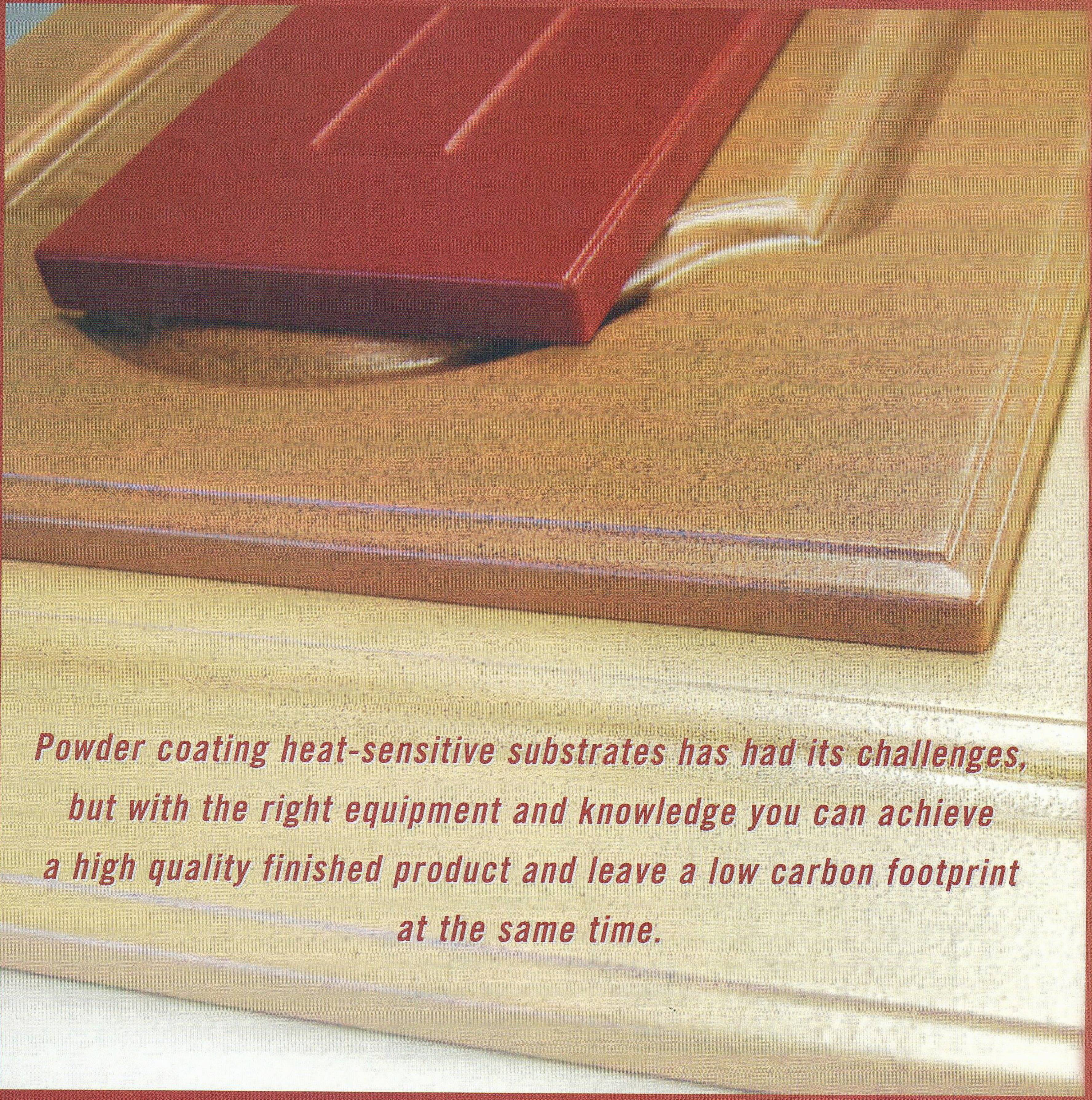
Powder on MDF:
That's a Wrap

BY SHARON SPIELMAN



Powder coating heat-sensitive substrates has had its challenges, but with the right equipment and knowledge you can achieve a high quality finished product and leave a low carbon footprint at the same time.

