IR Curing of Coatings on Steel Strapping

The Challenge: Improve Quality and Increase Productivity

A.J. Gerrard & Company of Des Plaines, Illinois manufactures packaging supplies and equipment, including the steel strapping used to secure products on pallets during shipment. The company processes several thousand tons of steel every year, all of which requires a protective finish. Fabrication and coating of the strapping is a continuous process with the lines operating at minimum speeds of 300 ft/min (150 cm/s). Thus, the protective coating must be thoroughly dried and cured to quickly achieve its full properties and prevent "blocking" after the strap is coiled for shipment.

Mike Malek, Plant Manager for the Strapping Division of A.J. Gerrard, recognized the need to retrofit the coating lines with new curing ovens. He stated "While the old ovens have been meeting our needs for several years, we now need to increase production to meet sales demands, but we are currently running at the maximum capacity of the ovens. In addition, due to their age, maintenance costs of the ovens have been steadily increasing and our reject rates, due to paint defects, have risen. Our goal is to install state-of-the-art curing ovens that will provide the flexibility we need to increase production, enable us to reduce emissions, provide a safer workplace for our employees, and improve the quality of our products."

The Old Method

A.J. Gerrard used a dip-tank method for both cleaning and coating the straps. The straps were automatically fed from the fabrication lines to the coating area, where they were immersed in a cleaning solution to remove oil and other contaminants that would affect adhesion of the paint. Immediately after cleaning, the straps were rinsed and traveled through the paint dip-tanks to receive the coating. After the straps emerged from the paint dip-tanks, excess coating was removed via an automatic wiping system prior to entering the drying and curing ovens.

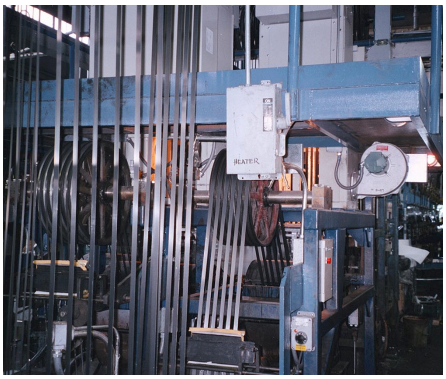
Vertical electric infrared ovens were used for curing the paint on the strapping. The old curing systems were equipped with one hundred twenty 2900 watt (348 kW) short-wave emitters per oven. The emitters were mounted in-line, or parallel, to the line of travel of the straps. This arrangement meant that the end-seals of the emitters were inside the ovens and exposed to the intense heat generated by the short-wave infrared radiation. The lamps were also exposed to the solvents and other volatile materials given off by the paint during the drying and curing process. Constant exposure to elevated temperatures and volatile materials caused lamps to fail prematurely and made it necessary to reduce line speeds in order to compensate for the diminished oven heating capacity. Average line speeds, due to failed lamps, were only 240 ft/min (120 cm/s). Oven fires were also a common occurrence due to the build-up of paint by-products on the oven walls and exhaust stacks. Due to the fires, oven insulation would degrade and require periodic replacement.

Quality also suffered. Due to the build-up of volatile materials on the emitters and reflectors, the old IR systems did not cool down sufficiently when there were line stoppages, resulting in over-baking and discoloration of the coating left in the ovens during the stoppages.

A.J. Gerrard had considered reverting back to convection ovens for drying and curing the coatings; however, large convection ovens would be necessary to accommodate their needs and space was already at a premium in the plant. They decided to investigate other alternatives.

The New Method

The new short-wave electric IR ovens, also positioned vertically, are nineteen feet (5.8 m) high by one foot wide (0.3 m). Each oven contains two hundred eighty 1000 watt (280 kW) short-wave emitters.



View of strapping as it enters the electric IR curing oven.

However, the emitters in the new ovens are mounted horizontal to the strapping, which allows the end-seals to be located outside the heating zones. This arrangement not only provides adequate cooling of the emitter end-seals, but also allowed the ovens to fit into the same area occupied by the old ovens. The ovens have five controllable heating zones and are equipped with optical pyrometers to automatically adjust the temperature of the last zone to prevent overheating of the product. The lines now run at a minimum of 300 ft/min (150 cm/s) and products are thoroughly cured in four seconds.

