Microbial Odor Control
in
Sewage Transport and Treatment

Bioscience, Inc.
Environmental Products & Services
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Sources of Odor

Odors may be generated in any section of a sewage collection system or wastewater treatment plant. These odors may be a result of industrial discharges, reactions which take place between combinations of industrial and municipal wastes mixing in the system, or anaerobic bacterial metabolism.

Hydrogen sulfide (H_2S) is the most common cause of odor complaints. In addition to the rotten egg odor, H_2S causes serious corrosion problems costing many millions of dollars in repairs each year. H_2S also serious health and safety concerns, and can diminish the effectiveness of any wastewater facility due to toxicity to the biomass that is necessary for biological treatment.

Another source of odors are fats, oils and greases (FOG). Volatile fatty acids, such as acetic, propionic and butyric acid, have a sharp or sour odor. These odors are generally caused by the decomposition of organic matter under anaerobic conditions.

Odor problems can also develop in composting facilities due to insufficient aeration or rapid ammonia production. Although composting is considered an aerobic process, there may be limiting factors (including the cost of turning piles and rainfall) that limit aeration.

In the collection system, biodegradation of organic matter rapidly consumes all or most of the available oxygen after which anaerobic processes take over. Odors escape from lift stations and maintenance access manholes as well as the headworks to the wastewater treatment plant. Perhaps the most serious foul smells are those that develop in interceptor sewers and lift stations, as they are often located in residential and/or commercial areas.

In recreational waters and treatment ponds/lagoons, odors are typically generated in the bottom or lower layers of sediment or in the water column from which the oxygen has been depleted by aerobic decomposition of organic matter.

In the wastewater treatment plant, odors are generated in the primary clarifiers and scum pits, aeration basins, secondary clarifiers, sludge processing equipment, and sludge storage areas. Sludge in drying beds, on vacuum filters, in storage tanks, or in sludge dryers is also a potential source of odor.

Production of Hydrogen Sulfide

The generation of H_2S in wastewater results principally from the biochemical decomposition of the waste components.

Bacteria remove electrons (oxidation) from the organic molecules, gaining energy. The electrons are then passed to an acceptor. This results in reduction of the acceptor. The electron acceptor can be an inorganic or organic substance.

Under aerobic conditions, free molecular oxygen (O_2) is used by the microbes as the electron acceptor in a process that produces water.

$$C_6H_{12}O_6 + O_2 \longrightarrow CO_2 + H_2O + \text{biomass} \quad \text{(aerobic heterotrophic bacteria)}$$

Under anaerobic conditions, various compounds or ions can be used by different groups of microbes as the electron acceptor. If neither oxygen nor nitrate (NO_3^-) is present, microbes that use sulfate (SO_4^{-2}) as an electron acceptor (sulfate reducing bacteria) predominate and these microbes generate sulfide.

$$C_6H_{12}O_6 + NO_3^- + H^+ \longrightarrow CO_2 + H_2O + N_2 + N_2O + \text{biomass} \quad \text{(denitrifying bacteria)}$$

$$C_6H_{12}O_6 + SO_4^{-2} + H^+ \longrightarrow CO_2 + H_2O + HS^- + \text{biomass} \quad \text{(sulfate reducing bacteria)}$$

(Note: equations are illustrative and not meant to show stoichiometry; H^+ on the left side indicates acid is consumed in the reaction while H^+ on the right indicates acid generation.)

Thus, as sulfate is normally present in wastewater, the sulfur cycle becomes a critical step in the breakdown of waste under anaerobic conditions. Sulfides are present in three forms: hydrogen sulfide (H_2S) at low pH, hydrosulfide ion (HS^-) at neutral pH and sulfide ion (S^{-2}) at high pH. The ionic forms stay dissolved in water while the neutral H_2S is easily volatilized. The oxidation of H_2S under highly aerobic conditions, e.g. in the biofilm above the waterline in sewers, generates corrosive sulfuric acid.

$$HS^- + O_2 \longrightarrow SO_4^{-2} + H^+$$

In contrast, the sulfur bacteria oxidize sulfide to elemental sulfur without the generation of acid.

$$H_2S + CO_2 \longrightarrow S^0 + CH_2O \text{ (organic cellular components)}$$

Elemental sulfur is not used by sulfate reducing bacteria, so the cycle is disrupted.