Photo credit Brett Ryden, Publisher

Because non-metal substrates by definition tend to be poor heat conductors, powder coating them has been a challenge. According to Mike Chapman, president at Vulcan Catalytic Systems, one of the secrets to the success of Vulcan's powder coating cure ovens lies in the design and placement of the company's catalytic heaters rela¬tive to the position, of the powder spray booths.

Vulcan was formed 18 years ago to develop the uses of catalytic heaters in the plastics industry, according to Chapman. He says, "The main market for this technol-ogy as it turned out was in the thermoforming end of the plastics business as opposed to curing thermoset resins." He explains that in thermoforming, thermo¬plastic sheets are heated with infrared (IR) for about 3 minutes and then vacuum-formed into molds, cooled and released. "Today the bulk of the spa/hot tub produc¬ers as well as many custom form¬ers heat their plastic with gas cat¬alytic systems supplied by Vulcan, the driving force being energy sav¬ings over electric IR heating costs," Chapman says.

Chapman says that thermoform¬ing is one of the most demanding industry segments for control of the IR heating process, as it is basically a heat-sensitive substrate, starting

Redline Garaggegear uses powder coated medium density MDF board for doors, drawer fronts and panels because of its strength and smooth, uniform surface

to get soft at 250°F with a forming temperature of 375°F. He says the sheet must be heated evenly across the entire area, with the heat pene-trated into the core as much as pos¬sible to give a material distribution during the vacuum process. Cold spots cause thick areas and hot spots cause thin areas—heating large sheets 8 ft x 10 ft for a spa tub with deep draws requires repeatable controlled temperature distribution.

"With this knowledge and con-trol equipment that was developed for the plastics industry," Chapman explains, "curing powder coatings on heat-sensitive sub-strates put Vulcan on a fast track to supplying successful MDF pow-der coating production lines.

In 2002, Vulcan supplied heaters and controls to Acre Products, a UK-based company producing TV Stands for the major TV brands, Chapman says. Realizing the strong potential for powder on MDF, Vulcan formed MDF Powder Coat Systems and installed an in-house system with three ovens and two powder booths to demonstrate the technol¬ogy and run production for local companies that required a tough, attractive finish on the MDF parts that they were routing on CNC machines. "Additionally, this facili¬ty became the testing ground for a number of powder coat manufac¬tures that could also see the potential growth in the MDF mar¬ket," Chapman says.

"Over the next 4 years, nine lines have been installed stretch¬ing between New Zealand, Europe and the United States," Chapman says. The largest company using the technology is in California and operates at 18 fpm, producing roughly 300 kitchen cabinet doors per hour. The smallest line pro-duces up to 100 parts a day, with multiple color changes for maxi-mum flexibility for a cost that is similar to a CNC machine. "This latter system is a grassroots sys¬tem that is not unlike the early days of powder on metal where powder is applied with hand guns and the whole system needs to be cost effective," Chapman says.

He goes on to say that preaching about how secure the process is to potential investors has been an uphill battle. "There is a legacy of confusion that persists, slowing these investors from pulling the trigger," Chapman says. The prob¬lem sterns from the failed early days of powder coating MDF using long dwell times of the MDF board in convection ovens for preheating the board and curing the powder.

"This prolonged heating time damaged the board, by virtually removing all the moisture in the board, altering its physical properties and dimensions. Additionally, this process was a high consumer of ener-gy, with expensive capital investment and at the end of the day produced low quality products and had very narrow window of production param-eters to successfully get the powder on the MDF and cured satisfactorily," Chapman adds.

In February 2007, one of the last convection-style MDF coating sys-tems was scrapped in favor of a catalytic IR system and is operating at the previously mentioned shop in California, Chapman says. "Besides dropping all the convection heat, a two-coat in-line process was adopted," he explains. "The first coat is an epoxy powder that is semi-cured, sealing the routed edges of the board, followed by the top coat of a blended powder. The system has three ovens and two fully automatic powder booths, with 700 feet of continuous track running at 18 fpm," Chapman says.

