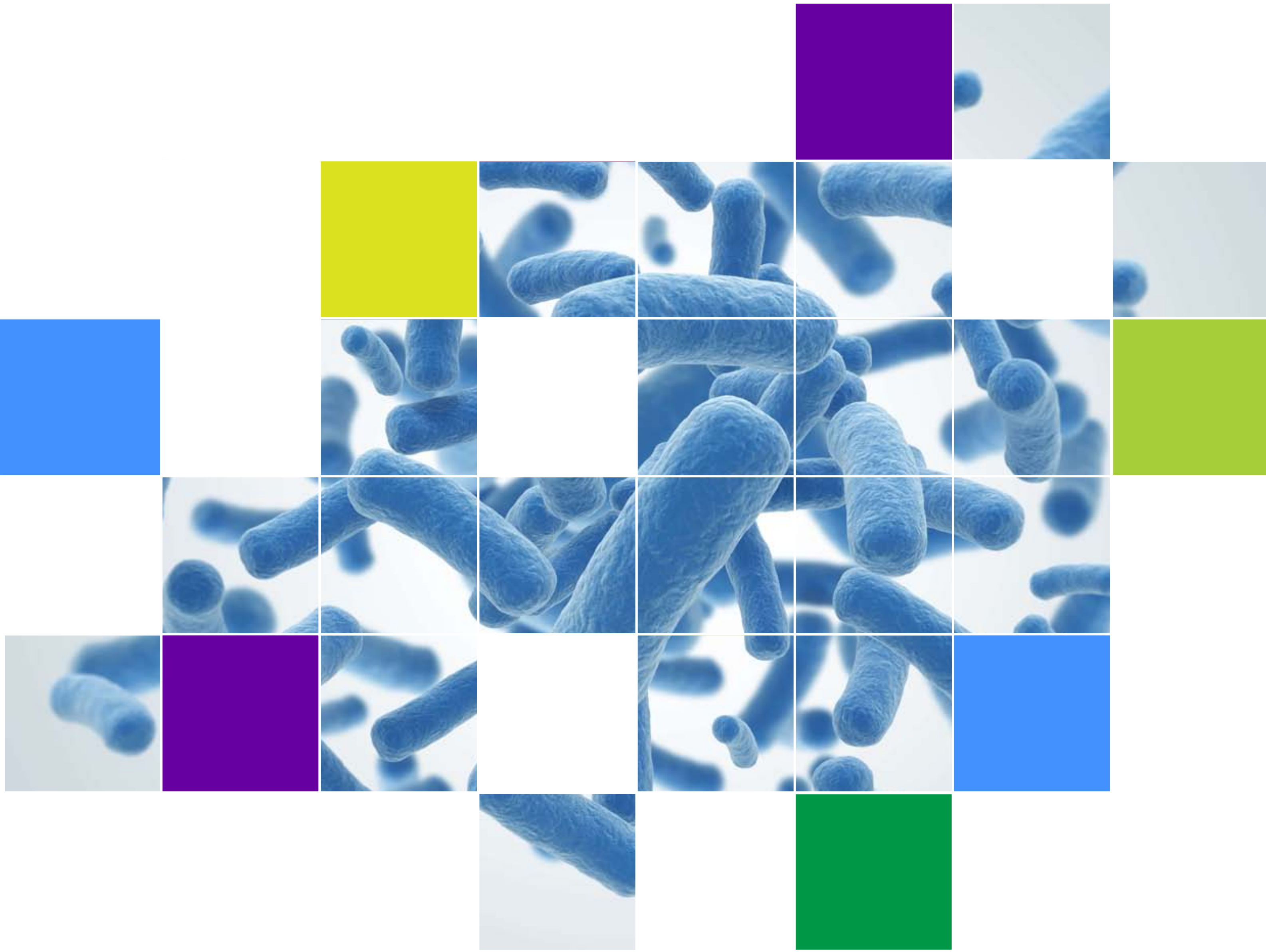
ECOTEC

dBiox®

Biotrickling filter



BIOGAS treatment, a clean technology

Global policies are progressively focusing on environment protection and the use of renewable energy souces. Livestock farms, breweries, food processing plants, ethanol distilleries, paper factories and waste water treatment plants must have their waste streams treated before they are discharged.

Anaerobic Digestion has proven to be the most cost-effective process to degrade the organic matter in waste streams . This process generates biogas, which contains a variable amount of methane (CH_4, 50-70%), carbon dioxide (CO_2, 30-50%) and hydrogen sulphide, in typical concentration ranges from 1.000 to 10.000 ppm and where biogas cleaning techologies can be used.

