# Environmental Technologies

FORBES

PLASTICS TANKS AND
ENVIRONMENTAL TECHNOLOGIES

# Environmental Technologies

**Our work in environmental fields is centred on the application of mass transfer technology applied to the abatement of air and water-borne pollution.**

**From the process design by our chemical engineering team through manufacture, installation and commissioning we are always conscious of the need to work to the highest standards.**

Forbes' success with a wide range of pollution abatement applications is in large measure due to our long practical experience in fabrication backed by our thorough, pragmatic, approach to chemical engineering.

We are continually appraising fresh approaches and up-to-the-minute technologies to ensure that our system designers offer customers an optimum balance between their initial investment and day-to-day running costs.

Although capable of producing large turnkey systems – from design and manufacture through to installation and commissioning – we are also flexible enough to provide low cost equipment for customers to install themselves. We endeavour to offer a cost-effective response to every enquiry, however large or small.

MASS TRANSFER TECHNOLOGY

Typical Applications

| SCRUBBING IN THE GAS PHASE | CHEMICAL FUMES | ODOUR CONTROL | VOC REMOVAL | DUST | FINE PARTICULATES | MISTS/ AEROSOLS |
|---|---|---|---|---|---|---|
| PACKED TOWER | ● | ● | | | | |
| FLUIDISED BED | ● | | | ● | | |
| VENTURI | | | | ● | ● | ● |
| CARBON ADSORPTION | | ● | ● | | | |
| BIO-FILTRATION | | ● | ● | | | |

| STRIPPING IN THE LIQUID PHASE | $CO_2$ REMOVAL FROM WATER | VOC REMOVAL FROM WATER | REMOVAL OF DISSOLVED GAS FROM WATER |
|---|---|---|---|
| PACKED TOWER AIR STRIPPING | ● | ● | ● |
| CARBON ADSORPTION | | ● | |

This table is intented as a guide to common applications for the techniques listed. Variations may be applied in particular circumstances.

# FUMES, ODOURS AND PARTICULATES

Fumes can be either organic or inorganic and are assumed to have a particle size of well below 1μm (one micron). Mercaptans, acetic acid, amines and acrylates are typical organic fume problems. Inorganic fumes include $NO_x$, $SO_x$, hydrogen chloride, ammonia and hydrogen sulphide.

An ODOUR is simply a smell, whether pleasant or unpleasant. Odours may be complex mixtures of organic and inorganic compounds although there are a number of common chemicals which are readily detected by the human nose.

PARTICULATES, whether organic or inorganic, are loosely classified by the particle size:
Normal dust 5-75μm;
Difficult dust 0.1-5μm;
Smoke and fume below 1μm;
Mist/liquid 0.01-10μm.

Whilst these figures cannot be definitive they can give an understanding of the particle sizes in dust and fumes experienced in industry.

## ODOUR THRESHOLDS AND EXPOSURE LIMITS (EH40:2002)(ppm)

| | ODOUR THRESHOLD | LONG TERM EXPOSURE (8 HOURS) | SHORT TERM EXPOSURE (15 MINUTES) |
|---|---|---|---|
| Ammonia | 5.3 | 25 | 35 |
| Chlorine | 0.3 | 0.5 | 1 |
| Dimethylamine | 0.042 | 2 | 6 |
| Dimethyl Sulphide | 0.0009 | | |
| Ethyl Acrylate | 0.00043 | 5 | 15 |
| Hydrogen Chloride | 1.2 | 1 | 5 |
| Hydrogen Sulphide | 0.00043 | 5 | 10 |
| Methyl Mercaptan | 0.00196 | | |
| Methyl Methacrylate | 0.19 | 50 | 100 |
| Phenol | 0.043 | 2 | 10 |
| Sulphur Dioxide | 0.42 | 2 | 5 |
| Trimethylamine | 0.0019 | 10 | 15 |