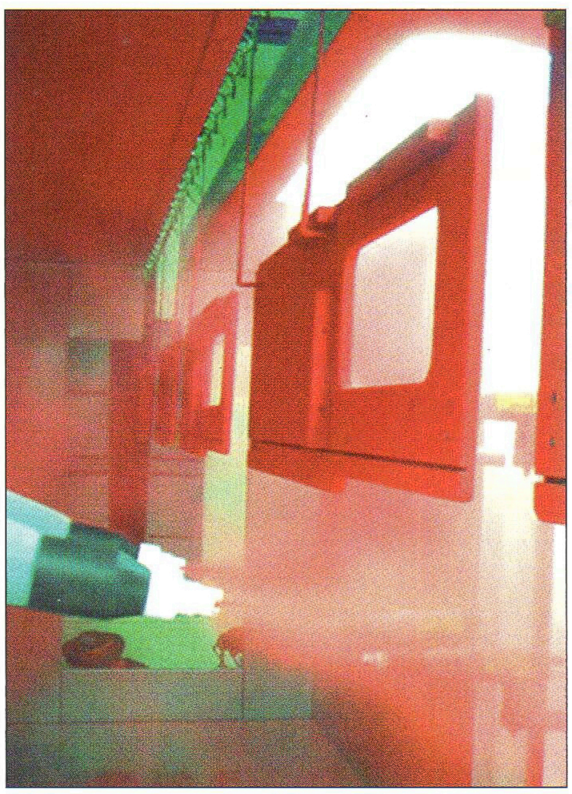


Photo courtesy Vulcan-MDF

The surfaces are primed, thoroughly cleaned, powder coated and then heated, causing the powder to gel and flow, bonding to the surface and completely sealing the piece. Here, powder is being sprayed onto the parts.

A smaller catalytic IR system is in place at Greenberg Casework Co. Inc. (GCC) in South Beloit, Ill. A company that specializes in custom casework for commercial construction and store fixtures/displays, it was founded in 1985. Troy Greenberg, president, explains that in 2004 the company launched Redline Garagegear, a division of GCC. "During the design phase of the project," he says, "we realized [that] the benefits of powder coating met all of the challenges of the garage environment."

The company markets its powder-coated exterior surfaces on its website, which boasts, "Only RedLine powder-coats all cabinet exterior surfaces, creating a seamless finish that outperforms plastic, paint or laminate, and resists chipping, denting, peeling or warping, making it perfect for the typical garage environment."

Redline uses medium density MDF board for doors, drawer fronts and panels because of its strength and smooth, uniform surface. All surfaces are primed, thoroughly cleaned, powder coated and then heated, causing the powder to gel and flow, bonding to the surface and completely sealing the piece. "The resulting finish is as attractive as it is durable, Greenberg says. "And the process is environmentally friendly, containing no heavy metals, solvents or VOCs," he adds.

The equipment supplied consists of a 16-ft. pre-heat oven, powder booth with a reclaim system and two hand guns, and a 40-ft. full cure oven. Parts are sent around twice—the first time for the epoxy primer and the second time for one of eight finish colors. Each loop takes 35 min., producing 400-500 coated parts in an 8-hour shift. The two catalytic ovens cost a total of $18/hour to operate on full production with the entire system sitting in 4,000 sq. ft. of space.

Greenberg says that they manufacture all of their powder coated

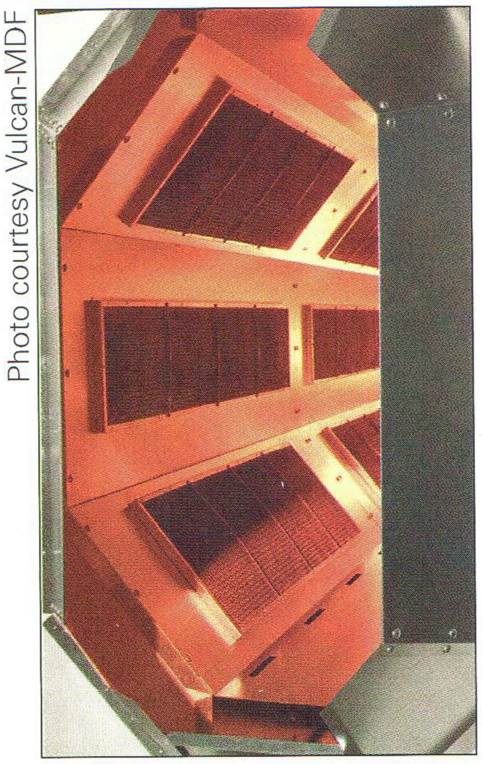


Photo courtesy Vulcan-MDF

A typical catalytic cure oven has upwards of 40 PLC-controlled zones for precise metering of the gas flow into the individual heaters. This multi-zoning capability for top to bottom and entrance to exit, develops a good heating profile.

parts using a just in time (JIT) process, shipping custom orders in 3-5 days. Currently Redline powder coats 2-3 days per week. "We are looking for custom MDF powder coating projects to fill in the gaps," Greenberg adds.