Clean biogas, H_2S free, is a renewable alternative to traditional sources of energy such as oil or gas, and it can provide efficient generation of electricity and heat by means of a profitable and enrironmentally friendly technology.

dBiox®:
A brief introduction to biotrickling filters

Biological systems for gas treatment is a technology with almost 100 years of history, which arised as a result of the search of efficient and cost-effective alternatives to physical-chemical treatments. Its operation is based on the capacity of certain mircoorganisms to use pollutant compounds as a source of carbon or energy and turning them into simple molecules. This capacity is used by systems known as bioreactors, being Biotrickling filters one of the most commonly used technologies in this field.

Biotrickling filters use an inert long-lasting packing with continuous liquid flow over the media bed. The sprayed liquid used in most applications is industrial water, and its purpose is to keep the bed moisted, which lowers costs even more.

The system does not generate secondary compounds, with the exception of a diluted water stream acidified with sulphate, that does not require of an specific treatment.

dBiox®: Operating principle

Our technology is based on a biological reactor with a scrubber-type washer (vertical configuration) which incorporates a high surface inorganic media where the microorganisms will grow. The metabolic process of these microorganisms will remove the pollutant compounds contained in the gas stream.

Unlike others, our media can be easily washed and it doesn't have to be replaced over time.

dBiox® technology does not require the use of chemical reactive (or a very small quantity whenever necessary). This fact minimizes running costs and eliminates the generation of toxic effluents that have to be treated.

dBiox® in desulphurization processes

H_2S removal in usable gases has traditionally been carried out by means of physical-chemical treatments such as adsorption or absorption with chemical reactives. In spite of their high efficiencies, they both have disadvantatges; the media must be replaced in the adsorption systems, while consumption costs of reactives in absorption systems are very high.

H_2S removal efficency of these systems is equivalent or even higher than conventional systems, while running costs are much lower, since reactive dosing and media replacement needs are reduced to almost zero. So, investment return is much faster than in tradicional systems.

The concept of the biotrickling filter is very similar to chemical scrubbers, but their design and operation conditions have been modified in order to adapt them to microorganisms requirements.

Below, a simplified representation of the reaction that takes place in a dBiox® filter:

Microorganisms

$$H_2S + 2O_2 =======> SO_{4}{-}^{2} + 2H^{+}$$

Advantages of dBiox® desulphurization

dBiox® application is specifically conceived to remove reduced sulphide compounds contained in the biogas for cogeneration.Our technology provides the following advantages:

- High H_2S removal efficiency
- Minimum reactive consumption
- Reduced operation costs, which provide short term investment return
- No waste generated
- dBiox® is feasible for high pollutant concentrations, and it can be used in applications where traditional systems are not suitable due to high running costs.

