

New EPA standards for Air Quality Management are mandating changes in the types of coatings being used as well as how they are applied. Newer coatings now require higher temperatures to achieve full cure.

The standard method of curing industrial coatings has been accomplished by slow open air drying or somewhat faster gas heated convection air ovens. Electric infrared has also been used for curing paints for certain applications. While enhancing the rate of cure, the energy costs become excessive to operate. The introduction of gas fueled infrared catalytic thermoreactors is changing the way industry is curing organic coatings as the following account describes.

WHAT IS INFRARED

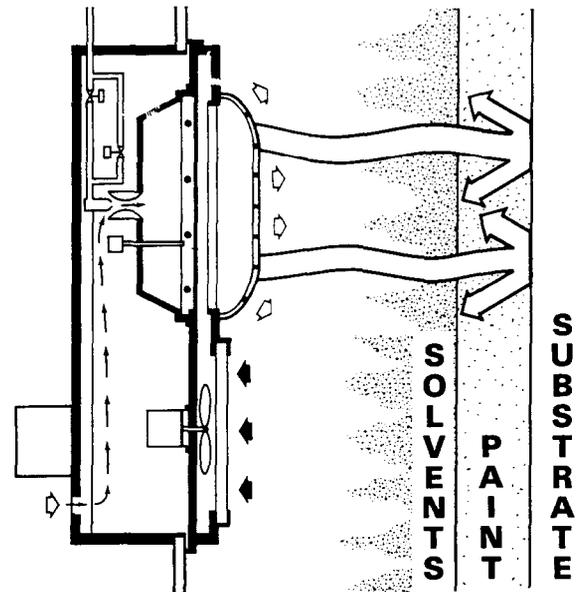
Infrared is a part of the ELECTROMAGNETIC SPECTRUM of energy. Infrared is an invisible radiant wavelength of energy between 0.07 and 1,000 microns (a micron is a unit of length equal to 0.00003937 in. 0.001 mm). It lies just beyond visible light to what is called the red side of the radiant spectrum. Visible light displays a spectrum of colors from violet to red. The wavelength range of visible light is 0.4 microns on the violet end of the spectrum to 0.7 microns on the red end.

All materials are affected by infrared wavelengths. This is identified as ABSORPTIVITY, and each material has a wavelength range of maximum absorptivity. There are charts available to determine the absorptive wavelength for almost every material.

EMISSIVITY is the measure of the infrared wavelength that an infrared device produces. AMPLITUDE is the power that the infrared wavelength is produced and its effective focal distance from the infrared device.

Every substance has a specific infrared absorption spectrum or wavelength. This wavelength is the one most readily absorbed by that substance. The absorption of this wavelength by the substance increases that substance's temperature.

The specific infrared absorption spectrum for an organic coating (paint) are the wavelengths between 3 and 10 microns. This is



Infrared radiation, emitted by the catalytic disc, passes through the wet paint film and is reflected back. In doing so, the radiation generates tremendous heat within the film through molecular excitation. This action drives solvents outward. The paint cures from the inside out. The metal is not heated by radiation.

precisely the wavelength range emitted by the catalytic thermoreactor. All paint, varnishes, and industrial finishes contain these organic materials and each of these organic materials readily absorb the infrared emissions in the range generated by the catalytic thermoreactor.

Substrates, however, do not absorb the infrared emissions as efficiently in this wavelength range, they reflect them instead. A coating of paint on a substrate is doubly affected by the infrared wave. The wave first passes through the coating of the organic paint to the substrate and is then reflected back through the paint. Several benefits result from the physics involved in this process.

First, the substrate being coated does not have to be heated to cure the coating. The finish is heated through molecular excitation from the infrared wave which causes the coating to cure from the substrate surface out.

A major benefit of this method of curing is the prevention of skinning of the coating's outer surface and its subsequent "pinholing."