Reducing Carbon Footprints

When asked how Vulcan's ovens/heaters specifically can help save energy, Chapman had a lot to say on the subject. In the case of the powder on MDF process, Chapman says Vulcan's approach is to only preheat the MDF for 1.5 min. Here the board temperature rapidly peaks at 250°F and rapidly cools down to 130°F within 2 min. at that point the board will accept powder electrostatically as the board has 5 percent to 8 percent of moisture content that has been energized, allowing it to be earthed in a similar fashion to metal parts, and the charged powder eagerly attaches to the MDF surfaces and wraps around the edges.

Chapman says that in the case of the convection system, the board is preheated for 15 to 20 min. and reaches 300°F+. He explains that by this time the board has relinquished most of its moisture so it is unable to act as a grounded part. The powder must be applied to the board while it is in the 250 to 300°F range so that the powder sticks via fusion to the MDF. "It is easy to imagine that the amount of extra energy required to raise the temperature of the board to 300°F vs. 130°F and the huge heating time differences between the two technologies, that there are large energy differences between the two technologies," Chapman says.

When the California plant made the switch, the powder savings was large, according to Chapman, with a more even coating producing a higher quality looking door. "It is also well known that when using textured powders, IR rapidly fuses and flows the powder, producing a more consistent [appearance] to the finish than a convection cure," he says.

Chapman says that Vulcan's catalytic heaters save energy over convection heating and electric IR heaters, and here are his reasons:

Convection. Thermal logging devices clearly demonstrate how much quickly the surface temperature of a powder coated part (metal or non-metal) increases when exposed to IR vs. hot convection air. In the case of preheating MDF or curing powder on MDF, being a flat sheet, it is an easy target for IR and rapidly increases the surface temperatures. A typical catalytic IR oven for curing

Photo courtesy Redline Garagegear

Redline Garagear's powder coated cabinets are durable and attractive. Redline uses medium density MDF board for doors, drawer fronts and panels because of its strength and smooth, uniform surface.

Troy Greenberg, president of Redline Garagegear, says that when they decided to launch this division of GCC, they realized that the benefits of powder coating met all of the challenges of the garage environment.

Photo courtesy Redline Garagegear

powder on MDF is one-third the length of a convection, he says, and for the pre-heat it is one-tenth that of a convection system. The infrared oven has fully reflective oven walls so the IR is absorbed by the object and not wasted on heating the oven structure as in convection ovens. This means less energy required at the start to ready an IR oven for production compared to a convection oven, Chapman says.