dBiox® operation diagram

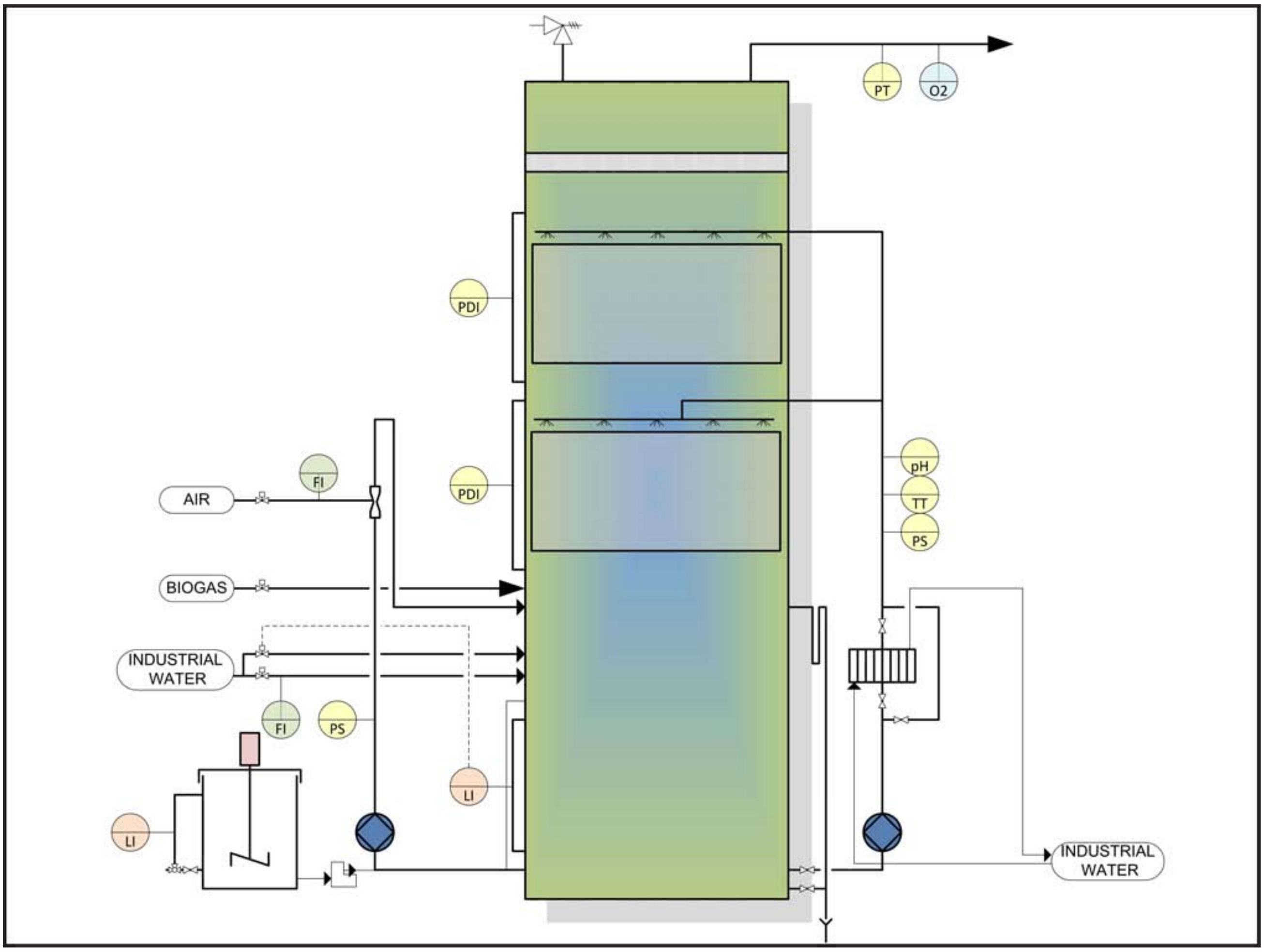


Fig: General diagram of dBiox® filter (one single stage)

Sulfur oxidizing bacteria (SOB) for H_2S removal

The group of SOB has traditionally included a very wide range of chemolithotrophic Bacteria that are able of lithotrophic grow (growth upon CO_2 fixation) on RSC oxidation (from which they obtain energy) like green sulfur bacteria, purple sulfur bacteria and colorless sulfur bacteria.

H_2S removal technologies are usually based on chemolithotrophic SOB.

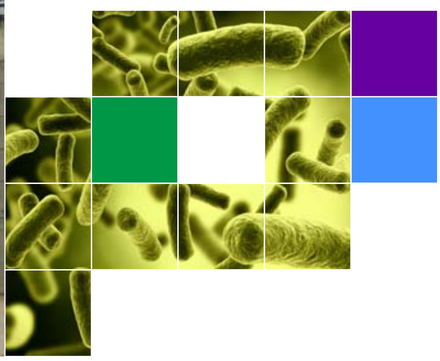
Among them, the colorless sulfur bacteria from the genus Thiobacillus are the most commonly reported and studied in literature due to its simple nutritional requirements and easy laboratory cultivation.

The colorless sulfur bacteria are prokaryotes that are able to obtain energy for their metabolism from RSC aerobic oxidation with oxygen as terminal electron acceptor,…

It means that oxidation of sulfur compounds in chemolithotrophic bacteria serves only to generate energy that will be used for CO_2 carbon fixation. It is not a process directly coupled to the carbon fixation process, but rather carbon fixation (bacterial growth) depends on RSC oxidation.

Due to the great number of species that fall into the group of colorless sulfur bacteria, they can be found growing at pH as low as 1 (such as Acidithiobacillus caldus) and up to mildly alkaline pHs of 10 (such as Thioalcalivibrio spp.) Also, some species can grow at temperatures as low as 4 ºC and others at temperatures as high as 95 ºC. However, the majority of them have optimum growing temperatures in the mesophilic range of 25-35 º C.

Morphologically, they can be shaped as rods, spirals, cocci, filamentous, etc., with lengths up to 100 um.



Metabolism of the reduced sulfur compounds oxidation in H_2S removal processes

Biological sulfide oxidation can be described by the following two overall reactions:

$$HS^- + 0.5\ O_2 \rightarrow S^0 + OH^- \qquad \triangle G^0 = -145.2\ kJ\ (mol\ S\text{-}substrate)^{-1}$$

$$HS^- + 2\ O_2 \rightarrow SO_4^{2-} + H^+ \qquad \triangle G^0 = -732.6\ kJ\ (mol\ S\text{-}substrate)^{-1}$$

From an energy gain point of view, bacterial respiration to sulfate is preferred over partial oxidation to sulfur since sulfate formation yields considerably more energy. Not considering any other issue, this suggests that biological sulfur formation is highly improbable in oxygen rich (sulfide limiting) environments and should only occur when sulfide concentration increases up to the point of turning oxygen into the limiting substrate. According to it, the O_2/H_2S concentration ratio would be the key parameter determining whether sulfur or sulfate is produced.

It is widely assumed that oxygen availability, under normal circumstances (i.e., no toxics or inhibitors presence or considering the bulk of SOB), determines whether sulfur or sulfate is the end product of biological sulfide oxidation.

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