The Results: Improved Production and a Better Workplace

The new state-of-the-art electric IR drying and curing system has enabled Gerrard to substantially increase production, improve quality, reduce rejects, reduce energy costs, reduce maintenance costs, reduce emissions, improve the environment of the workplace, and reduce overall operating costs. Customer satisfaction has been enhanced as a result of the improvements in quality and an increase in on-time deliveries.

Increased Productivity

Gerrard has achieved a 25% increase in overall productivity. The new electric IR system allows them to run the coating

lines at a minimum of 300 ft/min (150 cm/s), versus an average of 240 ft/min (120 cm/s) with old system. This has enabled the company to not only meet existing sales demands, but also to seek new business opportunities.

Reduced Emissions and a Safer and Cleaner Workplace

Now A.J. Gerrard can use coatings that contain less solvent than the former coatings. The new coatings not only reduce VOC emissions, but also provide a cleaner oven atmosphere, which is helping to extend the life of the IR emitters and oven insulation, and contribute to a safer and cleaner workplace.

Improved Quality and Reduced Rejects

Because there are less solvent vapors and other volatile materials in the ovens and, consequently, less fouling of the emitters and reflectors, the new ovens cool down much faster during line stoppages. This has virtually eliminated over-baking of the coating during a line stoppage. And since T-3 emitters achieve maximum operating temperature almost instantaneously, any strapping that is in the oven during a stoppage receives enough radiant energy to ensure thorough curing when production resumes. The result is an overall improvement in quality and a reduction in downgrading of product due to discoloration, to less than one tenth of one percent.

Reduced Operating Costs

Additional bottom-line profits have been realized through reduced energy costs and lower maintenance costs. Energy savings of $5,000 per month have been documented since the new system was installed and maintenance costs have decreased dramatically. The old system required replacement of 15 to 20 emitters per week at a cost of $50/emitter, and insulation had to be replaced periodically due to system overheating and oven fires. During the first six months of operation of the new system, no emitters have required replacement. And because the oven cools down rapidly and there are less solvent vapors and other volatile materials in the oven atmosphere, oven insulation does not degrade, thus eliminating expensive downtime and labor costs.

The Bottom Line: Increased Profitability

The dramatic increase in productivity and the reduction in reject rates have enabled A.J. Gerrard to meet current and future business and sales objectives. The reduction in VOC's has improved air quality for both the community and the plant. And the decrease in maintenance costs, along with the improved productivity, has improved overall profitability of the company.

Assistance From Local Utility

As part of its mission to assist customers with energy and productivity related issues, Commonwealth Edison (ComEd) enlisted the aid of technical consultants from the EPRI Center for Materials Fabrication (CMF) to identify equipment that would meet Gerrard's immediate and future needs. With the assistance of ComEd and CMF, Gerrard was able to select a drying and curing process for steel strapping, that would enable them to meet all their goals. The ComEd/CMF team conducted a thorough study of the Gerrard facility, conferred with several coatings and equipment suppliers, and investigated drying and curing methods within the strapping industry. CMF consultants identified

Working as a team, l-r, Mark Hamann, Principal Energy Engineer, ComEd; Michael Malek, Plant Manager, A.J. Gerard & Company; and Harpreet Singh, Account Manager, ComEd, identified the electric IR curing oven as the answer to meeting both A.J. Gerrard's and ComEd's goals.

"best practices" within the industry and recommended a course of action for A.J. Gerrard. The company now uses new technology short-wave electric IR ovens for drying and curing the coating.

Other Applications for Electric IR Drying and Curing Systems

Electric IR drying and curing is used extensively throughout the finishing industry on a wide variety of coated and printed products. Metal, wood, plastic, leather, and textile products can all be processed with electric IR. The technology is cleaner, safer, and quieter than alternative heating technologies and, quite often, produces superior finishes. Many coatings and inks are now being specifically formulated for use with IR heating.

Photographs courtesy of Commonwealth Edison Company.

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TA-113554

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