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FOR MANUFACTURING ENGINEERS WHO USE HEAT PROCESSING EQUIPMENT AND SUPPLIES.

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HYBRID DRYING

Combining infrared and convection in a single heating system delivers process benefits.

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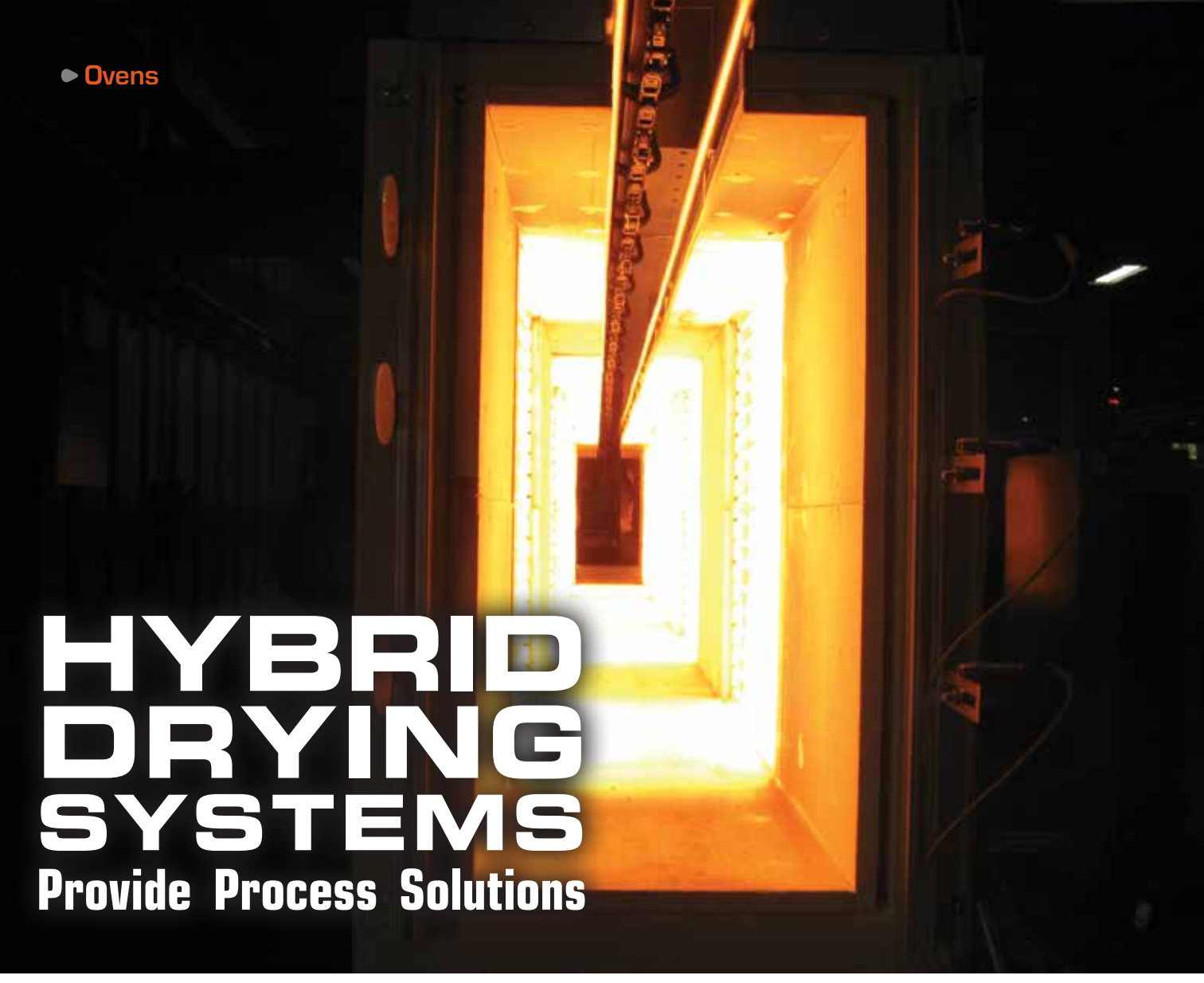

HYBRID DRYING SYSTEMS

Provide Process Solutions

Infrared and convection systems both have their strong points, and when combined, they create a winning arrangement.

By Justin Sierpinski,
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Any manufacturing process will require some input of energy. Often, that energy is in the form of heat in order to increase the temperature, evaporate a solvent or allow for a reaction in some way desirable to the manufacturing process. These effects are created in multiple ways. Among the most common methods are infrared heating and convection heating, and systems can use one or both methods to achieve the process objectives. A number of factors influence the design of the heating of the system, but the requirements of the process and the materials play a large part in dictating which method is the most cost effective, efficient and productive.

Infrared vs. Convection for Process Heating. Convection and infrared systems both have different methods and areas for which they are best suited based upon the application requirements. Generally, convection systems are less expensive per foot. A convection system – and any product in it – will never get hotter than its setpoint, which reduces the risk of product overheating in processes with frequent line stops. By contrast, infrared systems require less time – and, therefore, less space – to bring a product to a specific temperature. Because infrared generally only heats the surface of the product – rather than the full product mass as with convection – faster line speeds are possible. Also, depending upon the material, infrared systems may use tuning to increase efficiency.

