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INCREDIBLE INFRARED

Key to the use of infrared ovens is accurate process temperature measurement. Oven operators need precise temperature readings to maximize line speed, optimize efficiency, increase product throughput and reduce operating costs.

A conveyorized heating system with high intensity shortwave infrared is used to dry solvent from a Teflon sheet.

Infrared ovens are utilized in a range of industrial production processes such as curing of coatings, heating of plastic prior to forming, and processing of glass. In these applications, an infrared (IR) system can be regulated instantly to changing conditions as part of a closed-loop control system.

Within an infrared heating system, infrared heaters, or emitters, are set at a higher temperature than a manufactured part will attain. The heaters transfer energy to the part through electromagnetic radiation. Molecules within the product are excited by the infrared radiation and vibrate. Consequently, energy levels are raised, resulting in increases in temperature, changes in state (liquid to gas), polymerization or curing.

In a typical production application, final part temperature is determined by the dwell time of the part in the infrared oven. Radiant energy transfer is increased as the difference between the heater temperature and part temperature becomes greater. No contact or medium between the two bodies is needed for this process to occur.

When to Use an Infrared Oven

Convection ovens are controlled by air temperature and air speed only. Also, in a convection oven, a portion of the total product dwell time is necessary simply to bring the product to the process temperature. Of course, because a product in a convection oven can never get hotter than its environment, there is no danger of overheating the product as it dwells in the hot air.

By contrast, infrared emitters can use different energy densities and wavelengths to achieve the proper heatup rate and temperature. Infrared will raise the product temperature much more rapidly than the convection oven due to its higher energy transfer rate. For instance long wavelength infrared emits energy between 4.0 and 6.0 µm, with energy densities of 5 to 15 W/in^2. Medium wavelength infrared emits energy between 2.4 and 4.0 µm with energy densities of 15 to 60 W/in^2. Short wavelength infrared emits energy between 1.0 and 1.2 µm with energy densities between 100 and 200 W/in^2. When high energy densities are possible, it is possible to heat the product more quickly, but it also is possible to overheat the product.

Figure 1. Infrared thermometers improve the consistency of manufacturing operations, which can result in less product variation, improved product quality, and increased throughput.

Among the applications for which infrared is well suited is curing coatings. For instance, when using infrared to heat a coating applied on a continuous coil, the coating can be cured without fully heating through the thickness of the metal. Infrared heaters allow for discrete zone control and are suited for precise temperature profiles such as moisture control across a continuous web of paper or textiles. Another advantage of infrared technology is the rapid startup time to reach process conditions. The oven can cause the product to reach the process temperature desired in minutes or sometimes even seconds.

Process Control Requirements

In industrial plants, temperature plays an important role as an indicator of the condition of a process, product, or piece of

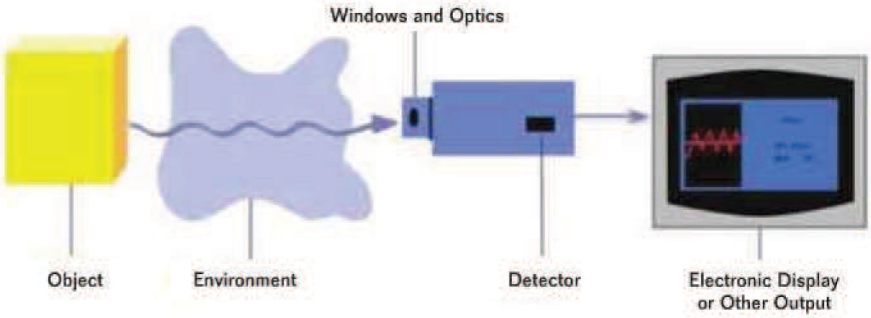

Figure 2. Optics located inside an infrared thermometer collect the infrared energy emitted by an object and focus the energy onto a detector. The detector then converts the energy into an electrical signal, which is amplified and displayed as a temperature reading.

equipment. Precise temperature monitoring improves product quality and increases throughput. It also minimizes downtime because production processes can proceed uninterrupted under optimal conditions.

For instance, temperature is a key variable when coatings are dried on paper, film and foil. Infrared dryers are used to raise the coating and base material to the desired dry/cure temperature. Precise process control requires closed-loop feedback from web temperature sensors providing operators with detailed temperature profiles.

Most importantly, end users need a temperature measurement solution able to withstand rigorous production environments. This sometimes means putting temperature instruments in insulating jackets or providing air- or water-cooling for the device. The use of an air cushion may even be required to thermally isolate the temperature sensor from harsh process conditions.

Temperature Measurement Options

Manufacturers of infrared ovens, dryers and other process heating systems design their equipment with accurate, reliable temperature control capabilities. During production, oven operators must have a precise reading of the actual product temperature; otherwise, process quality is diminished, and high scrap rates reduce the plant's profitability.

Traditionally, temperature measurement solutions included either contact or noncontact sensors. Contact-type instruments such as thermocouples are impractical in applications where the temperature sensor might touch the product before it is fully cooled, resulting in damage to coatings or the surface of the product itself. Thermocouples also may not be able to keep up with rapid temperature changes during heat cycles.

Noncontact infrared thermometers are useful for measuring temperature under circumstances in which thermocouples or other probe-type sensors cannot be utilized (figure 1). Infrared devices enable precise temperature control in process heating ovens used to bake, cure, bond, preheat, thermoform, cook, fuse, shrink, laminate and dry a range of products.

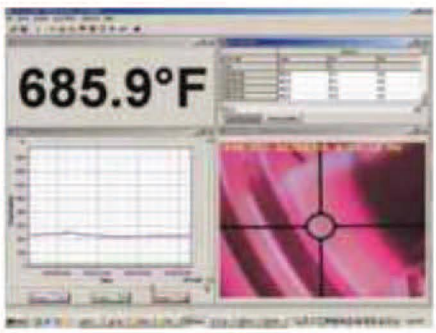

Figure 3. Combining noncontact infrared temperature measurement and data acquisition software, infrared sensor systems control a setpoint temperature.

To realize the benefits of infrared thermometers, it is important to understand how they function. All objects emit infrared energy. The hotter an object is, the more active its molecules are, and the more infrared energy it emits. Optics located inside an infrared thermometer collect the infrared energy emitted by an object and focus the energy onto a detector. The detector then converts the energy into an electrical signal, which is amplified and displayed as a temperature reading (figure 2).

Infrared thermometers can be used to monitor temperatures of dynamic processes quickly and efficiently. Unlike other measurement techniques, they measure the temperature of the process directly, allowing users to quickly adjust process parameters to optimize product quality. Infrared instruments also can help increase production efficiency and improve yields by enabling smaller units of measurement and a greater accumulation of temperature data. Temperature measurements can be made of a large area or a small spot.

The most sophisticated noncontact infrared sensors take temperature measurement a step further, providing multiple extended temperature ranges, laser sighting and high-resolution optics. Simultaneous analog and digital outputs allow temperature data to be integrated into a closed-loop control system and simultaneously output for remote temperature monitoring and analysis.

Combining infrared temperature measurement and data-acquisition software, infrared sensor systems control a setpoint temperature. The temperature of each process target is read and recorded by the sensor as the software produces an accurate production record. Upon reaching the setpoint temperature, the heat source can be shut off automatically, maintaining the correct temperature (figure 3).

Paired together, infrared ovens and infrared temperature measurement provide a powerful combination for process heating applications. PH

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End User Benefits

Infrared technology can help reduce costs, increase reliability, and result in noncontact infrared temperature sensors offering smaller units of measurement.

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