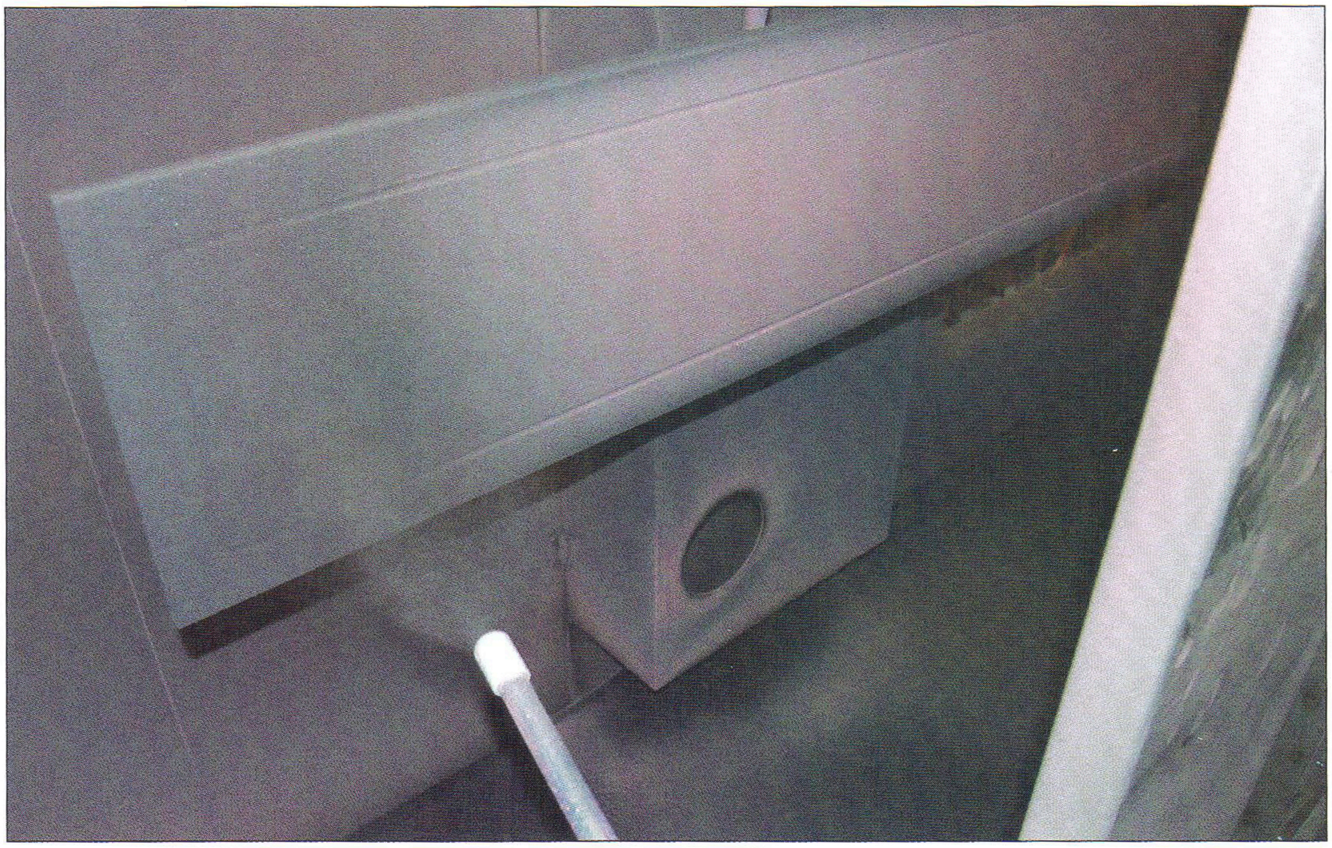
A typical catalytic cure oven has upwards of 40 PLC-controlled zones for precise metering of the gas flow into the individual heaters—especially once the part is up to temperature, which happens within the first minute of entering the oven; after that point the cure temperature is maintained through a heating profile with low heater settings, he says. BTU/hr consumption for a catalytic oven is about 60 percent that of a convection oven for the same process. Additional savings are realized during downtime, where the catalytic oven can be placed in "low fire" mode, cutting gas consumption by two-thirds during lunch breaks and color changes, Chapman notes. Vulcan finds that in many plants operating convection ovens, there is a high percentage of time that the line is empty and the ovens are still operating at full temperature. Catalytic IR ovens can quickly go to low fire mode and recover to a set heating profile within one minutes, this further reduces energy consumption.

From an environmental perspective, besides conserving natural gas, catalytic heaters do not emit any nitrous oxide (NOx), a gas that is reducing the ozone layer in the upper atmosphere. Low NOx burners for convection ovens are becoming mandatory in certain states, however, catalytic heaters emit no NOx and have been certified as such, Chapman adds.

Electric Infrared. There are some fundamental differences in the IR technology, Chapman notes, however like-for-like electric IR and catalytic IR have two basic differences: cost of operation and impact on the environment. In the MDF market, electric IR has been promoted mainly in Germany and Australia and has saddled these players with high utility costs.

Chapman explains that all IR heaters consume energy measured in kilowatts (kW), however catalytic heaters use gas measured in therms (100,000 BTU), which has a kW equivalent (1kW = 3,412 BTU or I therm = 29.30 kW) and use of electric IR will show up on a utility bill in kilowatts. From the National Average Utility Costs (see figure on page 31), natural gas has an advantage of 70 percent in lower

Photo credit Brett Ryden, Publisher



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kilowatt costs, he says. This may vary in certain parts of the country, he notes, where the east and west coasts tend to have higher electrical costs, however, gas prices are reasonably stable state to state.

