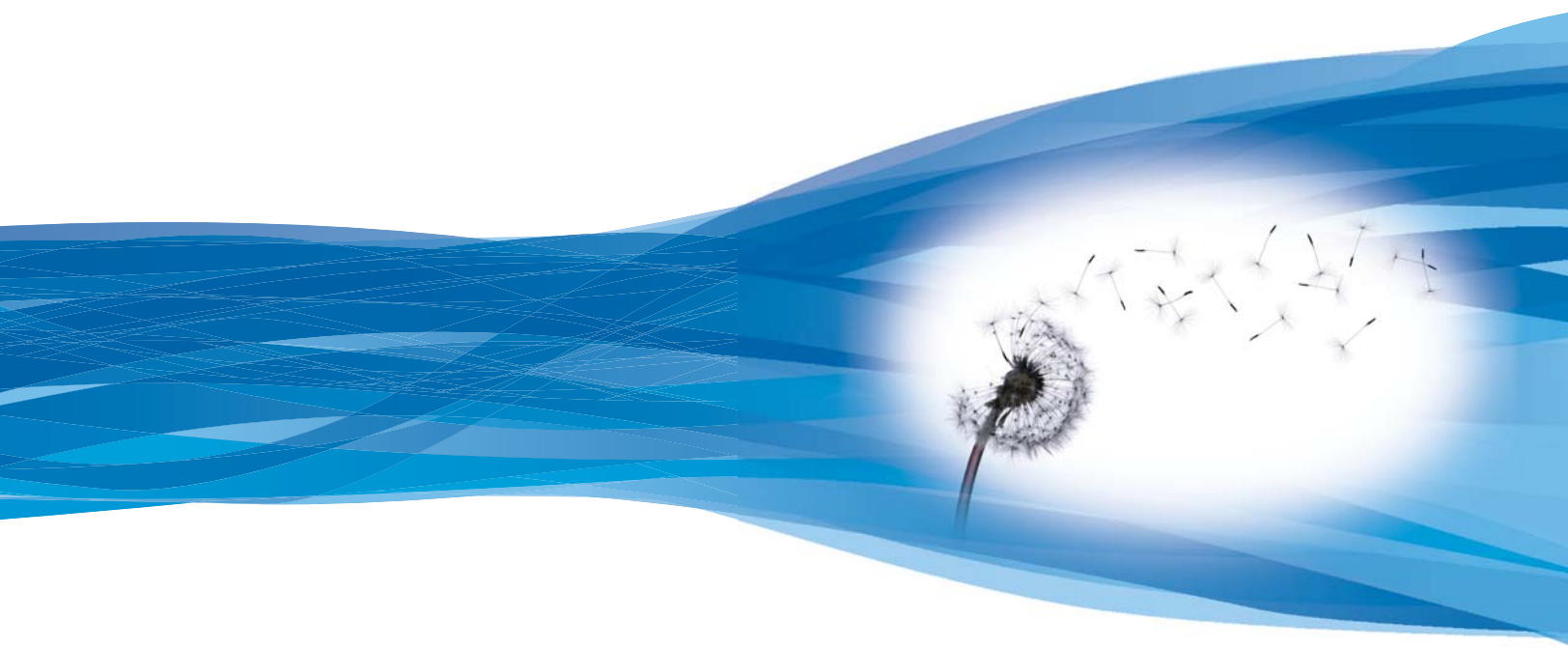
# Environmental Catalysts

# ODORGARD™

Odour control for a more pleasant environment



Johnson Matthey
Catalysts

# Sustainability

Sustainable Development is, in essence, a natural extension of our Corporate Environmental policies and standards, expanded to include the pursuit of economic and community benefits as well as the widely publicised environmental aspects of our business development.

At Johnson Matthey we take our corporate social responsibility seriously. We are firmly committed to managing our activities throughout the group so as to protect the environment and safeguard the health and safety of our employees, customers and the community.

The Johnson Matthey business is founded on the excellence of its people, products and technology. Our products reduce emissions, improve efficiencies and address pressing environmental and social concerns.

Johnson Matthey is committed to operating in a manner that protects basic human rights, provides real opportunities for our employees, protects the environment and makes a positive contribution to the community. We embrace a culture of continuous improvement in all aspects of our business.

## Johnson Matthey

Johnson Matthey is a speciality chemicals company, focused on its core skills in catalysts, precious metals, fine chemicals and process technology. Its products are sold across the world to a wide range of advanced technology industries.

Johnson Matthey Catalysts is a leading supplier of high performance process catalysts and technology for a diverse range of market applications.

