HYDROGEN SULPHIDE BIO-SCRUBBERS

The anaerobic digestion of organic matter produces methane and carbon dioxide. It can also lead to the production of other trace gases, such as hydrogen sulphide. As well as being a health and safety hazard, hydrogen sulphide can cause serious corrosion-damage to metal components in engines, burners and boilers. Therefore, it must be reduced to safe levels prior to the use of such gas in any commercial or long-term application.

Hydrogen sulphide can be removed from gas streams by means of several established technologies. The main advantage of a bio-scrubber is that in most circumstances there is no cost incurred for chemical-additions. The bacteria involved (*genera thiobacillus*) are ubiquitous. As long as the correct environmental conditions are maintained, the bacteria will function reliably and predictably in the removal of hydrogen sulphide from gas streams.

KEY FEATURES

Prevent corrosion in plant and equipment that can be brought about by hydrogen sulphide

Prevent emissions of sulphur dioxide

Remove health hazards that can result from high concentrations of hydrogen sulphide

Remove noxious odours

Organics gas bio-scrubbers meet all environmental standards for removing hydrogen sulphide.

SOME BASIC FACTS

Atomic weight 34.08
Melting point -85.5^{o}C
Boiling point -60.3^{o}C

Toxicological Summary:

Inhalation represents by far the most significant route of entry for hydrogen sulphide. Exposure to levels of hydrogen sulphide above 500 ppm even for short periods will generally result in rapid or immediate respiratory failure or collapse. Death will result unless the victim is rescued immediately and given pulmonary resuscitation. Exposure to levels below 500 ppm may result in serious consequences including unconsciousness and death

PROJECT ROUTE

FEEDSTOCK WASTE STREAM DEFINITION, QUANTIFICATION AND CHARACTERISATION

DETERMINATION OF MAXIMUM GAS FLOW RATE

DETERMINATION OF DESIGN RANGE OF HYDROGEN SULPHIDE CONCENTRATION

DETERMINATION OF DESIGN LOADING OF BIO-SCRUBBER

ASSESSMENT OF IMPACT OF AMBIENT CONDITIONS ON PERFORMANCE

LOCATION OF SOURCE OF MAKE-UP LIQUIDS FOR BIO-SCRUBBER OPERATION

DETERMINATION OF ANY MAKE-UP FLUID PRE-TREATMENT REQUIREMENTS

FIX CAPACITY, SYSTEM DIMENSIONS AND NECESSARY ANCILLARIES

SYSTEM DESIGN, PROCUREMENT, CONSTRUCTION AND DELIVERY

COMMISSIONING

OPERATION AND MAINTENANCE

DETERMINATION OF CAPACITY

Bio-scrubber capacity is a critical parameter for the successful long-term operation of a bio-scrubber. If, for example, at a given flow rate the hydrogen sulphide concentration were to increase from 2,000 ppm to 4,000 ppm, the bio-scrubber would require to twice the size to be able to achieve the same discharge concentrations. Clearly, discovering during project operation that the hydrogen sulphide loading expected was half of reality is a major set-back in a project's development and best to be avoided.

There is a great deal of data about probable ranges of hydrogen sulphide concentrations that might reasonably be expected from a yet to be constructed biogas plant. If this is coupled with an analysis of the sulphate loadings released with a specific organic waste substrate, it is possible to reduce to a small margin of error the design capacity of a specific facility. It is also highly advisable to maintain a healthy factor of safety in a performance specification. Whilst design can maintain environmental variables in a stable condition, there will be some inevitable variations in performance. Additional capacity comes with a relatively small margin of cost-increase at the design stage. After the project is built and operational, increasing the bioscrubber capacity can prove to be extremely expensive.

It should also be born in mind that ambient air conditions may impact upon performance. Very high ambient temperatures can have as much of a deleterious effect upon performance as low ambient temperatures. Bacteria will perform best when conditions in the bacterial colony remain as near constant as possible.

OPERATIONAL REQUIREMENTS

The main requirement of a functional bio-scrubber system is to provide a suitable environment in which bacteria can survive and flourish whilst they perform the duty required of them; in this case to remove hydrogen sulphide from a gas stream.

The bacteria will require the following parameters to be in place:

A suitable surface on which to grow and replicate. This is provided by packing within a fully sealed acid resistant vessel.

The bacteria require a certain amount of oxygen in order to remain healthy. This can come from atmospheric air

They will also require a sulphur supply, which in this case comes from the gas to be cleaned.

They must remain moist, requiring a continuous liquid spray to keep this condition stable.

They will require nutrients to grow and remain healthy.

The temperature must remain constant between 25^{o}C - 60^{o}C

In most cases the bio-scrubber will be operated with softened water as the liquid for keeping bacteria moist and making up fluids removed to maintain operational pH levels. Such water can come from an ion-exchange column, a distillation column or an RO-plant. Liquid NPK nutrient as specified by Organics will also be required. However, within the scope of certain applications it is an option to use treated water from palm oil or cassava production effluent treatment lagoons. It is a requirement that the treated water is free from suspended solids and without chemicals.

EFFLUENT

The effluent from an Organics bio-scrubber is an acidic solution of sulphate. The sulphur is bound as sulphate-S. The pH value of the effluent can be between 0.5 and 6.0 subject to operational settings. With the lowest pH value the effluent is not highly corrosive. It would correspond to a maximum of 3% sulphuric acid. However, care should be exercised in the selection of materials. Whilst not highly corrosive, long-term corrosion effects may be experienced.