From the impact on the environment and use of fossil fuel resources standpoint, Chapman says here is the big difference. For every electrical kilowatt produced by a power station, it requires 10,000 BTUs of fossil fuel—natural gas, oil, coal—to produce 1 kilowatt (3,412 BTUs) of electricity. Power generation is only 35 percent efficient, he says, plus there are other distribution losses before that kilowatt arrives at the electrical heater. So, whenever a company can deliver 1 kW (3,412 BTUs) of fossil fuel, i.e. natural gas, directly in front of the object to be heated and efficiently get 80 percent of those BTUs delivered to the part in the form IR heat, it will always be more environmentally friendly and cost effective than using electrical IR heaters, Chapman explains. When the carbon emissions and NOx that enters the atmosphere caused in burning the 10,000 BTUs to produce 1 electrical KW (3,412 BTUs) is considered, then catalytic IR is a factor of 70 percent cleaner in emissions than any electrical heater, he says.

Chapman also notes this can be proved through the "Carbon Trust" a UK-based fund for providing capital expense pounds for more efficient, i.e., smaller carbon footprint processing equipment.

Chapman says that to help his customers, both those who coat metal and non-metal substrates, run a more environmentally friendly business, Vulcan's aim is to lower their carbon footprint by using less energy.

"We are always amazed how little the customers understand about their utility bills and how much of that bill is a result poor heating practices," Chapman says.

In the case of an existing convection oven, he says there are two steps to take. "First, convert half of the existing BTU consumption to catalytic IR pre gel oven to rapidly increase the surface temperature and flow the powder. Second, by reducing and redirecting the remaining ductwork in the convection oven, so that the hot air impinges directly on the part (remember that the powder is now gelled and cannot be blown off), tremendous gains in heat transfer happen," he explains. This concept helps to either save fuel or speed the line up for greater capacity while remaining highly efficient from an energy point of view, he says.

"In some cases it is possible, depending on the part type, to run only the IR to effect a cure, and not requiring the convection heat. By having the two heating technologies on the line, the customer can choose the most efficient form of curing depending on part size and line speed." He adds that custom coaters could well benefit from this approach with the diverse product mix that they may receive from their customer base.

Chapman points out that energy use within the powder coating industry will become an increasing cost. "Oil prices and gas prices will drop based on demand in a slowing economy, however cost of electrical production will remain constant due to cost of more environmental controls that will be regulated on the power producers to meet global cuts in emissions of greenhouse gases," he notes.

"So now is not the time to sit back and think that we have a reprieve. Powder coaters should work hard to remove dependence on electrical consumption and use the most efficient combinations of gas catalytic IR and convection to meet their production needs and reduce costs," Chapman continues. "There is a general rush to 'go green' or appear to be doing so. Powder coaters can do the same by getting to grips with their energy bills and looking for ways to apply the energy in more efficient ways. This will reduce their costs and do their bit to 'go green' and reduce their carbon footprint."


Photo credit Brett Ryden, Publisher

To achieve wraparound on MDF, a two-coat in-line process can be used. The first coat is an epoxy powder that is semi-cured, sealing the routed edges of the board, followed by a top coat of a blended powder.

When it comes to Vulcan's own push to "go green," Chapman says that Vulcan has always been a lean manufacturer. "Because we supply capital equipment, the number of ovens and heaters that leave on a monthly basis may vary. We outsource all our metal fabrication to local vendors and concentrate on the fabrication of the catalyst systems and the assembly and testing of our heaters and oven systems," Chapman says. "Rather than invest in metal fabricating equipment, we concentrate our efforts and resources on new applications and testing facilities," he continues. "All our ovens are modular, they are pre wired and plumbed, designed to fit into containers with easy in easy out, and require minimum work at the job site to become operational. With the internet and an informative web site, the sales cycle is more efficient, customer requirements and approvals are faster, all contributing to less people traveling and less product transportation costs, all helping to lowering our overall carbon footprint."

National Average for Industrial Utility Costs:

Electrical Kilowatt Hr cost incl. demand cost	- $0.10/Kw
Natural Gas Cost per CCF (29.30KW) - $0.85/CCF	- $0.029/Kw

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