

Anaerobic Bacteria of Water & Soils

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You've probably heard these terms; Sulfate-Reducing Microorganisms, Sulfate Reducing Bacteria (SRB), Turf Slosh, Root Rot, Black Layer, Organic Matter, Rotten Egg odor, Stinky Feet odor, Hydrogen Sulfide Gas (H₂S), Sulfurous Acids, the lethality of H₂S to humans commonly posing challenges in manholes, sewer lines and under ground wells of all sorts, the safety training of H₂S and creation of H₂S detectors to prevent fatalities.

Have you ever observed roots from plants or turf in soils laden with black layer, sustaining vegetation?

Below you will find how that water retention, that constant wet area, that non-draining slosh, odor and or vegetation challenge is likely caused by "compromised infiltration" followed by bacteria colonization, namely sulfate reducing bacteria, also referred to as SRB, and commonly mistakenly identified as black layer and or organic matter. It's not so much the bacteria that is the problem, as are its exudates, its waste products, which are water, sulfurous acids and toxic / lethal hydrogen sulfide gas. The gas itself can be non-detected by human smell and be lethal to vegetation and humans.



Mitigating the problem can be nearly impossible as the bacteria feed on common water and soil products including sulfur, sulfate and possible manganese and iron, turning waters both above ground and in soils, septic, then exuding its toxins. These bacteria, in ideal circumstances of moisture and temperature can duplicate exponentially, and about the only way to minimize they is through continuous oxygenation.

Below are details about SRB and how they compromise our world of soil, water vegetation vitality and crop production and how WaterSOLV™ BC, also perhaps in combination with other catalysts, can be used effectively and efficiently in a soil and water treatment program.

When you see accumulations Sulfur, Sulfate, Zinc, Iron and or Manganese in your soils, or visualize a darkened hue of your soils, and or odor, the sooner you address the problem the better as the bacteria is growing exponentially.

Desulfovibrio vulgaris is the best-studied sulfate-reducing microorganism species.

Sulfate-reducing microorganisms (SRM) or sulfate-reducing prokaryotes (SRP) are a group composed of sulfate-reducing bacteria (SRB) and sulfate-reducing archaea (SRA), both of which can perform anaerobic respiration utilizing sulfate (SO_2-4) as terminal electron acceptor, reducing it to hydrogen sulfide (H_2S). Therefore, these sulfidogenic microorganisms "breathe" sulfate rather than molecular oxygen (O_2), which is the terminal electron acceptor reduced to water (H_2O) in aerobic respiration.

HCT States: Sulfate and sulfur are food sources. Exudates, sulfurous acid, dissolves scale, minerals and metals, H_2S is hydrogen sulfide gas, and is lethal to humans as well as vegetation. The H_2O respiration is an example of "slosh" in turf. A stinky odor is the gas of the hydrogen sulfide. WaterSOLV™ BC overcomes these conditions. With Curative, the BC is catalyzed, even more effective.

Sulfate-reducing microorganisms can be traced back to 3.5 billion years ago and are considered to be among the oldest forms of microbes, having contributed to the sulfur cycle soon after life emerged on Earth.

Many organisms reduce small amounts of sulfates in order to synthesize sulfur-containing cell components; this is known as assimilatory sulfate reduction. By contrast, the sulfate-reducing microorganisms considered here reduce sulfate in large amounts to obtain energy and expel the resulting sulfide as waste; this is known as dissimilatory sulfate reduction. They use sulfate as the terminal electron acceptor of their electron transport chain. Most of them are anaerobes; however, there are examples of sulfate-reducing microorganisms that are tolerant of oxygen, and some of them can even perform aerobic respiration. No growth is observed when oxygen is used as the electron acceptor. In addition, there are sulfate-reducing microorganisms that can also reduce other electron acceptors, such as fumarate, nitrate (NO_3), nitrite (NO_2), ferric iron (Fe^{3+}), and dimethyl sulfoxide (DMSO).

HCT States: Hence the value of WaterSOLV™ BC and Curative as a catalyst, which degrades to dissolved oxygen and water.

In terms of electron donor, this group contains both organotrophs and lithotrophs. The organotrophs oxidize organic compounds, such as carbohydrates, organic acids (such as formate, lactate, acetate, propionate, and butyrate), alcohols (methanol and ethanol), aliphatic hydrocarbons (including methane), and aromatic hydrocarbons (benzene, toluene, ethylbenzene, and xylene). The lithotrophs oxidize molecular hydrogen (H_2), for which they compete with methanogens and acetogens in anaerobic conditions. Some sulfate-reducing microorganisms can directly use metallic iron (Fe^0 , also known as zerovalent iron, or ZVI) as electron donor, oxidizing it to ferrous iron (Fe^{2+}).

