Towards a Cleaner Environment

CATALYTIC INCINERATION IN THE PRINTING INDUSTRY

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Catalytic combustion is a safe way of destroying volatile organic compounds produced during a variety of manufacturing and processing operations, while the ability to recover heat is an additional benefit.

A wide range of industrial processes that provide useful products simultaneously generate waste gases which may cause atmospheric pollution. In particular, emissions of volatile organic compounds are often responsible for odours that cause local nuisance. More widespread environmental damage may result if these compounds react with nitrogen oxides in the presence of sunlight to form tropospheric ozone, causing photochemical smog and resulting in damage to plant and animal life.

The most effective way of ensuring essentially complete destruction of volatile organic compounds present in gaseous effluents is incineration. This can be performed by direct flame heating in a combustion chamber, at temperatures which are usually in excess of 700°C. However, if a suitable catalyst is incorporated into the incineration system the oxidation reaction, that is the combustion of the organic compounds to carbon dioxide and water vapour, takes place at significantly lower temperatures and at a much faster rate, resulting in both reduced fuel consumption and lower capital investment costs.

Catalysts for air pollution control applications should be active at relatively low temperatures and must be chemically and physically stable in oxidising atmospheres. Largely as a result of the requirements imposed by the adoption of catalytic afterburners for the control of automobile exhaust emissions, a range of advanced catalysts are now available to meet these demanding criteria.

The development of ceramic honeycomb support materials, and improved methods of impregnating them with catalytically active platinum metals, presents a major opportunity for their use in catalytic incineration systems for industrial air pollution control. The thin walled honeycomb materials have a very high surface to volume ratio, and their resistance to gas flow is an order of magnitude lower than that exhibited by a pelleted or granular catalyst bed of the same geometric shape and size. The inherent stability of the platinum metals employed and their high activity as catalysts in oxidation reactions of the type experienced in air pollution control applications impart a long effective life to the catalyst, and minimise operating fuel costs.

The Honeycat® Air Pollution Control System

The basic components of a typical Honeycat® air pollution control system, designed and engineered by Johnson Matthey, are shown opposite. The contaminated process exhaust air is pre-heated to the temperature required to sustain the oxidation reaction in the catalyst bed. The combustible organic compounds in the air stream react with oxygen on the surface of the catalyst to produce what is essentially carbon dioxide and water vapour. The clean hot air then passes back through the heat exchanger where 50 to 70 per cent of the heat content is transferred to the incoming contaminated air stream. The cool air may then be either exhausted directly to the atmosphere or additional heat can be recovered for use elsewhere.

All catalytic oxidation reactions require a minimum temperature to be reached before any significant degree of oxidation will occur. The

Table I

Comparative Operating Temperatures for the Oxidation of Volatile Organic Compounds

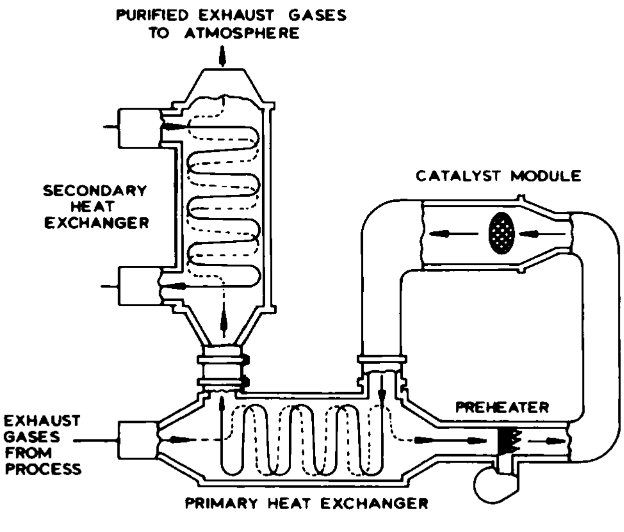
Contaminant	Honeycat® incineration, °C	Thermal incineration, °C
Formaldehyde	100–150	825
Carbon monoxide	250	800
Styrene	350	880
Paint solvents	350	850
Phenol/ formaldehyde	400	800
Phenol/creosol	400	800
Ethyl acetate	350–400	750

temperature required for essentially complete reaction is dependent upon the type of catalyst and the time it is in contact with the contaminated airstream. Typical operating temperatures for the destruction of various volatile organic compounds by direct flame heating, and over an appropriate platinum metals catalyst, are given in Table I. An analysis of the constituents of a contaminated process airstream can therefore be used to define the catalyst operating temperature necessary to achieve the required degree of fume removal.