Our unique platform of experience in both precious and base metal catalysts and technologies underpins Johnson Matthey Catalysts' development of leading edge products and services for the process industry worldwide.

We offer an extensive range of products, services and technologies supported by a global network of sales offices, manufacturing facilities and research and development capability.

## Chemical Catalysts

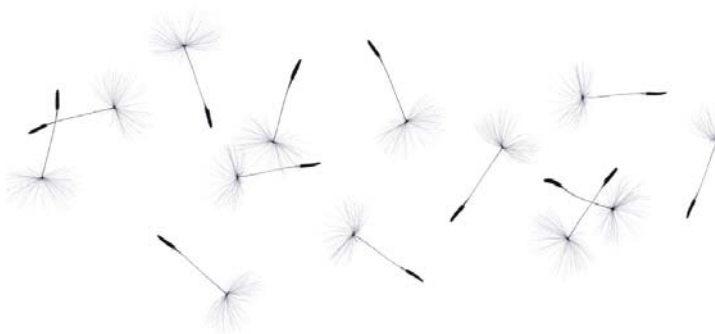
Our global Chemical Catalysts business highlights our extensive capabilities and expertise in the chemical market area. With our dynamic group of dedicated and skilled people we can meet the needs of our customers worldwide, to develop and manufacture the catalysts that optimise chemical processes. Our heritage in chemical processes further enables us to provide practical solutions to maximize the value of your business.

Today, the Johnson Matthey name remains synonymous with accuracy, reliability and integrity.

## ODORGARD - the effective solution

The Johnson Matthey Catalysts **ODORGARD** process is a single-stage catalytically enhanced alkaline scrubbing system with high efficiency in both odour and low-level VOC destruction and chemical consumption.

- Removal of different sulphur compounds from $H_2S$ to dimethyl tetrasulphide
- Removal of amines and ammonia
- Removal of low-level VOCs
- Low investment cost
- Low chemicals consumption due to good control of chemicals addition via pH value and Redox value
- High efficiency ($H_2S$ removal demonstrated to be in excess of 99.9%)
- No formation of chlorinated compounds



Both the public and regulators are highly sensitive to odour nuisance. An unpleasant odour is perceived to be caused by the release of harmful chemicals, but even a 'pleasant' odour can be considered a nuisance if it is of high intensity or persistent.

Odour may arise from the processing of natural products by industries such as food production, tanning, animal rendering and sewage treatment plants. It also originates from the use of chemicals such as solvents in the surface coatings and forming agents prevalent in industries such as printing works, foundries, electronics and in chemical and pharmaceutical manufacture.

Recurring industrial odour problems increasingly provoke local opposition and unfavourable press, attracting the attention of the local regulatory authority. Fines and enforcement notices for non-compliance can be issued, followed by the ultimate sanction of closing the site of persistent offenders, either until the odour nuisance is resolved or permanently.

### Putrid malodorous substances

| Substance | Formula | Characteristic odour | Odour threshold (ppm v/v) |
|---|---|---|---|
| Amyl mercaptan | $CH_3(CH_2)_4SH$ | unpleasant, putrid | 0.003 |
| Dimethylamine | $(CH_3)_2NH$ | putrid, fishy | 0.047 |
| Dimethyl sulphide | $(CH_3)_2S$ | decayed vegetables | 0.001 |
| Ethyl mercaptan | $C_2H_5SH$ | decayed cabbage | 0.00019 |
| Hydrogen sulphide | $H_2S$ | rotten eggs | 0.00047 |
| Methylamine | $CH_3NH_2$ | putrid, fishy | 0.021 |
| Methyl mercaptan | $CH_3SH$ | decayed cabbage | 0.0011 |
| Thiophenol | $C_6H_5SH$ | putrid, garlic-like | 0.000062 |

### Pungent malodorous substances

| Substance | Formula | Characteristic odour | Odour threshold (ppm v/v) |
|---|---|---|---|
| Ammonia | $NH_3$ | sharp, pungent | 0.037 |
| Butylamine | $C_2H_5CH_2CH_2NH_2$ | sour, ammonia-like | unknown |
| Chlorophenol | $ClC_6H_5O$ | medicinal, phenolic | 0.00018 |
| Tert-butyl mercaptan | $(CH_3)_3CSH$ | skunk, unpleasant | 0.00008 |
| Triethylamine | $(C_2H_5)N$ | ammoniacal | 0.08 |

## How the ODORGARD process works

The **ODORGARD** process from Johnson Matthey Catalysts uses a heterogeneous supported catalyst in a fixed-bed reactor for the destruction of odours and low level VOCs (volatile organic compounds). It is particularly effective at dealing with odours formed from the processing of natural products (organic sulphides, amines etc.) and a wide range of gas streams (phenols, cresols, alcohols, aldehydes, ketones, carboxylic acids, esters etc).