HCT States: Which in turn can lead towards the nutritional sources of iron reducing bacteria and bio-films.

The toxic hydrogen sulfide is a waste product of sulfate-reducing microorganisms; its rotten egg odor is often a marker for the presence of sulfate-reducing microorganisms in nature. Sulfate-reducing microorganisms are responsible for the sulfurous odors of salt marshes and mud flats. Much of the hydrogen sulfide will react with metal ions in the water to produce metal sulfides. These metal sulfides, such as ferrous sulfide (FeS), are insoluble and often black or brown, leading to the dark color of sludge.

During the Permian–Triassic extinction event (250 million years ago) a severe anoxic event seems to have occurred (National Geographic - The Cosmos) where these forms of bacteria became the dominant force in oceanic ecosystems, producing copious amounts of hydrogen sulfide.

Sulfate-reducing bacteria also generate neurotoxic methylmercury as a byproduct of their metabolism, through methylation of inorganic mercury present in their surroundings. They are known to be the dominant source of this bioaccumulative form of mercury in aquatic systems.

Economic Importance

Sulfur is intimately involved in production of fossil fuels and a majority of metal deposits because of its ability to act as an oxidizing or reducing agent. The vast majority of the major mineral deposits on Earth contain a substantial amount of sulfur including, but not limited to: sedimentary exhalative deposits (SEDEX), Carbonate-hosted lead-zinc ore deposits (Mississippi Valley-Type MVT) and porphyry copper deposits. Iron sulfides, galena and sphalerite will form as by-products of hydrogen sulfide generation, as long as the respective transition or base metals are present or transported to a sulfate reduction site. If the system runs out of reactive hydrocarbons economically viable elemental sulfur deposits may form. Sulfur also acts as a reducing agent in many natural gas reservoirs and generally ore forming fluids have a close relationship with ancient hydrocarbon seeps or vents.

Important sources of sulfur in ore deposits are generally deep-seated, but they can also come from local country rocks, sea water, or marine evaporites. The presence or absence of sulfur is one of the limiting factors on both the concentration of precious metals and its precipitation from solution. pH, temperature and especially redox states determine whether sulfides will precipitate. Most sulfide brines will remain in concentration until they reach reducing conditions, a higher pH or lower temperatures.

Ore fluids are generally linked to metal rich waters that have been heated within a sedimentary basin under the elevated thermal conditions typically in extensional tectonic settings. The redox conditions of the basin lithologies exert an important control on the redox state of the metal-transporting fluids and deposits can form from both oxidizing and reducing fluids. Metal-rich ore fluids tend to be by necessity comparatively sulfide deficient, so a substantial portion of the sulfide must be supplied from another source at the site of mineralization. Bacterial reduction of seawater sulfate or a euxinic (anoxic and H₂S-containing) water column is a necessary source of that sulfide. When present, the $\delta^{34}\text{S}$ values of barite are generally consistent with a seawater sulfate source, suggesting baryte formation by reaction between hydrothermal barium and sulfate in ambient seawater.

Once fossil fuels or precious metals are discovered and either burned or milled, the sulfur become a waste product which must be dealt with properly or it can become a pollutant. There has been a great increase in the amount of sulfur in our present-day atmosphere because of the burning of fossil fuels. Sulfur acts as a pollutant and an economic resource at the same time.

Human Impact

Human activities have a major effect on the global sulfur cycle. The burning of coal, natural gas, and other fossil fuels has greatly increased the amount of sulfur in the atmosphere and ocean and depleted the sedimentary rock sink. Without human impact sulfur would stay tied up in rocks for millions of years until it was uplifted through tectonic events and then released through erosion and weathering processes. Instead, it is being drilled, pumped and burned at a steadily increasing rate. Over the most polluted areas there has been a 30-fold increase in sulfate deposition.

Although the sulfur curve shows shifts between net sulfur oxidation and net sulfur reduction in the geologic past, the magnitude of the current human impact is probably unprecedented in the geologic record. Human activities greatly increase the flux of sulfur to the atmosphere, some of which is transported globally. Humans are mining coal and extracting petroleum from the Earth's crust at a rate that mobilizes 150×10^{12} gS/yr, which is more than double the rate of 100 years ago. The result of human impact on these processes is to increase the pool of oxidized sulfur (SO₄) in the global cycle, at the expense of the storage of reduced sulfur in the Earth's crust. Therefore, human activities do not cause a major change in the global pools of sulfur, but they do produce massive changes in the annual flux of sulfur through the atmosphere.