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## PACKED TOWER SCRUBBING

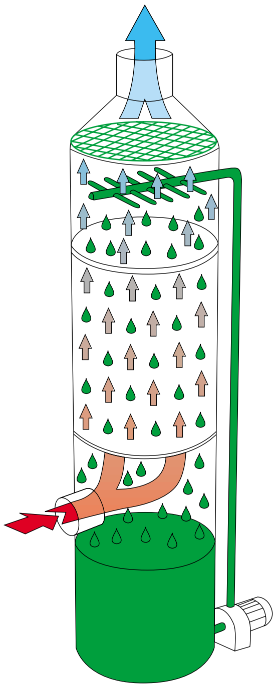
Packed towers are the simplest and most commonly used approaches to gas scrubbing.  The principle of this type of scrubber is to remove contaminants from the gas stream by passing the stream through a packed structure which provides a large wetted surface area to induce intimate contact between the gas and the scrubbing liquor.  The contaminant is absorbed into or reacted with the scrubbing liquor.

The packing of the tower is normally a proprietary loose fill random packing designed to encourage dispersion of the liquid flow without tracking, to provide maximum contact area for the 'mass transfer' interaction and to offer minimal back pressure to the gas flow.  The reactivity between the contaminant and the scrubbing liquor influences the system designer's determination of gas and liquor flow and the height and diameter of the packed bed.

A demister is fitted at the top of the tower to prevent entrainment of droplets of the scrubbing liquor into the extraction system or stack.

Packed towers can be designed for very high efficiencies with relatively low capital and running costs.  The low pressure drop associated with packed bed scrubbers permits the use of smaller more economical fans.  Although efficiency may be affected, a packed tower will usually function when gas or liquor flows vary from its original design parameters.

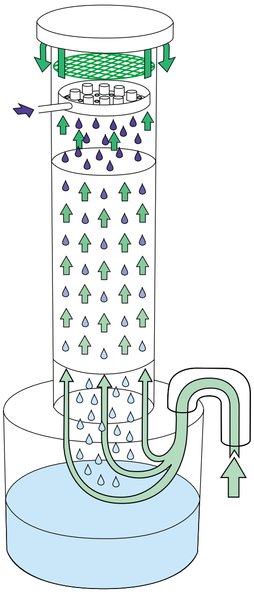
Packed towers can become clogged by insoluble particulates or the insoluble products of chemical reactions and this scrubbing technique should not be used where this is cause for concern.  Our chemical engineers can advise in this regard.



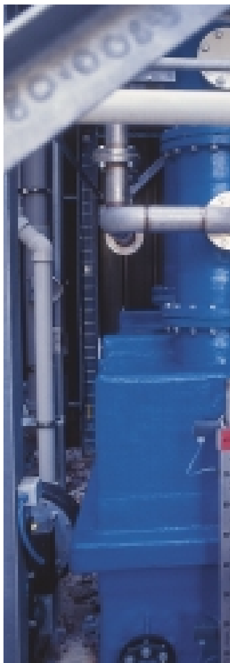
TYPICAL WET SCRUBBER

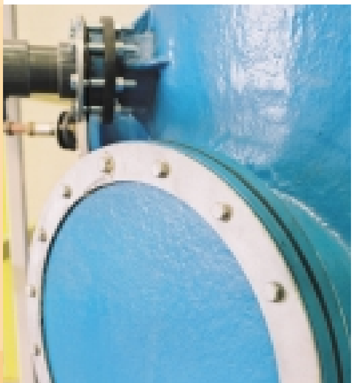
## PACKED TOWER STRIPPING & DEGASSING

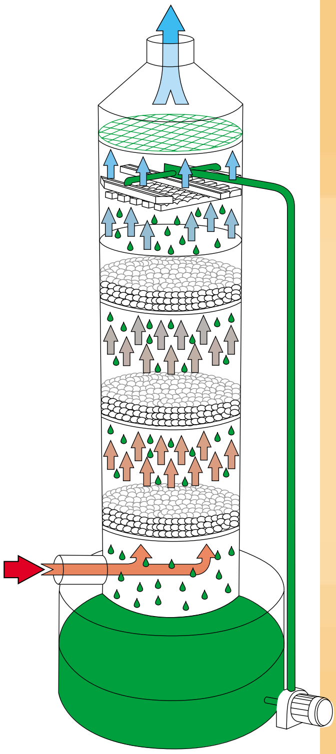
The principle of air stripping has been used for a number of years for the removal of dissolved gases such as carbon dioxide, hydrogen sulphide and ammonia from aqueous liquors.  It has also been used as a means of increasing  dissolved oxygen content for the oxidation of dissolved metals such as iron.  It was in the late 1970's that this technology was applied to the removal of volatile organic compounds (VOCs) from water.