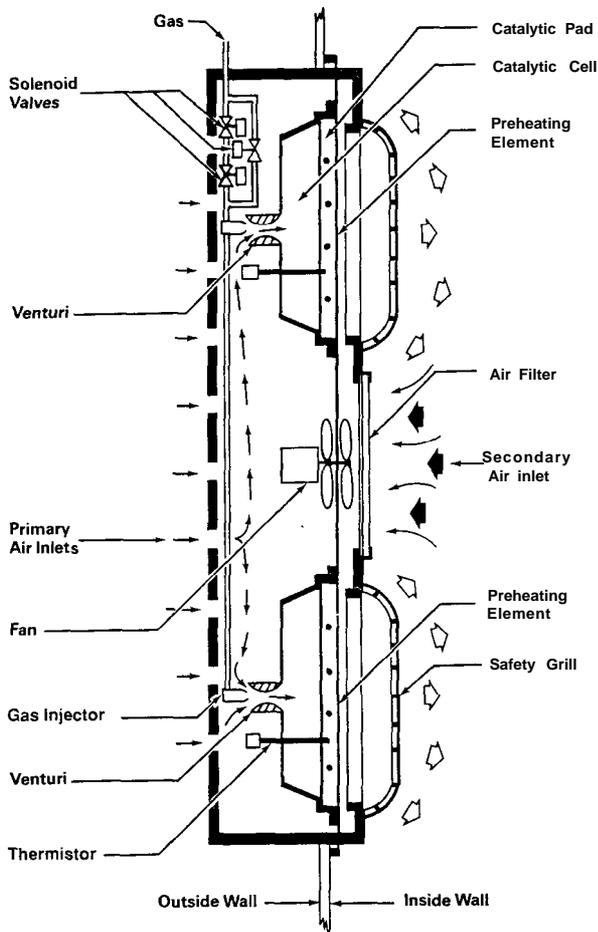


Figure 2
 Cross section of a Catalytic Thermoreactor. When propane or natural gas is mixed with the surrounding air of the curing oven, a flameless combustion reaction takes place within the thermoreactor's catalytic pad. An electric heating element inside the thermoreactor's catalytic pad provides the initial energy for the catalytic oxidation.

(Pinholing is caused by the fast evaporation of the solvents through the "skinned" outer surface of the coating.) The curing occurs from the inside out and the outer layer remains fluid while the inner layer of coating proceeds to cure. Solvent is forced from the substrate level to the surface of the coating and evaporates through the outer film. When the outer surface has finally cured, all internal solvent has since escaped and none is left to break through the skinned over outer surface and leave a blemish. Infrared cured finishes have a higher gloss appearance than coatings cured by conventional methods.

This is the distinct advantage in furniture finishing, automotive finishing and re-finishing, and numerous other industrial applications. Conventional paint curing methods, such as in a hot air convection oven, the coating film dries from the outside and skins over before internal curing is completed. When, as curing progresses, trapped solvents eventually escape, they must break through the already partially solidified surface, leaving pinholes and craters. It is the presence of these pinholes, in all sizes, even microscopic, that renders a finish dull and rough.

The difference between drying the surface of the coating and curing the entire film is that when the film is cured, it can be sanded and rubbed to the desired degree of finish. The surface dried coating is dry to the touch only and may take hours or even days before final cure sets in.

THE CATALYTIC THERMOREACTOR

The catalytic thermoreactor has been developed to generate infrared using natural gas or propane gas in a most efficient manner. The thermoreactor employs a special catalytic pad to sustain a continuous reaction between the gas fuel and oxygen out of which infrared radiation is emitted.

The thermoreactor is a flameless, catalytic oxidation of the gases used as fuel in the system. Catalytic oxidation will only occur when the proper proportions of oxygen, fuel, and heat are brought together in the presence of the correct catalyst. The thermoreactor system provides the means of producing the appropriate environment for the catalyzed oxidation to occur under stringent control to be inherently safe. The thermoreactor uses an electric resistance coil inside the catalyst pad to initiate the preheat condition required to raise the catalyst pad temperature above the point of safe catalytic oxidation. Once the internal control verifies that the temperature has been met, the electric resistance coil is turned off and the gas solenoids are opened to release gas fuel to the catalytic pad, where it is oxidized, producing the correct wave-

length of infrared used for curing. The thermoreactor does not have spark plugs, ignitor points, or open flame within the system. If, for any reason, the temperature of the catalytic pad does drop below the safe operating temperature, the internal controls will automatically shut the unit down. Any power failure will also automatically shut the entire system down.