Production of Fatty Acids

Anaerobic metabolism typically generates volatile fatty acids such as acetic, propionic, butyric and longer chain acids. Although these compounds can be metabolic products of a variety of substrates such as amino acids, sugars and lipids, they are formed in large amounts from the breakdown of fats. These compounds contribute to the sour odor of anaerobic polluted water.

$$CH_3\text{-}(CH_2)_n\text{-}COOH + H_2O \longrightarrow CH_3\text{-}COOH + CH_3\text{-}CH_2\text{-}COOH + CH_3\text{-}(CH_2)_2\text{-}COOH$$

MICROCAT-ANL Odor Control Bioformula

Microcat®-ANL Odor Control Bioformula is a blend of strict and facultative anaerobic microbes selected for their ability to oxidize sulfides to elemental sulfur (collectively referred to as sulfur bacteria). Because it is a blend of several species and strains, some components of the blend can function when oxygen is present, some can use alternate electron acceptors such as nitrate, others only function in the absence of oxygen, and some are photosynthetic. Fatty acids are also metabolized by the strains in Microcat -ANL.

Applications

Microcat ANL is often used in primary clarifiers, ponds and lagoons, open tanks, and secondary clarifiers to control odor. Recommended maintenance dosage ranges from 1-30 ppm depending on sulfide concentration and biochemical oxygen demand (BOD). Dosage is normally higher initially until a population is established, then reduced to the maintenance dosage (see BSE033).

Microcat ANL is also used in collection systems (lift stations and sewer lines) and sludge storage and processing operations to reduce sulfide levels and odors. It replaces nitrate based chemicals for odor and corrosion control in the collection system and chlorine and masking agents in sludge processing. Downstream wastewater treatment plants have reported reduced oxygen demand and improved settling (see BSE72 and BSE104).

Microcat ANL can be used by composting facilities to reduce odor from compost piles (see BSE056). ANL targets H_2S and volatile fatty acids but will have minimal effect on released ammonia. ANL is especially effective when added to leachate and runoff from composting operations and when sprayed onto the surface of compost piles.

We recommend dilution of ANL (one gallon ANL plus 4 gallons water) and application at 10 gallons per 1000 ft^2 for surface odor control. If treating leachate or runoff in a holding pond, only 1.5 to 5 gallons per million gallons of pond water are required.

The following conditions are recommended:

- pH: must be between 6.0 - 9.0.
- eH: must not be below - 350 millivolts
- Temperature: must not exceed 108° F.
- H2S: must not exceed 80 ppm dissolved when ANL is introduced.
- Toxic conditions - which adversely affect the naturally present biomass will have the same effect on the ANL microbes.

Example Applications

Industry	Maintenance Dosage	Results
Dairy/Cheese	40	Eliminated H_2S odors , Reduced effluent BOD_5, Reduced pond aeration costs.
Rendering	40	Eliminated odor complaints, Reduced aerator costs, BOD/TSS permit standards met.
Meat Packing	10	Dramatically reduced H2S odors.
Municipal	6	Dramatically reduced odor calls, Pond H_2S levels < 0.05 ppm,
Municipal/ Food Processing	7	Drastically reduced H2S levels, BOD removal increased up to 90%.
Municipal	1.25	Dissolved H_2S reduced from 5 to <1 ppm.
Municipal	2	Reduced trickling filter odors.
Pulp and Paper	2	Primary clarifier odor eliminated, Belt press room H_2S levels reduced from 50 ppm to <2 ppm.
Soy Bean Refining	11	Odor complaints eliminated, Effluent COD/TSS improved.

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