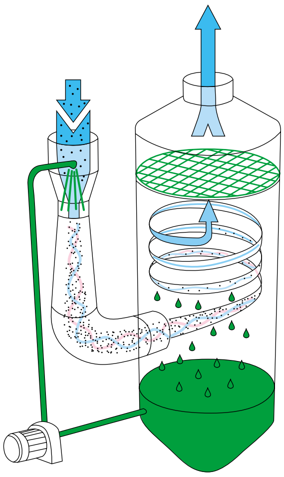
TYPICAL DEGASSER



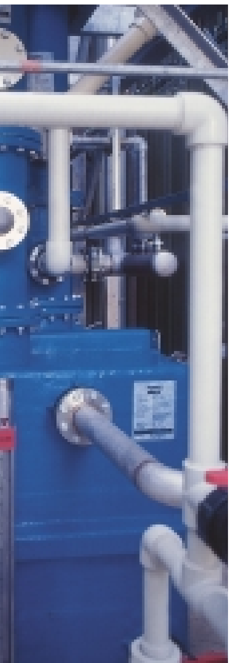


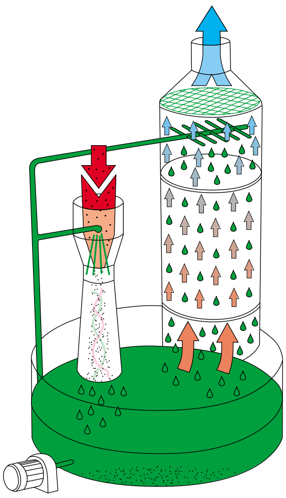


TYPICAL WET SCRUBBER



VENTURI SCRUBBER





2 STAGE VENTURI/WET SCRUBBER

## FLUIDISED BED SCRUBBING

In a fluidised bed scrubber the typical single bed of a packed tower structure is replaced by two or more shallow beds, and the high surface area angular packings are replaced by hollow ellipsoids which are 'fluidised' by the gas stream. This is relatively fast moving when compared to the velocity of the gas flow through a packed tower.

The residence time of the gas in the tower is thus rather less than in a packed tower but this tends to be compensated by the higher mass transfer induced by the gas turbulence in the 'fluidised' packings.

Fluidised bed scrubbers are not normally used for odour control because of the short residence time of the gas flow within the tower.

A prime advantage of the fluidised bed is that the mobility of the packings minimises the aggregation of particulates and insoluble depositions. Very small particulates, 8$\mu$m and below, will however tend to pass through a fluidised bed.

With the higher gas velocity the tower diameter can be narrower and a more compact unit designed. Additional costs are, however, incurred with more expensive packing, the complexity of the structure, and the capital outlay and running costs of larger fans.

The efficient function of the fluidised bed depends on the velocity of the gas stream being maintained between specified minimum and maximum levels – and this would typically be a narrower range than in a packed tower.

## VENTURI SCRUBBERS

Venturi scrubbing is a most effective technique for the removal of particulates from a gas stream, even down to sub-micron size. Scrubbing liquor and gas stream are brought together in turbulent contact within the venturi throat and the particulates are forced into the atomised liquor.

Venturi scrubbing may be adequate to handle some more reactive contaminants but to reduce fumes to acceptable levels it may be necessary to effect further treatment using a packed tower scrubber. Combination units incorporating both types of scrubber using a common sump are most practical in some circumstances.

Venturi scrubbing is typically a cost effective and efficient approach to removing particulates.

# CARBON ADSORPTION

Solvents, volatile organic compounds (VOCs) and other contaminants in the liquids or gas phase can be adsorbed onto activated carbon.

The principle of adsorption is based on the highly porous structure of the granular carbon. Each gramme of activated carbon may typically have a total surface area, including all its internal pore structure, in excess of 1000m$^2$.

