SCHUBERTS

FINISHING SYSTEMS
WET & DRY

THE CATALYSIS PRINCIPLE AS A SOURCE OF INFRARED DRYING TECHNOLOGY

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(1) INTRODUCTION

In the last few years the thermal treatment of metallic surfaces, textile products, paper, powder coating and wood substrates used in conjunction with catalytic infrared radiation, is considered a technology of great interest, both for the high quality of the final product, and the low general running costs.

Comparing the catalytic infrared treatment with traditional convective technology (warm air/electric IR), catalytic infrared has the following benefits:

1) Higher power density.
2) The wavelength radiated, from the source of infrared radiation, is well absorbed by the products to be treated. For example, the drying of solvent based liquid paint and lacquers (AC and Pre-cat Lacquers) using warm air could produce a superficial skin without allowing the solvent to leave the paint. With the consequent risk of the **"bubbling effect" or "solvent popping".** With the catalytic infrared technology, the treatment is made from the heart of the product to the surface ie from the inside out and the **"bubbling effect" is absent,** leaving the product with no solvent left in the lacquer, therefore curing the lacquer.
3) The long-wave infrared radiation produces a direct treatment on the product itself, while with the convective heat technology it is necessary to have a much higher temperature treatment inside the oven. Consequently, with the long-wave infrared radiation it is possible to save energy whilst cutting the curing time drastically.
4) Costs. Catalytic IR is 98% conversion efficient from the gas energy to the IR/heat energy.

The particular type of infrared source we use is the **"GAS CATALYTIC HEATER".** They all share the following characteristics:

- The infrared emission spectrum matches exactly the same spectrum as absorbed by product. Such as: paint, lacquers, inks, enamels, adhesives etc..........
- The wavelength produced is in a range of 2 – 10 μm. Modifying the inlet gas pressure (manually or automatically) allows different temperatures on the catalyst surface and therefore the emission of different wavelengths.
- Flame absence without risk of fire. If the temperature of the catalyst is lower than the solvent flammable temperature, it will never be possible to complete the fire triangle.

To have any flame, it is necessary to have the presence of the following three different conditions:

A) A COMBUSTIBLE MIXTURE– CALLED THE 'COMBURENT'
B) THE CONCENTRATION OF THE COMBUSTIBLE MUST BE BETWEEN THE LOW AND HIGH LIMITS OF EXPLOSION.
C) THE TEMPERATURE MUST BE EQUAL OR HIGHER THAN THE FLASH-POINT TEMPERATURE

If one of the above mentioned conditions is not fulfilled, the flame cannot occur.
Using our catalytic radiant heaters, where the temperature is higher than the flammable temperature, the VOC concentration is lower than the lower limit of explosion.
Where the VOC concentration is included between the lower limit of explosion and the higher one, the temperature is lower than the temperature to have the flame.

Properties of the catalytic reaction:

- Absence of Carbon Monoxide (CO) and Nitrogen Oxides (NOX)
- With the catalyst process it is possible to have a VOC pollution reduction, as it is able to oxidise the solvent molecules (Volatile Organic Compounds – VOC), destroying their structure.

(2) THE HETEROGENEUS CATALYSIS

The heterogeneous catalysis (or catalysis made by contact) occurs when a liquid or gaseous reagent comes into contact with the catalyst face. The chemical process is obtained on the solid – liquid interface, thanks to the contact of the reagent with the catalyst.
In general, a catalyst is a solid, able to increase the chemical reaction speed in liquids or gases. This property is called: ACTIVITY.
With or without the use of a catalyst, the chemical reaction develops in the same manner, but with the catalyst the energy necessary to transform the reagent into the product is less.
The catalyst does not interfere directly in the reaction, but accelerates the process.

The equation that represents a chemical reaction speed can be expressed with the Arrhenius law:

$$K = A \exp(-E_a/RT)$$

Where:
K = Kinetic constant
A = Arrhemius constant
Ea = Activation energy
T = Temperature
R = Gas constant

From this equation, to increase the speed of the chemical reaction it is possible:
- to increase the temperature, or
- to reduce the activation energy.

The use of the catalyst allows a lower activation energy than a similar reaction without the catalyst. This means that with same temperature, the reaction speed will be quicker or having the same speed, the reaction will develop at a lower temperature.

(3) THE CATALYTIC COMBUSTION AND THE COMBUSTION CATALYSTS

The combustion process allows a chemical – physical reaction with the complete or partial oxidation of a combustible (natural gas, propane or butane) with the presence of a comburent (air).
Traditional combustion with a flame is difficult process to control.

Example:

Gas type	**Inflammable temperature**
Propane	466°C
Natural gas	537°C

The combustion is an exothermic reaction, and in the case of natural gas, the products obtained are carbon dioxide (CO_2) and water vapour (H_20).

The expression of the reaction is indicated below:

$$CH_4 + 2O_2 \longrightarrow CO_2 + H_2O$$

This reaction can be catalysed, and in this case the energy necessary to obtain the products is reduced from 260 KJ/mole to 70-100 KJ/mole.

The oxidation of the natural gas with the catalyst is obtained at a temperature of 350°C, which is lower than 537°C, which represents the inflammable temperature of natural gas. For this reason, the catalytic combustion is a reaction where there is no risk of flame or explosion risk.

The catalytic combustion has the following characteristics:

- Flame absence, with no risk of explosion
- The reaction temperature is lower than the temperature necessary to have formation of $N0_x$.
- Absence of CO
- Possibility to alter the temperature of the catalytic surface, therefore obtaining different wavelengths emitted from the face.
- Reduction of VOC concentration in the atmosphere. (VOC abatement plants)

(4) MAIN FEATURES OF INFRARED TECHNOLOGY RADIATION

The infrared radiation has a range of wavelength of 0,76-100 μm.

This range is divided in three different groups:

Type of wavelength	Emitter Surface Temperature(°C)	Type of absorption
Short Wave	1050 – 2200	Poor on most materials
Medium Wave	500 – 1050	Fair on most materials
Long Wave	Up to 500	**Excellent** on most materials

Our catalytic heater produces infrared radiation with both medium and long wavelengths, with temperature range from 300 to 650°C. (Depending on the applications)

Our Applications:

- ‘Schubox™®’. (Static modular drying box for paints/lacquers, 10Kw relative power)
- ‘Schushine™®’. (mobile catalytic drier. 2-3kw relative output)
- Flat Tunnels. (up to 80-100m/min)
- Powder Coating. (Pre-heating, gelling and curing in very short vertical tunnels)
- Vertical Tunnels. (After impregnation and after top-coating)