight-zone catalytic IR oven with 12 feet of heated length. This customer was outsourcing the coating for his 10 ladders per day production requirements. By installing the new "powder cell" approach, the customer cut 9 days from a 10-day manufacturing cycle, creating a shipment date (of one-off color units if necessary) 1 day after powder coating the unit.

In Figure 5, the flight bars, showing a group of 14-gauge steel parts, require a dwell time of 4 ½ minutes to cure, with a line speed of 2.7 feet per minute through the same oven. The three key oven properties required for this degree of curing flexibility are as follows:

1. Multi-zone control that adjusts zones from top to bottom of the oven as well as from entrance to exit, with a programmable logic control (PLC) recipe function that sets the line speed, as well as the zone percentages.
2. The capability to control the line speed for the various part weights and geometry.
3. Fully reflective oven design that has a large part window, allowing the IR to adequately disperse and be absorbed into all facets of the part. IR energy that travels past

FIGURE 4

Portable stepladder

the part and is reflected back as usable energy and bounced around the oven further disperses the IR. As a result, the IR is evenly absorbed on all facets of the part surface.

The production flexibility of coating various batch sizes while requiring multiple color changes is a result of innovative modular track design. Operating with this degree of flexibility while using an energy efficient, low carbon dioxide emitting curing system is achieved by the use of catalytic IR technology.

While this may not apply to all coating scenarios, a growing number of manufacturers and coaters are designing these "powder cells" to meet the different and new economic challenges of powder coatings—for example, extra long structures, multi-racked components, and medium-density fiberboard (MDF)—while getting lean at the same time.

Powder coating MDF goes mainstream

After all the talk about how difficult it is to get the powder to stick to the non-conductive MDF substrate, and how to cure the powder so that the edges don't crack and the corners remain coated, a solution was catalytic IR ovens. Powder-coated RTA (ready to assemble) MDF products (Figure 6) can be found sitting on the shelves of big box stores and super centers across the US.

This was no accident. It took the resolve of a few innovative material and equipment suppliers, and the courage and foresight of a handful of cabinet producers both in the US and Europe, to bring a successful process together. Today, a large majority of the cabinets sold in Belgium have powder-coated doors produced by one of two companies—Ledro Keukens and PolyLac.

The US producer had been struggling with a convection system to powder coat large-volume requirements on a consistent basis. After a visit to one of the Belgium plants, with US produced MDF and powder coating, tests were conducted, resulting in a supersized layout for using the production techniques back in the US with an in-line two-coat application system.

The successful MDF process uses three gas catalytic IR ovens and two automatic powder booths spaced as shown in Figure 7. The gas catalytic

FIGURE 5

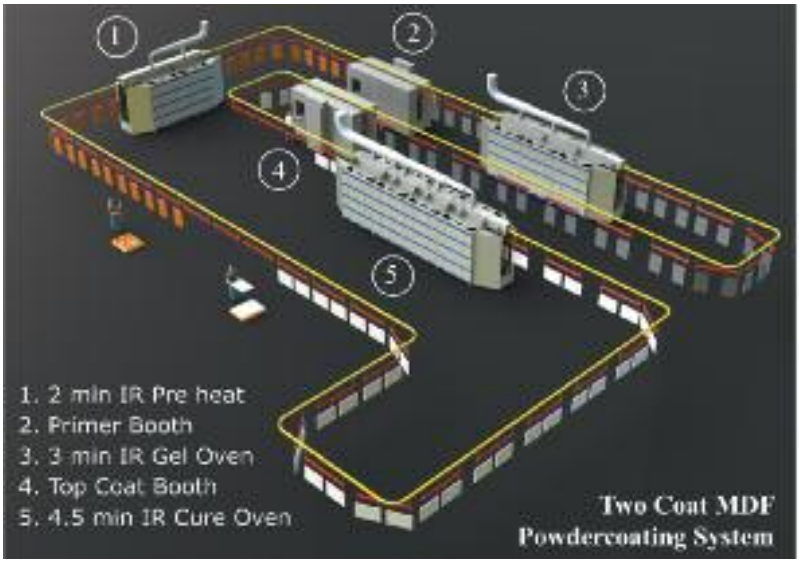
Flight bars ready for processing

FIGURE 6

Powder-coated MDF

FIGURE 7

MDF powder coating process



IR ovens are constructed, with a fully reflected concept, for multiple zone control. The key to curing the MDF parts is to direct the IR energy toward the edges of the board to drive the powder to a gel and then to the cure point along these difficult-to-heat areas. As a result, the edges seal quickly, preventing out-gassing.

The first coat addresses the outgassing issue. This is followed by a topcoat. All powder applications are applied to the MDF board with surface temperatures below 140°F. The grounded board attracts the powder as it completes a 2-minute preheat from a catalytic IR oven. The charged powder particles attach, wrap, and coat the entire board surface the same way they attach, wrap, and coat metal substrates.

With the lean concept in smaller batch production for MDF parts (Figure 2), the dry-off oven becomes the preheat followed by the powder primer application. This primer coating is cured in a catalytic oven specifically designed to cure MDF. The parts are then sent around again for topcoat application and one more pass through the cure oven.

A final word

The powder coating industry is changing. New innovative markets for powder are being sought after to broaden the market base for powder. To this end, IR heating has some unique properties that will, in time, be part of the solution to return the volume of domestic powder sales lost to offshore manufacturing and the recent market downturn. PC

For more information or to submit a question, contact Anne Goyer, executive director of IRED, at 859/356-1575; e-mail [aygoyer@one.net]. See also [www.IHEA.org]. Click on the IRED link.

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