There are more than 100 units installed world-wide with both major global companies and smaller, sometimes family-owned companies. With patents for both the catalysts and process granted around the world, the **ODORGARD** process is recognized as a unique and practical solution to a high profile environmental problem.

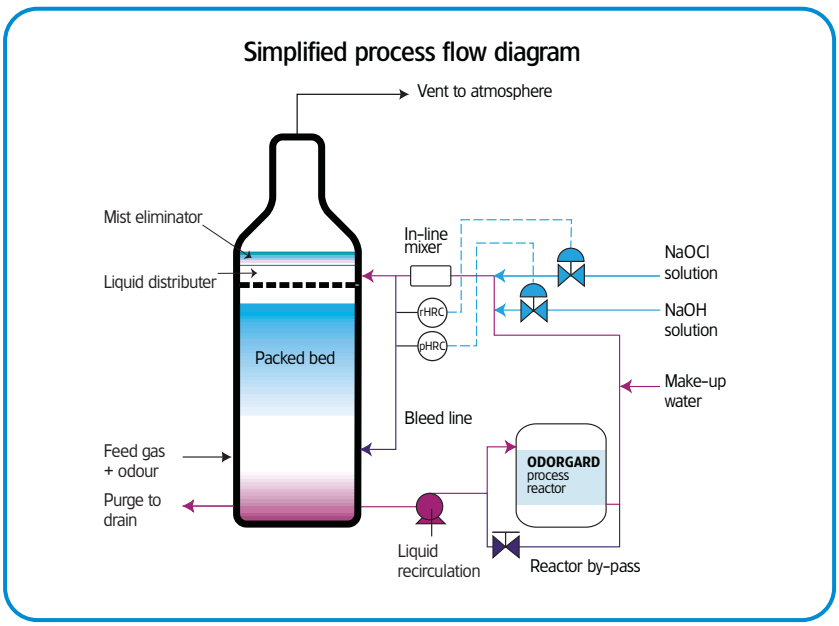
The **ODORGARD** process is based on conventional alkaline bleach scrubbing. It utilizes a catalyst to convert the sodium hypochlorite molecule into brine and a highly reactive oxygen atom held on the surface of the catalyst. The reaction which takes place over the catalyst can be summarized thus:

$$NaOCl + CAT \longrightarrow CAT - O + NaCl$$

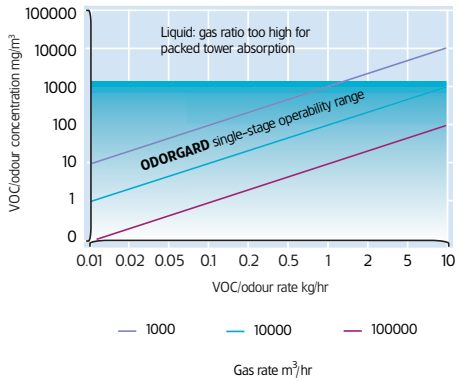
It is this oxygen species which is responsible for the enhancement of scrubbing efficiency, both in the level to which particular compounds are oxidized and the range of compounds that can be oxidized.

The catalytic system allows efficient scrubbing of a wide range of odorous compounds and low-level VOCs in a single stage with no by-production of chlorinated organics, but highly efficient use of the chemicals (sodium hypochlorite).

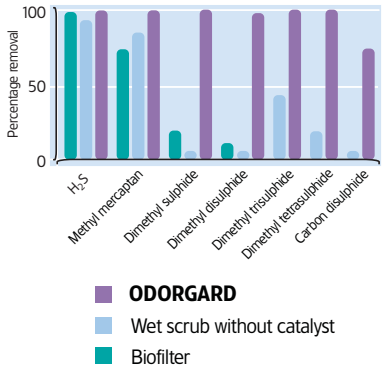
Because the **ODORGARD** process utilizes traditional hardware and control systems, it can be effectively retrofitted to existing scrubber systems to add a new dimension to high efficiency scrubbing.



