

Odor Generation and Removal Within Wastewater Systems

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After experiencing the in-field affects that Biotifx™ products have on odor reduction; it is easy to understand that these products can reduce hydrogen sulfide and odor levels in a variety of industrial applications. The common question following that understanding is: how? Although *Bacillus* work in similar ways when it comes to pet odors, landfill odor, and drain odors, let's focus on the process of odor removal within wastewater systems.

Let's first start with some terms and concepts:

- **Hydrogen Sulfide (H₂S):** a colorless, corrosive and poisonous gas with a smell of rotten eggs
- **Volatile Fatty Acids (VFA's):** also known as "short-chain fatty acids"; weak organic acids containing one to six carbon atoms that are often malodorous
- **Sulfate Reducing Bacteria (SRB):** obligate anaerobes that use sulfate (SO₄) as electron acceptor instead of O₂, convert sulfur from SO₄ to H₂S, and depend on VFA's as a food source
- **Acid Producing Bacteria (APB):** obligate anaerobes that produce VFA's through fermentation
- **Septicity:** the souring of wastewater in uncontrolled anaerobic conditions

Wastewater systems release biological odors in the form of H₂S and VFA's from septic conditions where SRB's and APB proliferate due to a lack of oxygen, an abundance of sulfur and organic food source.

Sulfur Utilization: SRB

SRB proliferate, producing vast quantities of H₂S within anaerobic environments depending on the presence of sulfur compounds and food sources created by Acid Producing Bacteria APB.

One way Biotifx™ products lower H₂S concentrations is through the need for sulfur. For *Bacillus*, sulfur is a compound in great demand due to its assistance in producing certain amino acids required for proteins. A recent study of the genomes for many of our unique *Bacillus* strains in Biotifx™ indicates a high number of genes involved in the binding, utilization and assimilation of various forms of sulfur. Taking things a step further, by adding Biotifx™ we expect to see an increase in overall growth of the microbial community. This opens the door for other bacteria to increase their sulfur requirements in a similar fashion as populations grow.

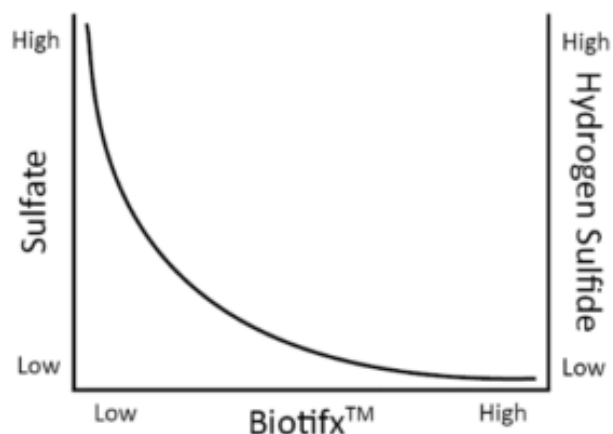


Figure 1: illustration of relationship between Biotifx™ and Sulfate/Hydrogen Sulfide

Considering the increase in growth of *Bacillus* and other microbes through the addition of Biotifx™ products, a lot of sulfur is used for creating proteins and enzymes required by the microbial cell. This limits the amount of sulfur and sulfate available for conversion into H₂S.

Acid Utilization:

In a similar way that *Bacillus* increase competition for sulfur, they also increase competition for VFA's. APB's produce various VFA's that SRB's require for growth. At the same time, the *Bacillus* bacteria in Biotifx™, as well as increased microbial populations, also considers these short carbon acids as food sources. As competition for these food sources increases, SRB's ability to produce H₂S declines. Additionally, many of the VFAs that APB produces are also malodorous and contribute to that "rotten-sewer smell". Consumption of these VFAs also limits their direct contribution to odors.

Sludge and Biofilm Digestion:

SRB are *obligate anaerobes* which means they cannot grow in the presence of oxygen. SRB and APB can proliferate in biofilm, sludge and grease caps commonly found in anaerobic lift stations, force mains, sewer lines and lagoons or anywhere septic conditions are prevalent. In sludge and biofilm, oxygen is quickly used up in the first 0.1 to 0.2 mm of sludge. Thus, everything below is oxygen limited or depleted making these environments an attractive place for SRB's to grow. The thicker and deeper the sludge and biofilms, the more H₂S and odor compounds can be produced.

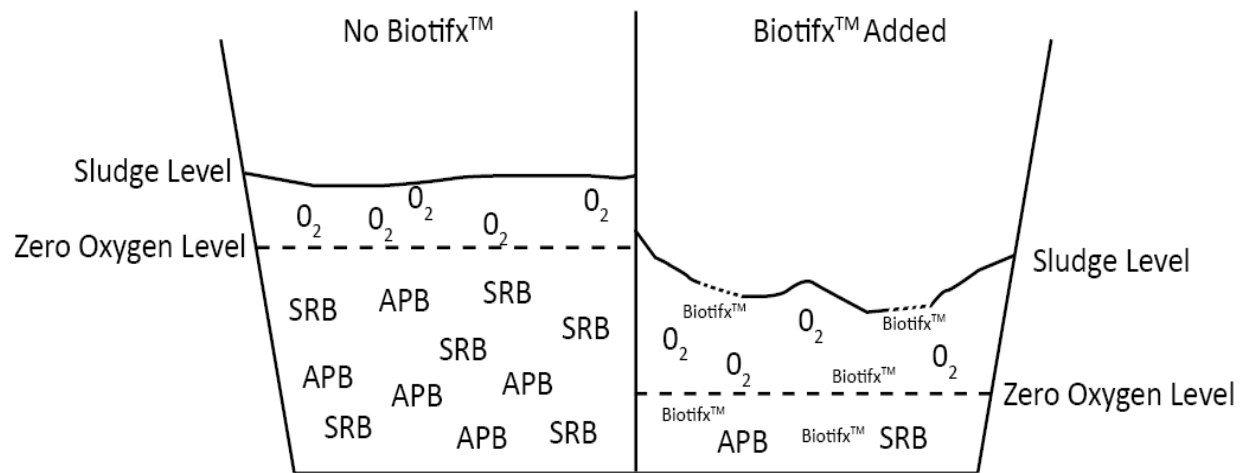


Figure 2: illustration of relationship between Biotifx™ and Sulfate/Hydrogen Sulfide

As many of you already know, Biotifx™ products greatly increases digestion of sludge, biofilms and grease caps. As these substrates are broken up and digested; oxygen is able to reach SRB and APB. This destruction of SRB's and APB's habitat inhibits their growth and proliferation and in turn reduces H₂S and odor production.

Summary:

Biotifx™ products increase sulfur consumption as well as digestion of sludge, biofilms and shorter chain acids. This reduces formation of H₂S and other odors in waste lagoons, lift stations, sewer lines, force-mains, sludge holding tanks and digesters.