The normal discharge arrangement is that effluent from the bio-scrubber is mixed with the treated effluent or biomass from the process lagoons. The quantity of liquid effluent from a bio-scrubber is generally small in comparison to the main discharge and has no measurable effect upon process effluent characteristics.

Where such an arrangement is not an option, effluent may be treated by a wide range of conventional processes. These range from recovery of elemental sulphur to use of lime to form gypsum. However, it should be remembered that the great advantage of the bio-scrubber is operational simplicity and low cost. Where significant chemical processing is to be considered in order to manage the effluent it may be appropriate to review other processes for the removal of hydrogen sulphide, such as amine scrubbers. Organics is able to supply such chemical processing solutions. (Please see Organics Datasheet ODSG12)

EFFLUENT USE OPTIONS

There are a number of viable options for use of the effluent from a bio-scrubber. Two of the main options, which fit in with the objectives of simplicity and low cost, are addressed below.

Effluent may be used as a liquid fertiliser. The sulphate-S present in the effluent is readily available to flora. S-fertilizers with sulphate-S have a greater value than S-fertilizers with elemental-S. Elemental-S requires to be oxidised to sulphate-S before it can be taken up by plants, a reaction which might take up to two or three growing seasons.

It is also possible to bind effluent sulphate as gypsum. This option requires that the effluent from the bio-scrubber is mixed with slaked lime. Lime reacts with the sulphate to produce gypsum. The gravity of gypsum is such that it may be rapidly settled out by means of simple sedimentation in a settling tank or pond and used directly for soil enrichment or, for example, within a composting facility.

As many bio-scrubbers are located in remote agricultural locations, the use of the effluent for soil enrichment and enhancement by either of the above processes provides an overall net benefit to the user.

ORGANICS

PROVEN EXPERIENCE IN GAS AND BIOGAS SYSTEMS WITH MORE THAN 20 YEARS EXPERIENCE AND OVER 500 INSTALLATIONS AROUND THE WORLD

STAND-ALONE COMPONENT SUPPLY

FULL PROJECT TURNKEY DESIGN, MANUFACTURE AND INSTALLATION AVAILABLE

FINANCE AVAILABLE THROUGH AFFILIATED COMPANIES FOR BIULD,OWN, OPERATE AND TRANSFER PROJECTS.

OPERATION AND MAINTENANCE SERVICES AVAILABLE

ORGANICS PROVIDES A ONE-STOP SOLUTION FOR A COMPLETE SERVICE RELATING TO THE COLLECTION, TREATMENT, COMBUSTION AND USE OF WASTE AND SURPLUS GASES

SPECIFICATION DATA

Flow rate in this standard range:
100 to 20,000 normal cubic metres per hour

Hydrogen sulphide concentrations:
Minimum 500 ppm (mass)
Maximum 30,000 ppm (mass)

Removal efficiency:
Typical = 90%,
Maximum = 99%

Pressure drop across scrubber:
Typical = 25 mbar gauge

Design standard:
"Good engineering practice" for low pressure systems
ASME UL approvals available
BS5500 approvals available
Lloyd's certification available

Flow control:
Flow rate is controlled by either a manual or a solenoid-actuated chemical duty butterfly valve. All valves are chosen to suit the chemical duty.

Materials:
To suit application. Materials include stainless steels, high quality alloys and plastics.

Control options:
Manual
Automated
Gas concentration alarms
Feed-back loops
SCADA

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WHY BIO-SCRUBBERS?

There are several principal options for removing hydrogen sulphide from gas streams. These range from simple water-scrubbing to liquid oxidant scrubbers, reduction reactors, bio-scrubbers, the use of activated carbon adsorbers, and ferric or zinc oxide beds.

Each method has its own distinct advantages and disadvantages. Each has proven to be the optimum solution for specific process situations. Organics can assess the governing parameters of specific situations and provide the best technical/ commercial solution on a case-by-case basis.

With regard to biogas, the currently generally preferred options are based upon the use of sodium hydroxide (caustic soda) solutions, sodium hypochlorite solutions or liquid amines.

The use of bio-scrubbers, however, has been recognised as an option carrying significant advantages over conventional technologies. When properly installed, bio-scrubbers can provide long-duration, reliable and predictable performance, making them highly suitable as a low-cost gas cleaning system in processes such as the generation of commercial power or preparation of feed-gas for use in industrial boilers.

STANDARD SCOPE OF SUPPLY

The standard scope of supply for a component delivery will be comprised of the following main components:

Main bio-scrubber vessel. There are a number of options for the selection of a suitable containment system, ranging from glass-reinforced plastic to glass or rubber-lined steel tanks and suitably treated concrete vessels. The selection of which containment system to use is based upon plant-capacity, location of use, location of manufacture and overall general compatibility with any existing facilities and systems.

Packing media. This is selected to maximise surface area for bacterial growth whilst minimising the possibility of blockages forming during operation.

Gas and liquid distribution systems. Whilst a bio-scrubber is not a counter-flow chemical scrubber or stripper, it does need to be designed to ensure proper distribution of flows within the vessel.

Ancillary components. These include circulation pumps, air blowers, valves, filters, instrumentation and controls. In colder climates, heating systems are required to maintain process temperatures.