When SO₂ is emitted as an air pollutant, it forms sulfuric acid through reactions with water in the atmosphere. Once the acid is completely dissociated in water the pH can drop to 4.3 or lower causing damage to both man-

made and natural systems. According to the EPA, acid rain is a broad term referring to a mixture of wet and dry deposition (deposited material) from the atmosphere containing higher than normal amounts of nitric and sulfuric acids. Distilled water (water without any dissolved constituents), which contains no carbon dioxide, has a neutral pH of 7. Rain naturally has a slightly acidic pH of 5.6, because carbon dioxide and water in the air react together to form carbonic acid, **a very weak acid**. Around Washington, D.C., however, the average rain pH is between 4.2 and 4.4. Since pH is on a log scale dropping by 1 (the difference between normal rain water and acid rain) has a dramatic effect on the strength of the acid. In the United States, roughly two thirds of all SO₂ and one fourth of all NO₃ come from electric power generation that relies on burning fossil fuels, like coal.

As it is an important nutrient for plants, sulfur is increasingly used as a component of fertilizers.

Anaerobic Organism

An anaerobic organism or anaerobe is any organism that does not require molecular oxygen for growth. It may react negatively or even die if free oxygen is present. In contrast, an aerobic organism is an organism that requires an oxygenated environment. Anaerobes may be unicellular or multicellular. Most fungi are obligate aerobes, requiring oxygen to survive. However, some species, such as the Chytridiomycota that reside in the rumen of cattle, are obligate anaerobes; for these species, anaerobic respiration is used because oxygen will disrupt their metabolism or kill them. Deep waters of the ocean are a common anoxic environment.

Welcome . . .

WaterSOLV™ BC

Still founded on peroxide, but very different because it does a whole-lot-more.

- Still a disinfectant so to speak in the agronomy world. I prefer to refer to it as a biocide. Two totally different items/terms.
- **It sequesters water minerals and metals, meaning the elements in the water will never complex or bond – available nutrition from all water source minerals and metals.**
- **It should affect soils dramatically with respect to soil cake and some available nutrition.** What I mean is it's not that great at "fixing" soils like what one does with sulfuric and gypsum. It does not have the power to dissolve the complexes in soil.
- **We detoxify the sodium and the chloride. Nobody else does this. No phosphoric acid or other things needed to deal with the Na or Cl.**

Our use rate will be 1/2 to 2.5 ppm – that's just 1/2 to 2.5 gallons per million gallons of water. Sold in pails, drums and totes. Enhanced product growth is stunning, visual, due to the detoxification of Na and Cl, and the acetates it adds to the soils forming, all forming readily hydratable and re-hydratable nutrition from the water and the soils.

Lots of features and benefits:

Like HCT WaterSOLV™ Curative requires 1/9th the amount of acid to sulfurous acid, this product is more than effective at the 1 to 2.5 ppm use rate. The use rate is science and biology. See how; https://www.hctlc.com/files/ugd/725874_42ec2cb588e141358dda7e2c8de92a1b.pdf

We have references! Lots and lots.

Pricing, you have 2 choices, the OMRI or NON-OMRI. See attached pricing list "WaterSOLV™ BC"

Our OMRI Certificate:

https://www.hctlc.com/files/ugd/725874_ea76ea0ff22044148be0fd8170dfbfc3.pdf

Restrictions: **For use as a plant disease control or as an algicide, disinfectant, or sanitizer.**

May only be used if the requirements of 205.206(e) are met, which requires the use of preventive, mechanical, physical, and other pest, weed, and disease management practices. Also for use as an inert ingredient in passive pheromone dispensers.

Product Data Sheet:

https://www.hctlc.com/files/ugd/725874_5160835f1a10421f8ac56082222ce5d4.pdf - See WaterSOLV™ BC ORGANIC.

The rewards of using our technology usually outweigh its expense significantly. We call this the Offsets:
<https://www.hctlc.com/value-and-offset>

HCT WaterSOLV™ Curative and WaterSOLV™ BC have attributed to 20% increase in nut yields, 50% increase in citrus yields, the best strawberry harvest ever by a national growing organization on the west coast, blueberries grown at near neutral pH values, all while growers harvest existing nutrient accumulations from their soils and reduce water demand upwards of 15%.

Seeing is believing, Trying is seeing. Harvest what you already have in your soils, you bought and paid for that is also likely hindering your crops production.

For more information, contact a dealer near you. See our dealers at www.hctlc.com

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Vegetation vitality through soil by water treatment.

Well-Klean®, WaterSOLV™, Water Treatment for Agronomy™, Water SOLV™ pHix & WaterSOLV™ Grow are trade names of HCT, LLC - Prescription without diagnosis is malpractice. HIS plan is always perfect and we choose to follow HIS lead - We are always open to testing things we have not already invested significant resources to know.