Above: A high-intensity infrared preheat system is positioned before the convection oven on this curing line.

These points can decide which system is best for a specific application. Figure 1 shows some of the other differences between infrared and convection systems. Maintenance and operating costs should be taken into account when looking at heating and drying systems.

Convection/Infrared Hybrid Systems

For many process heating applications, a hybrid solution can provide the most cost-effective, energy-efficient and productive solution. Convection/infrared hybrid systems allow the end user to exploit the unique advantages of both heating methods while minimizing the disadvantages.

The application of powder coatings is a perfect example of where a hybrid infrared/convection system is most applicable. In powder coating applications, using only a convection system results in a less efficient operation of the production line. The rate of heat transfer in a convection system is proportional to the flow rate of the fluid. (In the case of a convection oven, the fluid is air.) High airflow rates will bring the paint to the ideal temperature quickly. However, the coating is in a powder state when applied. If the operator uses such high airflow rates, quality control issues can result. High airflow can cause the coating to blow off. Coating entrapped in the air will remain in the oven when the parts exit. If the next batch is a different color, the entrapped powder can bleed onto the parts. These quality control concerns mean the plant manager must work slowly and may need to vent the convection air during a line change.

Because of those limitations, powder coating is a typical application for infrared systems (or convection/infrared hybrid systems). The infrared heaters heat the powder coating to its gelling or curing temperature more quickly than a convection system. Because infrared heats via electromagnetic waves rather than heated airflow, there is no concern about airflow blowing off the coating. However, some coatings require specific minimum times in order to cure: They must be held at a specific temperature for a specific amount of time to achieve a full cure. For applications such as those, a convection/infrared hybrid system can be used, or an alternative is a long-wave infrared system. A long-wave infrared essentially creates a convection environment, but the initial investment is greater than using a natural gas convection system.

Both infrared and convection systems can get the job done for process heating applications. However, using only one or the other may mean you pay more – in time or money, or both. With a convection only system, the line speed will be slower than it could be with an infrared heating system. With an infrared only system, the initial investment is higher than convection. To optimize this process, use both in a convection/infrared hybrid

One of the advantages of an infrared heating system is the zoning capabilities. In applications such as paper drying, infrared heater zones can by turned on or off in response to moisture content readings from sensors.

Infrared vs. Convection for Process Heating

Infrared Heating	Convection Heating
Quick startup time	Heats independent of reflectivity properties
Quick cool down time	Better with mixed thicknesses in the same batch
Operational tuning	Does not require different zoning for mixed parts
Only heats target material (based on absorption coefficients)	Require less involved design work
Compact oven size	Lower operational cost when holding a temperature
Fast processing rates	
Many zones per oven in and across machine direction	
High efficiency	
Friendlier work environment	

Figure 1 shows some of the differences between infrared and convection systems. Maintenance and operating costs should be taking into account when looking at heating and drying systems.

system. Oftentimes, this means adding an infrared preheat section to a standard convection process. The infrared preheat can bring the coating to curing temperature quickly. This design allows the operator to run convection area at a higher feed rate without causing any quality control issues due to airborne powder.

More Applications for Convection/Infrared Hybrid Systems

Many examples exist in industry that combine two or more different technologies to offer the best system performance. One example is the paper manufacturing industry. The standard method to dry wet paper involves conduction heating, where the wet paper passes through and over heat drums to remove moisture. When heated in this way, the moisture content in the wet paper is not uniform. This is because a conduction system does not have accurate moisture measurement and control across the machine profile. However, paper manufacturers must produce paper that weighs the same throughout a run – this bit of quality control is indispensable to them. In order to provide for this quality control constraint, engineers may design systems that remove all of the water from the paper. Afterward, the process is designed to add moisture back into the paper in a controlled manner so that the moisture content is consistent in all areas. This process is inherently wasteful. It requires the addition of extra energy, and it uses an extra material and floorspace to create the best system for this application.

An infrared system could achieve the desired results for the paper manufacturer. The ideal infrared system for this case would use moisture sensors across the paper to profile the moisture content as the paper dries. The infrared heaters then could selectively dry the parts with higher water content by turning on or off in specific zones. This would keep the moisture content consistent for the entire run without using extra water or overdrying first.

This infrared curing system is used for ceramic paint. The infrared preheat can bring the coating to curing temperature quickly.

In addition, adding infrared can improve the system line speed. Often the earliest drums in the line cannot run at higher temperatures and rates because doing so will cause some pickoff onto the surface of the drums. The use of infrared allows for a correction and then allows for increased line speed. This is a case where an effective engineering solution demonstrates the most efficient system in a capital cost, operational cost and time.

When it comes to process heating, the answer is seldom simple. Complex processes require well-engineered systems to create the optimal scenario for the end user. However, a system designed to be efficient ultimately will save money in the form of increased productivity, better product quality and decreased operational cost. When purchasing infrared and convection process heating systems, be sure that the desired process drives the specifications for the heating or drying system rather than the type of heating or drying system driving the process. This will ensure the most effective system design and be the better decision for the process needs. ✲

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WEB EXCLUSIVE

The Basics: How Convection and Infrared Are Used for Process Heating

Convection heat transfer is a movement of energy between molecules in a fluid substance (typically air). Infrared refers to a band of electromagnetic wave spectrum that objects release whenever they have more energy (at a higher temperature) than their surroundings.

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