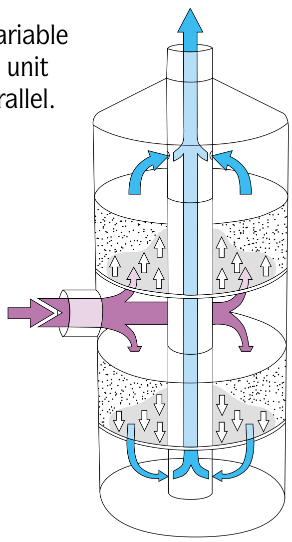
Contaminants are removed from the gas or liquid stream by the process of physical adsorption. Contaminant removal efficiencies are dependant on the nature of the contaminant, the carbon type, initial levels of contamination and gas flow rates.

When a carbon bed is saturated with the contaminant the material would normally be removed and exchanged for new material and the exhausted carbon either disposed of or reactivated by the carbon supplier. In certain applications in-situ regeneration can be undertaken a number of times by flooding the carbon bed with a chemical reagent. The carbon will, however, eventually become ‘poisoned’ by contaminants and need replacement.

Carbon adsorption is highly efficient and achieves high levels of removal, especially with VOCs and odours. However with large flows it may prove uneconomical. A useful procedure is to combine the economy of wet scrubbing or stripping with a subsequent ‘polish’ with activated carbon. The packed tower will remove the bulk of the contaminant while the final fraction – plus stray components not scrubbed or stripped – can then be adsorbed without prematurely exhausting the rather costly carbon bed.

Operating conditions and humidity levels are critical for carbon adsorption but the technique will usually accommodate variable flows.

An economical approach to larger or variable throughputs is to design an adsorption unit with two or more beds operating in parallel.



CARBON FILTER

## BIOLOGICAL FILTRATION

Biological abatement systems are based on the dispersion of the contaminated gas through a medium supporting specific bacteria which decompose the offending compounds and use them as feedstuff. The bacteria are encouraged to grow on special fibrous organic media in a large container or tower. Biological methods are commonly considered for odour abatement and we offer equipment specifically designed for difficult odour problems.

The Forbes biological odour control system offers:

- Virtually negligible operating and maintenance costs
- High efficiency with a very high internal surface area.
- Odours are transformed into harmless oxygen, carbon dioxide and a microbial biosludge which in some instances can be used as protein feedstock.

**For additional information please refer to our individual product leaflets.**

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## ANCILLARY EQUIPMENT

The effective operation of our scrubbers and strippers depends completely on the reliability of equipment such as pumps and fans so we are careful to select products of good quality. We specify well-designed, well-made products which are efficient to run.

Magnetic-drive pumps help to avoid problems with shaft seals and packings – especially when handling corrosive liquids.

Instrumentation is also important. We exercise the same care in procuring a simple VA flowmeter or a sophisticated automatic dosing control system with pH and redox control.

Please remember that we supply a wide range of small tanks and systems suitable for the storage of dosing chemicals.

## INSTALLATION

We offer a full offloading, positioning and installation service. Our experienced site engineers are fully trained in all aspects of site work, including confined space working, and are very experienced in handling this type of equuipment.

Alternatively, if you need a full turnkey service we can engineer, manufacture, install and commission plants to perform to your specification.

# PRODUCT RANGE

- Thermoplastics Tanks
- Tanks, Vessels & Fabrications
  GRP/THERMOPLASTICS DUAL LAMINATES
- Tanks, Vessels & Silos
  GRP COMPOSITES
- MINIBULK® Chemical Storage Systems
- Sectional Tanks
- Silos FOR SOLIDS & LIQUIDS
- Salt Saturators
- Pressure and Vacuum Vessels

- Fume and Odour Scrubbing Systems
- Vent Scrubbers
- $CO_2$ Degassers
- Stripping Towers
- Carbon Adsorption Units
- Bio Treatment Systems

- Ancillary Steelwork
- Skid Mounted Modules
- Turnkey Projects

**For further information visit our website at: www.forbesgroup.co.uk**

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