The Control of Air Pollution

PLATINUM CATALYST SYSTEMS FOR INDUSTRIAL ODOUR CONTROL

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Honeycat catalyst systems have been successfully evaluated and used in a wide range of industrial processes that emit organic fumes and odours. These include wire enamelling, paint baking, phthalic anhydride manufacture, paper coating, and nitric acid manufacture. More recently the system has been successfully evaluated for the removal of odours from the animal, fish and food processing industries.

The development of a new platinised ceramic honeycomb catalyst for the combustion of organic fume offers considerable scope for the control of various types of air pollution (1). These THT catalysts consist of platinum supported on the Du Pont honeycomb ceramic known as Torvex. They possess a low pressure drop, high activity and resistance to attrition, making them suitable for a wide range of industrial processes requiring fume control.

Air pollution takes various forms. It may consist of toxic emissions or of emissions that offend the eye, the ear or the nose, or a combination of these types. For example, the exhaust gases emitted by diesel engines are frequently both a health hazard and a nuisance to the public. These gases, black smoke and smell included, can be minimised by careful engine design but catalytic combustion constitutes a more effective method of purification (2). Honeycomb catalysts incorporating platinum are suitable for diesel-engined road vehicles and for diesels working in enclosed conditions.

While current legislation on air pollution control is mostly concerned with the toxic emissions, the public often reacts even more to the pollution which offends the senses of sight, hearing and smell. Emissions that provoke most public resentment are those which contain some unpleasant characteristic odour. This is not merely because the odorous materials may be dangerous but because the smells cause immediate public annoyance. The presence of an unpleasant smell does of course often indicate the presence of other and more noxious pollutants.

While several systems have been developed for the elimination of industrial fume, the problem still presents technical and economic difficulties in some industries. Notable are those processing animal carcases, fish and food. Work carried out by Johnson Matthey to combat these difficulties has resulted in the successful development of Honeycat* catalyst systems to remove both smell and noxious fumes.

Abatement Systems

There are five basic methods of fume abatement. They can be classified according to the physical and chemical techniques that are used: dispersion; absorption; masking; oxidation by agents other than air; air oxidation. Generally, odours become less objectionable as their concentration decreases. They are considered to be eliminated when the concentration drops to the threshold level of perception. However, both the threshold level and the relationship between concentration and odour strength depend upon

*Johnson Matthey Chemicals registered trade name.

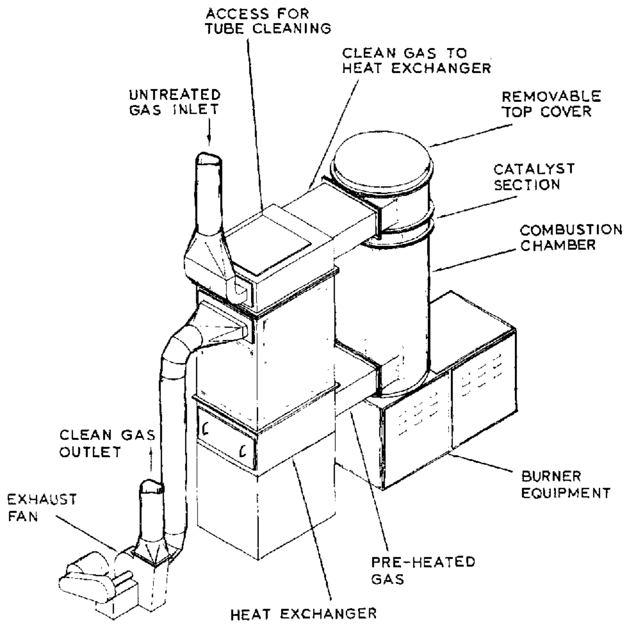

Fig. 1 A typical Honeycat system for industrial odour control comprises the catalytic combustion unit and a heat exchanger to give about 50 per cent heat recovery

the material creating the odour. The dilution required to achieve complete abatement can be determined by sampling techniques (3).