The design of a catalytic incineration plant is very dependent on the temperature of the process exhaust stream. When this temperature is above that required to sustain the catalytic oxidation reaction, no additional heat is required, fuel costs are zero, and the capital cost of the incinerator unit is relatively low. More usually the process exhaust gas temperature is lower than the catalytic oxidation temperature, so some preheating is necessary. In many cases, however, preheat is only required for start-up, since if the concentration of the contaminants in the process stream is relatively high, the amount of heat generated by the oxidation reaction is then sufficient to heat the incoming gas stream to the required oxidation temperature.

Types of Pollution Controllable by Catalytic Incineration

Emissions that can be controlled by catalytic means include those from processes involving a natural product such as food, drying or curing solvent-containing products, and chemical processes which produce gaseous organic emissions



The Honeycat® pollution control system is based upon the catalytic properties of the platinum metals oxidation catalyst formulation, which is dispersed over the surface of a ceramic honeycomb support. The latter causes only low resistance to gas flow, and the unit withstands both high temperatures and temperature cycling. The ability to recover heat energy from the system is an additional benefit

Table II

Industries Using Honeycat® Systems

Paper printing and coating
Metal decorating and printing
Food processing
Food frying
Animal rendering
Coil coating
Wood and board printing
Carpet manufacture
Tobacco drying
Organic chemical manufacture

or nitrogen oxides in oxygen deficient atmospheres. Industries currently using Honeycat® systems are listed in Table II.

Honeycat® Technology Applied to the Printing Industry

Printing is one specific industry which has benefited considerably from the use of catalytic incineration systems. The web-offset printing process uses solvent-based inks in large quantities. Once the inks have been applied to the paper all of the solvent is driven off in the print drier, with the result that heavily solvent-laden air is exhausted from the process. Increasingly planning or environmental protection authorities are placing restrictions upon the emissions that can be discharged from an industrial process. These regulations vary in different locations, but typical emission levels require catalyst efficiencies ranging from 95 per cent to greater than 99 per cent removal of the volatile organic compounds for many thousands of plant operating hours.

One of Europe's largest printing companies, Jarrold Printing of Norwich, England, specialising in the printing and binding of high quality magazines, catalogues and books has now installed its third Honeycat® system to treat the exhaust gases from print drying units. Jarrold installed its first Honeycat® system in 1985 following a successful on-site demonstration using a mobile Pilot Plant Unit (1). The trial was witnessed by members of the Norwich Environmental Department who expressed their satisfaction with the results.

The Honeycat® system was designed with a primary heat exchanger to preheat the incoming process gases, thus reducing the energy input requirement. Depending on the process conditions and solvent loadings the requirement for additional energy may be eliminated. Indeed, the temperature rise of around 80°C across the catalyst justified the installation of a secondary heat exchanger to provide hot water for factory heating. With the recent commissioning of the third Honeycat® system at least 50 per cent of the thermal energy needed to heat the factory in the coldest part of winter will be available, thus significantly reducing costs while controlling exhaust pollution.

There are now seventeen Honeycat® systems, designed and engineered by Johnson Matthey to comply with the local pollution regulations, operating on printing processes. These form part of over two hundred Honeycat® installations controlling the emission of volatile organic compounds from a vast range of industries throughout Europe.

Acknowledgement

Honeycat® is a Registered Trade Name of Johnson Matthey PLC.

Reference

1 Anon, *Platinum Metals Rev.*, 1987, **31**, (3), 122

Monitoring Combustible Gases

A recent report from Case Western Reserve University, Cleveland, Ohio, describes an experimental study of miniature thick-film calorimetric sensors which show good sensing characteristics for carbon monoxide, hydrogen and hydrocarbon gases. (A. Chen, R. Luo, T.-C. Tan and C.-C. Liu, *Sens. Actuators*, 1989, **19**, (3), 237–248).

A pair of identical platinum heater/resistance thermometer films are employed; one is coated with a platinum black or palladium oxidation catalyst while the other serves as a compensating element. Any resistance change due to heat released on catalysis can be related to the concentration of the combustible gas.