Typical operability range for **ODORGARD**




Comparative performance of processes for sulphide removal




## Odour control - traditional approaches

The starting point for technology selection should always be to analyze and measure the contents of the gas stream to be treated. A number of traditional options exist for control:

Incineration – generally expensive in both capital and, more importantly, operating costs for odour streams, since the low combustibles content makes a negligible contribution to energy requirements. Thermal catalysts are prone to poisoning, especially by certain sulphur containing compounds.

Adsorption – effective means of combating low volume and/or concentrated odour streams, but replacement costs become prohibitive as volume and concentrations rise.

Bio-systems – considered a 'green' option and cope well with steady, consistent odour loading, but sensitive to all environmental change, especially peaks of odour, and thus require skilled (and therefore expensive) attention. Bio-filters usually require considerable space.

Ozone, counteractants and masking agents – effective with odour abatement close to the source, but are unlikely to destroy the odour and, as they disperse, can transfer rather than solve the problem.

Chemical scrubbing using sodium hypochlorite – although reasonably successful, is generally multi-stage to avoid the production of chlorine and/or chlorinated by-products leading to high capital cost, space required and chemical consumption.

## Benefits of the ODORGARD process

A single-stage catalytically enhanced scrubbing system with high efficiency in both odour and low-level VOC destruction and chemical consumption, the technology is the most attractive option for odour control across a number of industries and applications.

## Control

The **ODORGARD** process gives a high degree of control because the residence times and hypochlorite concentrations for the **ODORGARD** process are significantly lower than in traditional hypochlorite scrubbing systems. Low purge rates and a highly buffered system allow close control of pH (typically 9-9.5) and hence redox, which is used as a measure of hypochlorite concentration.

## Performance

The **ODORGARD** process gives high performance because far more efficient scrubbing of odorous compounds is achieved (e.g. $H_2S$ destruction demonstrated to be in excess of 99.9%). One of its unique advantages is the capability of coping with sulphur compounds and ammonia/amines at the same time without any changes in the process or additional equipment.

## Versatility

By utilizing the catalyst and its highly reactive surface oxygen, a much wider range of compounds can be oxidized than in traditional scrubbing, which relies upon the autogeneous oxidation reaction of the hypochlorite ion. Scrubbing efficiency with and without catalyst is illustrated in the sludge thickening application table overleaf.

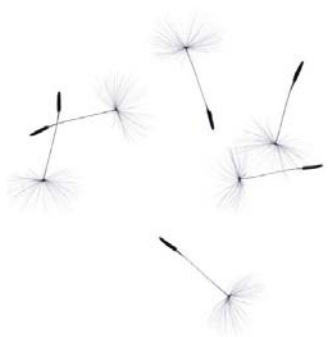
## VOC removal

Apart from the pure abatement of odours the removal of VOCs gains more and more importance in all industrialized countries.

These VOCs may come directly from chemical production units, food processing units or industrial wastewater treatment facilities. They might also occur in combination with other odorous substances like sulphur compounds, especially when originating from food processing or industrial wastewater treatment units. **ODORGARD** has a proven capability of treating these substances simultaneously.

For the removal of VOCs the only needed condition is the solubility of the relevant compound in water, i.e. in alkaline aqueous solutions. As a rule of thumb, VOCs are treatable with **ODORGARD** if Henry's Law Constant of the substance is above 0.55 mole/(kg * bar). This applies for a large number of organic compounds, especially for those with functional groups like alcohols, aldehydes, ketones, carboxylic acids, esters and amines. The treatment of simple hydrocarbons, e.g. aliphatic, aromatic and cyclic hydrocarbons, is in general not possible with very high efficiencies as they show insufficient solubility.

**ODORGARD** installations in the chemical industry as well as in food processing have proven that efficiencies above 85% VOC removal are very well achievable.



## The pilot-plant

Initial development of the process was carried out on the Pilot-plant at Billingham followed by trials on commercial sites around the UK.

## Pilot-plant data

The following tables of data demonstrate the typical performance achieved in a number of trials on sewage treatments works (STW).

**$H_2S$ removal (STW in South of England)**

| | $H_2S$ in (ppb v/v) | $H_2S$ out (ppb v/v) | Reduction (%) | Odour in (OU/m³) | Odour out (OU/m³) | Reduction (%) |
|---|---|---|---|---|---|---|
| A | 70,000 | 13 | >99.9 | >630,000 | <100 | >99 |
| B | 70,000 | 8 | >99.9 | >630,000 | 1,160 | >99 |
| C | 90,000 | nd | >99.9 | >630,000 | 1,900 | >99 |
| D | 90,000 | nd | >99.9 | >630,000 | 2,200 | >99 |