Dilution of an odorous emission is usually achieved by dispersion from a high stack but, although this is usually the most economical method, it is rarely satisfactory because of geographical and climatic effects which prevent complete dispersion of the smell. Odours emitted from the tall stacks of animal, fish and food processing plants have been detected up to ten miles away where in theory their concentration should have been many times lower than the threshold value.

Both solid and liquid absorption systems may be used to remove odours from exhaust gases. A water scrubber system is commonest. While these systems are relatively cheap to operate, they do not always achieve the required degree of abatement because some fume is insoluble in water. In addition, in the food processing industry they create the secondary pollution problem of disposal of the contaminated water from the scrubber.

Masking relies upon the principle that two substances, each with a distinctive smell, can combine to produce another less objectionable smell. This technique is cheap to install but, unfortunately, separation occurs in some climatic conditions, leaving pockets of either the original unpleasant process odour or the odour of the masking agent.

The majority of odours are organic in origin and may be chemically oxidised to other compounds having no odour or one less objectionable than that of the original material. A number of oxidising agents may be used for this purpose, including ozone and chlorine, but these agents generally do not convert organic substances to their most highly oxidised products, namely carbon dioxide and water, and the presence of objectionable intermediates plus the smell of residual chlorine and ozone may be critical.

While the techniques described above can be designed to remove the main sources of the smells, they do not achieve the objective of the perfect odour abatement system, namely to remove the materials causing the odour without creating another pollution problem and at the same time not to increase the operating costs of the process. Catalytic and direct flame combustion systems are, however, generally recognised to be the ultimate answer to odour abatement, because they destroy completely the organic compounds creating the smells by oxidising them to carbon dioxide and water. Emissions containing sulphur and nitrogen compounds, which are frequently encountered in the animal and fish processing industries, are also oxidised and, although the combustion

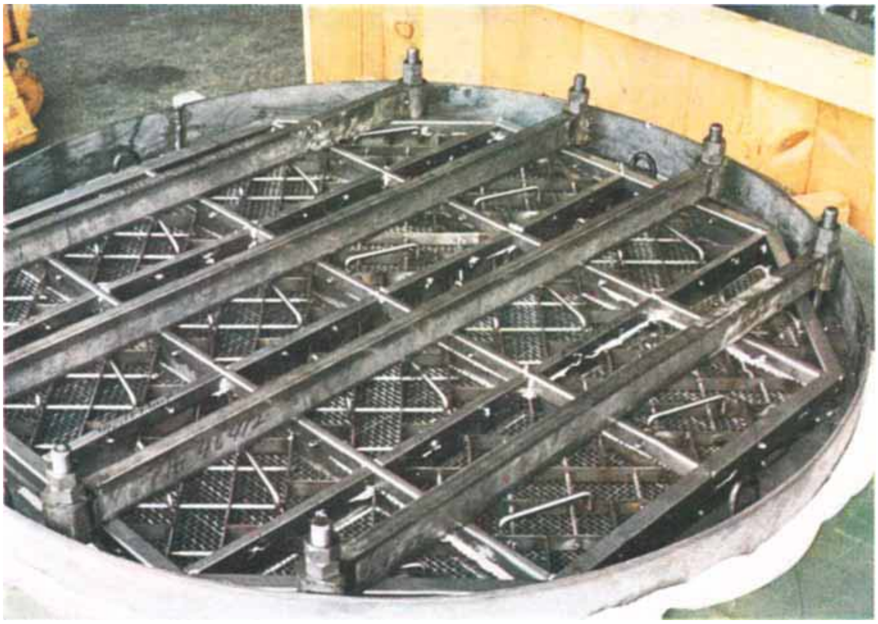

Fig. 2 Catalyst units in Honeycat systems consist of twelve inch square and triangular modules of the platinum on Torvex catalyst. The simplicity of design aids installation of the catalyst and removal for regeneration

products may contain sulphur dioxide and nitric oxide, the treated exhaust gases are odour-free because of their low concentration and the high threshold values of these compounds. With few exceptions the exhaust streams from industrial processes create smells. In particular those in the food processing industry contain organic compounds mixed in air in non-flammable concentrations. For combustion to occur these gases must therefore be heated to between 600 and 1000°C for thermal incineration or, by incorporating a catalyst into the system, oxidation temperatures may be reduced to between 250 and 450°C.

