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ABOUT ELECTRIC INFRARED HEATING

The focus of the next few pages is to give some background and definition to how infrared heat is used to heat products, substrates, coatings and other process applications. Electric infrared was first developed by Ford in the 1930s to cure paint on car bodies. Since its inception, gas and electric infrared has been used for many in heat processing applications. Although it is very cost efficient and has many uses and features, infrared is not always applicable to all processes.

There are three types of infrared, short wave infrared, .76 to 2.3 microns of the Electromagnet Spectrum, which has emitter temperatures as high as 2600°C (4712°F) at 300 KW/m2. Medium wave infrared which is between 2.3 to 3.3 microns at 70 KW/m2 and emitter temperatures up to 1300°C (2372°F) and long wave infrared that operates between 3.3 microns to 1mm at 40 KW/M2 with emitter temperatures up to 600°C (1112°F).

When infrared is directed at a product the amount of infrared that is absorbed, reflected or transmitted through the product is determined by the wavelength of the infrared or radiant source and the product. Only the absorbed radiant energy will contribute to the heating process and efficiency of heat transfer. As an example, short wave infrared will transmit through glass and will not be absorbed. Long wave infrared has lower temperatures and shallow penetration, tends to be more conductive, and would not allow as much radiant energy to transmit through the glass. Although it is possible to match an ideal wavelength to a product, it may not lend itself to the actual production requirements. Many processes can be accomplished using any of the three types of infrared but the heat time or desired result may take much longer to accomplish. Medium wave infrared is generally used to cure water and solvent based coatings and to heat plastics, glass, textiles, paper, and related substrates because it is less intense than short wave infrared and covers much of the required absorption rates and operates within the required temperature ranges of many applications.

Short wave infrared is usually a tungsten filament which is almost instantaneously on but with an inrush of up to 17 times it normal current until it reaches its maximum output . Medium wave infrared usually has some type of nichrome winding which is a pure resistive load with no inrush. Heat up times can be from 30 seconds to 2 minutes, but once at temperature, they control quickly, relative to their mass. Long wave infrared is also a pure resistive load with no inrush. Heat up times can be from 8 minutes to 20 minutes, once at temperature, it can take minutes to completely adjust to a temperature change requirement.

In theory, infrared only heats what it sees and the distance to the product or product shape will change the transfer efficiency. Absorption of the infrared is determined by the physical and chemical properties of the product, the rate of heating and maximum temperature. Other factors are color, thickness, humidity and air currents. Short and medium wave infrared will not heat air. Air passing over the element can be heated through conduction. Cold air passing over a radiant heated surface will cool depending on the temperature differential of the air to the heated surface.

In most infrared applications, the radiant energy penetrates the item to be heated thus shortening the time to heat the product. As an example, a common process is to cure coatings on substrates.

The radiant energy penetrates the coating, which brings the coating to the desired cure temperature. The substrate will also be heated through some conduction and radiant penetration but does not reach the temperature of the coating. Unlike convection systems, it is not necessary to bring the substrate and coating to the same temperature to obtain a required cure or adhesion. In many cases there can be a large temperature differential from the bottom of the coated substrate to the top of the coating, the coated surface being the hotter side. Usually the thinner the coating the faster the desired cure. Infrared curing times are generally 3 to 5 times faster than convection curing times.

Infrared processes are a time and temperature relationship. A product exposed to a constant infrared source for a given time will reach a certain temperature. If the product is exposed to the source for a longer or shorter period of time or is closer or farther away, the end temperature will be different with respect to the condition affecting the temperature.

The chart below shows the relationship between the percentage element output to the input control voltage. Using voltage control of a medium wave infrared heating element rated 1,000 watts (1kW) designed to operate at 480 volts, the wattage output would be approximately 250 watts (.25kW) at 240 volts.