**GCMS data for sulphides and VOC removal (STW South of England)**

| Pollutant | Inlet concentration (µg/m³) | Outlet concentration (µg/m³) | Reduction (%) |
|---|---|---|---|
| Methyl mercaptan | 45 | 0.1 | 99.8 |
| Dimethyl sulphide | 26 | nd | >99.9 |
| Carbon disulphide | 35 | 3.1 | 91.1 |
| Acetic acid | 150 | nd | >99.9 |
| Dimethyl disulphide | 1,730 | 3.4 | 99.8 |
| Triethyl amine | 170 | 24 | 85.9 |
| Dimethyl trisulphide | 560 | nd | >99.9 |
| Limonene | 390 | nd | >99.9 |
| Dimethyl tetrasulphide | 96 | nd | >99.9 |
| Methyl naphthalenes | 260 | 20 | 92.1 |
| $C_9$-$C_{12}$ alkenes | 2,170 | 383 | 82.4 |

**GCMS data for sulphides and VOC removal (STW North of England)**

| Pollutant | Inlet concentration (µg/m³) | Outlet concentration (µg/m³) |
|---|---|---|
| Hydrogen sulphide | 18,300 | 30 |
| Toluene | 60 | <10 |
| Undecane | 180 | <10 |
| Cycloheptatriene | 160 | 70 |
| Methyl cyclohexane | 1,500 | 500 |
| Dimethyl disulphide | 120 | <10 |
| Dimethyl trisulphide | 120 | <10 |
| Dimethyl tetrasulphide | 140 | <10 |
| S-methyl methane thiosulphate | 25 | <10 |

**Sewage: sludge thickening application**

| | | Without catalyst | | With catalyst **ODORGARD** | |
|---|---|---|---|---|---|
| **Contaminant** | **Odour (T.L.V. µg/m³)** | **Feed (µg/m³)** | **Removal (%)** | **Feed (ppb v/v)** | **Removal (%)** |
| Hydrogen sulphide | 0.67 | 44,600 | 96.9 | 40,200 | 99.8 |
| Methyl mercaptan | 2.1 | 290 | 78.3 | 15 | >99.3 |
| Dimethyl sulphide | 5.9 | 540 | <1.0 | 210 | >99.9 |
| Dimethyl disulphide | 48 | 3,800 | <1.0 | 1,250 | 97.3 |
| Dimethyl trisulphide | 8.7 | 530 | <1.0 | 390 | >99.9 |
| Dimethyl tetrasulphide | unknown | 20 | 15 | 31 | >99.7 |
| Carbon disulphide | 300 | 30 | <1.0 | 22 | 74.5 |

Compounds such as ammonia and amines are oxidized over the catalyst. The lower hypochlorite concentrations of the **ODORGARD** process are not conducive to chlorination reactions. Laboratory studies also show that chlorinated compounds are destroyed over the catalyst.

**ODORGARD commercial units: meat renderer**

| | Concentration (ppm v/v) | |
|---|---|---|
| | **Inlet** | **Outlet** |
| Ammonia | 10 | nd(<0.5) |
| Amines | 4 | nd(<0.05) |
| Mercaptans | 0.5 | nd(<0.1) |
| Hydrogen sulphide | 0.5 | nd(<0.05) |
| Odour | - | none perceived |

Cost effective, reliable and proven in large scale commercial use, the **ODORGARD** process offers unique performance advantages and efficient chemical use across a range of industries where odour is traditionally a major problem – satisfying both their needs as well as public demand for a cleaner, 'odour free' environment.

# **ODORGARD** in action

Any industrial process, which produces an odour and/or a low-level VOC in a vent gas can benefit from the **ODORGARD** process. Any process currently using traditional hypochlorite scrubbers could improve abatement performance by retrofitting a catalytic reactor, for example in: sewage treatment, composting facilities, animal rendering, animal feed, leather and tanning, food and drink, tobacco, natural product processing, foundry, paints and resins, pulp and paper, chemical production, refinery.

## Meat Rendering

Canterbury Mills

## VOC removal unit

Castings Plc foundry

## Water Treatment

Treatment of odours (sulphides and amines) and VOC from a wastewater treatment at a chemical plant in Israel; **ODORGARD** reactor in front of the scrubber

Treatment of odours from a municipal water treatment plant (Workington, UK); **ODORGARD** reactor right of the scrubber

# ODORGARD

odour control for a more pleasant environment

For further information on Johnson Matthey Catalysts, contact your local sales office or visit our website at www.jmcatalysts.com

ODORGARD is a trademark of the Johnson Matthey Group of companies.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