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Bio-Scrubbers for Environmental Protection

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Abstract

Bioscrubbers involves the physical separation of Volatile Organic Compounds and its biological treatment. The waste gas is purified in the absorber called gas liquid contactor, in which the transformation of pollutants takes place from gas to liquid phase. The H_2S removal efficiency is higher in the bioscrubber. There are several types of bioscrubbers are discussed here under. Principles involved in the bio scrubbing process are bio transformation and bio-oxidation of pollutants present in air. It contains absorption column, gas liquid phase and liquid contactor. Operations are based on the few parameters like liquid flow rate, gas velocity, filter material, microbes and moisture content. It also has its specific view on the environmental benefits like no usage of chemicals, which does not cause any harm to environment. Advantages and disadvantages of these bioscrubbers and its drawback on removal of gases like H_2S, NH_3 and VOC are discussed.

Introduction

The bio scrubber is biological systems which are used for treatment of waste gas, air deodorization and in pre-treatment of air pollutants. It is a combination of water adsorption column and the other one is biological wastewater treatment for purifying waste water. The principle behind this is the pollutants are transferred from gas phase into a liquid phase (absorption step). This operation is performed with different technologies: a spray empty column, a packed column, or a venturi scrubber the column consists of plastic mass transfer packing of high specific surface area. In the biological treatment plant purification of the washing solution containing pollutants takes place.

Principle

In bio-transformation step-degradation of molecules by microbes takes place in activated sludge reactor. For oxygen concentration (air is > 2 mg/L) applied externally to the activated sludge. The bacterial suspension gets sedimented in sedimentation basin. Recycling of water takes place at top of gas liquid column. Clogging takes place in gas liquid contactor, to prevent them, settling tank is fixed before recycling. For this basic solution of pH 6-8 is adopted for bio-scrubber. But acidification of this aqueous solution takes place due to the VOC biooxidation process, so external application of lime is applied. If the solution is azeotropic in water, they are used in mass transfer column for absorption solution.

Construction

The bioscrubber contains a gas absorption chamber in order to give an extensive area of liquid surface getting close contact with the gas phase under the favorable conditions for the mass transfer. Contactors should have the

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following characteristics like dividing the gas into the small bubbles in a continuous liquid phase and the other one is spreading the liquid into the thin films so that it flows through the gas phase and finally the accumulation of the liquid into small drops in a continuous gas phase like spray chambers.

Operating Conditions

Bio-scrubbers are mainly for the molecular pollutants. Pre-treatment like filtration, gas washing by spray column or venture and separators are done to prevent clogging of the system. First step involves separating the pollutant present in air and converting from the gas phase to liquid phase and fro. Liquid gas flow rate ratio (L/G) parameter should be maintained carefully. Optimum quantity of water is allowed to avoid the flooding at the top of column. For complete degradation, biomass production and energy demand maintenance, a large amount of oxygen is required. But in multiphase bioscrubber, the bacteria needs higher amount of oxygen concentration to disintegrate the pollutant obtained at the organic solvent water phase. The adsorption columns are done with plastic type of material. The specific characteristics are, high bed porosity (> 80%) to prevent clogging caused by microbial film growth, high specific surface area for producing liquid film trickling for the transfer of pollutants in liquid solution. The diameter may vary based on flow rate and fraction of the gas velocity. Height of the column is obtained by the concept given by Whiteman two film theories (Pau san-Valero, 2019).

Environmental Uses of Bioscrubber

There are many technical of scrubber like carbon bed absorber, chemical absorber *etc*. as they are used for the prevention of odour emission in many other industrial applications due to cheap and effective cost and also have the lower impact on environment. We use only small amount of nutrients and no chemicals so it has effective side to the environment. Its efficiency is higher which is greater than 98% removal of H_2S gas so it maintains the level of sulfur gas and other pollutants in the environment. For carbon removal, carbon filters are used. The end products are not accumulated so it does not cause any harm to microbes.

Parameters to consider are:

- Selection of filter material;
- Moisture content of filter material;
- Micro-organisms;
- Concentration, flow, particulate matter and temperature.

Types

Anaerobic Bioscrubber

Not all the pollutants are removed under the aerobic condition so at that situation, the anaerobic reactors are used to improve the efficiency of the bio scrubber which is involved in the removal of the pollutants especially the hydrogen sulfide gas. For degrading complicated chemicals like perchloro ethylene UASB type of reactors are used, as the chlorinated hydro carbons are insoluble in water, to dissolve it, the organic solvent are added to the scrubbing liquid. The anaerobic bio-scrubber is used for rejecting of nitrous compounds and sulfur compounds.

Thermophilic Bioscrubbing

It is one of the largest bioscrubber types. In 1991, in Australia, a bioscrubber was adopted to treat 4,00,000 m^3 gas/h from a wood plate factory and other industries. The hot gas are passed to it containing formaldehyde, organic acids and wood particles which are all coming to the contact with the scrubber where the water is sprayed in the top direction in the mist form. This mist drop along with the pollutants which it absorbed enters into the top chamber in the upward direction, and the aerated sump enters into the bottom chamber. Here the sump is the thermophilic micro-organism suspension, and is the place where the pollutants were bio-degraded.

Bioscrubbers with Two Liquid Phases

This is the conventional type of bio-scrubber which is used for the water soluble compounds. The limit is set by Henry's law's co-efficient of 0.001. Here alkanes are used for the dissolution of the hydrophobic compounds. The water/solvent emulsion with the absorbed pollutants mainly in the organic phase are subsequently transported to a bio-reactor in which microbes first degrades the pollutants that is dissolved in the aqueous phase.in this method complete biological regeneration takes place. Separation of the aqueous and organic phase which plays an important role in bioscrubber. For this combination type is used like spray tower and liquid impelled loop reactor.

Cometabolic Bioscrubbing

Cometabolism is done only when the compounds are aerobically bio-degradable. It differs from substrate to substrate. This type of bioscrubbing is mostly done for the eradication of the trichloroethylene from gases. The gases were lead through a bio-reactor which contains the microbe namely *Pseudomonas cepacia* in the bubbles format. The growth substrate is added for the essential growth of the microbes. So phenol is added. It is not a classical bioscrubber but has the conventional configuration.

Removal of Gases

Hydrogen sulfide is efficiently removed in aerobic gas with 99% accuracy. This takes place in bio-reactors where the sulphide compound is first converted into sulfate to maintain pH alkali solution is added to control salt, water is flushed inside upto this is incomplete oxidation to proceed from this microbes takes place like *Thiobacillus* sp. In anaerobic condition H_2S is removed using amine absorbers and claus plants, whereas sulphur compounds are removed from flue gases by scrubbing with the solutions. EDTA is used

in the scrubber to remove the nitrogen compounds as it is poorly soluble in water (Van Groenestijn, 2001).

Advantages

- Small equipment volume.
- pH control is maintained better.
- It is reliable and predictable.
- We can experience the clogging does not occur.
- Toxic concentrations are in low level.

Disadvantages

- Operational cost is high.
- Difficult to dispose the sludge.
- Startup procedures is difficult to handle.
- Slow growing microbes get leached.

Conclusion

Comparing to bio-filters and bio-trickling filters, bio-scrubber are most effective in cost and pollutant removal, thought it has its own drawback the efficiency of removing pollutant is high and causes no harm to the environment. It treats waste gases and reduces the high concentration to the low concentration. Comparable programmes and technologies are made related to bio-scrubber in the anaerobic treatment. Combinations of bio-scrubbers are used wisely when the treated pollutants are not removed effectively. This process is the most important process for the biological waste gas treatment.

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