While combustion satisfies most of the requirements of the perfect odour abatement system, it suffers from the disadvantages of high capital cost and high operating costs because of fuel requirements.

Incorporation of a catalyst into the system greatly reduces both of these costs as shown in Table I. This table, which was first published by Hardison (4), is often quoted to

Table I
Equipment and Fuel Costs for Odour Abatement Systems

	Operating Temperature °F	Equipment Cost \$/scfm	Annual Fuel Cost \$/1000 scfm
Flame	2500 +	5 – 50	0 – 20
Thermal	1000 – 1500	1.75 – 10	0 – 7.5
Catalytic	600 – 900	1.75 – 5	0 – 4.5

give an indication of operating temperatures and costs. However, it should be recognised that these costs are only approximate and cannot be used as a basis for determining the cost of a system for a specific problem.

Honeycat Odour Abatement Systems

The incorporation of a catalyst into a combustion system, while significantly reducing the operating costs, can introduce other problems which complicate the system. Notable among these are the pressure drop across the catalyst bed, attrition of the catalyst by vibration or by dust impingement, and catalyst poisoning. As a result most catalytic combustion systems have hitherto been less reliable than thermal systems and more difficult to service. The development of a new platinised honeycomb catalyst (1) has made the construction, reliability and servicing of the equipment very much more practical.

The design of a typical Honeycat system with heat recovery is shown in Fig. 1. The burner with its ignition system and flame failure probes is easily removed for cleaning and maintenance and is supplied with clean combustion air from a subsidiary fan to prevent damage to the burner from dirty process gases. The combustion chamber is lined with stainless steel to minimise its size and weight and the process gases are heated in the combustion chamber and pass directly to the catalyst. This is installed in the catalyst chamber in modular form to simplify installation and removal for cleaning and maintenance as shown in Fig. 2. The catalyst modules are removed through the top of the combustion chamber.

In the Honeycat system a heat exchanger may be added to the combustion unit to give about 50 per cent heat recovery. This ensures that odour-free outlet gases are above the dew point and thus prevents condensation in the unit. The process gases, prior to catalytic treatment, are passed down the tubes, which are arranged so that the inner walls may be cleaned. The tube bank may also be removed from the heat exchanger shell to let the outer walls of the tubes be cleaned.

Honeycat System Design

The operation of a Honeycat catalyst system and the factors affecting its performance were described in a previous article (1). Both the operating temperature of the system and the volume of catalyst relative to the volume of air to be treated must be determined to optimise performance. In the majority of odour problems it is possible to specify a range for the temperature and catalyst volume required to eliminate the odour. However, as the composition and concentration of an odour-laden emission are rarely known, it is preferable to make pilot plant tests to find the optimum conditions.

The compactness of a Honeycat system has also made it possible to construct a transportable pilot unit for on-site evaluations of the system. This unit is designed to treat 200 standard cubic feet per minute of contaminated air at temperatures up to 450°C and carries its own fuel supply and process air fan. It may be connected to an exhaust stack without disrupting the process emitting the odours. The pilot plant is fully automatic and incorporates flame-failure devices. It is also fitted with gas sampling points for conventional analysis or odour sampling.

Pilot plant tests enable the optimum size of Honeycat system to be specified for fume elimination in particular industrial plants. Successful installations, as well as those for the elimination of odourless noxious fume, include units for the processing of animal wastes and in fish and meat processing.

References

1 G. J. K. Acres, *Platinum Metals Rev.*, 1970, **14**, (1), 2–10
2 G. J. K. Acres, *Platinum Metals Rev.*, 1970, **14**, (3), 78–85
3 A. Turk, "Industrial Odour Control and its Problems", *Chem. Engng.*, 1969, **76**, (24, Nov. 3), 70–78; "Measurement of Odour in Atmosphere", *A.S.T.M. Method D 1391–57*, 1964, Part No. 23, 612
4 L. Hardison, "Disposal of Gaseous Wastes", presented at Seminar on Waste Disposal, Cleveland, May 1967