The optimum fuel flow for the thermoreactor is fixed by the inlet orifice diameter and the gas volume supply pressure. The necessary oxygen for combustion is provided by the ambient air drawn through a venturi, along with the incoming gas. Secondary combustion air is provided by a forced air system which propels the air across the face of the catalytic pad.

The catalytic oxidation reaction is totally safe. In fact, solvent can be squirted into the catalytic pad, when it is operating, without ignition occurring. This is because the oxidation reaction is so rapid, that the volatile material is consumed before it can autoignite. The thermoreactor is approved by Factory Mutual for use in spray booth curing systems as a separate operating cycle. The necessary interlocks on controls will prevent using the spray booth for both painting and curing at the same time.

The advantages of catalytic thermoreaction in fostering good community relations by minimizing air pollution and in reducing insurance costs by virtue of its inherent safety, are readily apparent. There are, in addition, other advantages relating to installation and operation costs, and improved product quality. Some of these are:

1. Require minimum venting with fans since thermoreactors safely oxidize solvent vapors that come in contact with the catalytic disc.
2. Units do not have to be covered up like quartz tubes or lights in a spray booth. Any dirt, dust, or overspray which accumulates on them is burned off safely.
3. Units can be retrofitted into an already existing spray booth, thus avoiding the need for additional space.

4. Versatile controls provide total operational flexibility.
5. Saves space, time, and energy, up to 90% fuel savings compared to bake or convection ovens.
6. The high temperature units can be used in industrial drying painted metal panels, fabrics, leathers, etc.
7. Due to the very narrow range of the infrared radiation, many substrates never get too hot to handle.
8. Provides proper curing temperature and does not overcure or cause color change to the film.
9. Drives off solvents and reduces blushing, solvent popping and skinning.
10. Highly effective on acrylics, enamels, fillers, lacquers, polyurethanes and putties.
11. Reduces risk of dust and dirt contamination because there is minimal air movement, only 10 standard cubic feet per minute per head.

Special high temperature catalytic units are available for industrial application. Selection of these usually is based on results of tests performed with the actual product which evaluate the degree of radiation absorbed as well as heat losses due to convection, radiation, and conduction.

- * Radiation absorbed depends on distance between work surface and thermoreactor part shape (hidden areas, etc.), type of coating (resin, solvent amount, etc.).
- * Heat loss through convection occurs when cooler air sweeps over a warmer surface, extracting heat from it.
- * Radiation loss is the heat reflected from the work surface.
- * Conduction loss is where heat transfers to a colder body (substrate) that is in direct physical contact with the heated body (paint film). It depends on the thickness and nature of the substrate. Thin metallic substrates conduct away less heat than do thick ones because they offer less of a heat risk.

SOME CONSIDERATIONS

The catalytic disc requires an electrical resistance wire to bring the disc up to temperature before the self-sustaining catalytic reaction takes place. Approximately 10 amps at 120 volts are required for each disc. Reaction temperature is reached in only a few minutes of time. After that, electrical power input is not needed.

The units are provided with individual filters to ensure that clean air for combustion reaches the catalytic surface. Filters should be changed after approximately one month's operating time.

All in all, the potential benefits of the Catalytic Infrared Curing System are considerable. With today's need for energy conservation and pollution control improvements, it is heartening to find a product that answers so many of the concerns of the painting and finishing industry. Not only are these systems economical to operate, but they also reduce the time it takes to cure paint and finishes. When in use, Catalytic Thermoreactor Curing Systems are safe to operate and are noted for their long life span. Finally, the versatility of these systems in curing various types of coatings is excellent.