ZymeOut™

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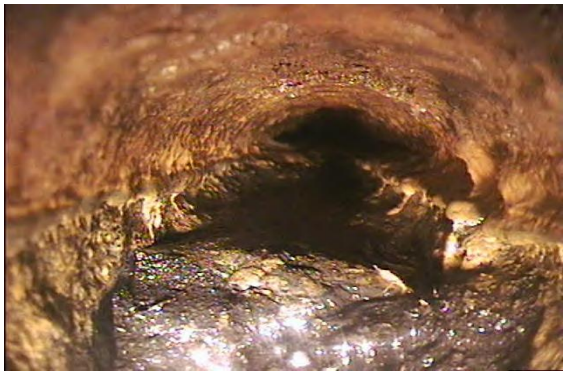
LCP Tech, Inc has developed a mixture of non-toxic chemistries and enzymes called **ZymeOut™**. This chemistry takes out the odor by preventing hydrogen sulfide (H2S) gas created by the presence of Sulfate Reducing Bacteria (SRB). SRB convert sulfate in water to sulfide, resulting in a number of adverse effects, which includes:

1. Generation of toxic hydrogen sulfide, "rotten egg smell"
2. Severe pitting and corrosion [(MIC) Microbial Induced Corrosion], even in stainless steels and concrete
3. Metal precipitation, which enhances biologically generated sulfide
4. Forms biofilms (slime layers) which resist even the strongest biocides
5. Presence of SRB also contribute to fungal growth

Benefits of using ZymeOut™

1. Non-Toxic, Non-Biocidal, Worker Friendly Product
2. Stops generation of hydrogen sulfide gas at the source and eliminates odor of "rotten eggs"
3. Controls microbial induced corrosion (MIC)-by Stopping H2S.
4. Natural death rate of SRB exceeds growth rate.
5. Slime layers naturally soughs off where sulfide is generated.
6. Stabilizes the pH
7. Not impacted by varying pH or temperature
8. Extends sewer or bath life
9. Eliminates black sulfide precipitates.
10. Controls fungal growth caused by presence of sulfide and clears up pond water which provides the potential for recycling. This also can mean less evaporation.



Buildup in Sewer Pipe resulting in clogging and corrosion

The use of **ZymeOut™** breaks the sulfur cycle by preventing the formation of sulfide within the slime layers. It is not a biocide and does not harm any bacteria – aerobic or anaerobic. It allows the slime layers to break up on there own by disrupting the capability of sulfate reducing bacteria (SRBs) to form and fortify the slime layers. This results in slime layer sloughing off, thereby eliminating the major source of sulfide production within the sewer pipe.

Industries that can benefit from using ZymeOut™

Sugar & Sugar Beet Ponds & Lagoons , Municipal Sewers, Pulp & Paper Industry, Oil Drilling, Biogas Production in Anaerobic Sludge Digesters.

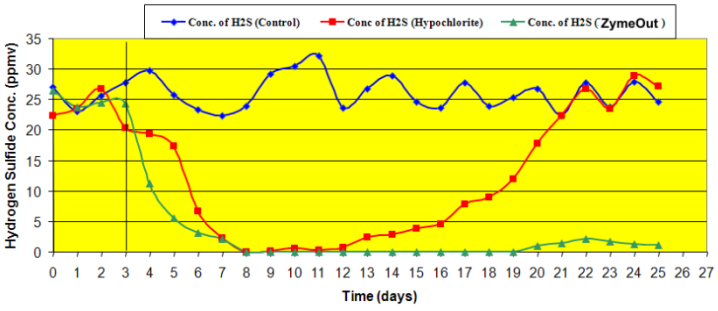
Any Industry with Odor or Corrosion issues due to H2S

Customer Studies

Case Study:
ZymeOut™ has been tested by two sugar beet companies where it is added to lagoons to prevent the generation of hydrogen sulfide gas. The companies were concerned about odor and government fines for exceeding H2S levels. **ZymeOut™** successfully controlled the H2S and the associated odor. Over time the lagoons became clearer. The reduction of sulfides helps prevent the growth of algae and other types of anoxic bacteria that can produce foul smell and turbidity in the lagoon.

Laboratory Studies

Lab Study 1:
Three continuous stirred tank reactors were operated with sulfate and organic feed, with nitrogen gas being bubbled to remove any hydrogen sulfide formed. The control reactor had no additive. In Reactor 2, Hypochlorite was added and in Reactor 3. **ZymeOut™** was added on Day 3. The concentration of hydrogen sulfide gas was measured in the exit gas as shown in the graph below. **ZymeOut™** was able to inhibit the production of the H2S significantly better than hypochlorite. On a 25 day period, based on the total H2S produced, **ZymeOut™** was 60% more effective than hypochlorite.

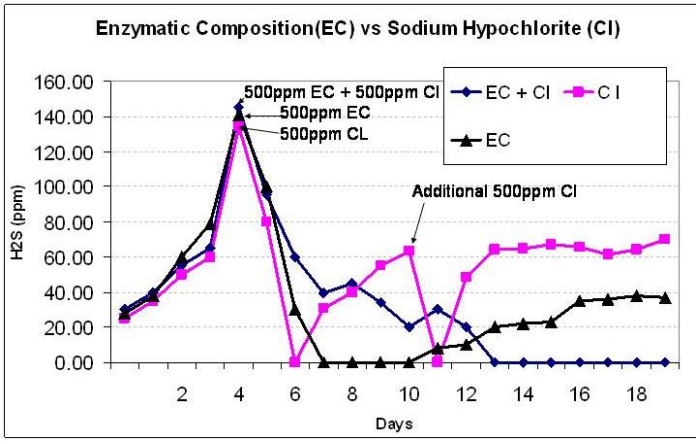


Effect of Addition of Hypochlorite and ZymeOut™

Lab Study 2

A test was conducted at bench scale using four sealed 5-gallon containers. Each 5-gallon container was essentially a SRB landfill reactor filled with waste drywall (calcium sulfate), a nutrient source and leachate from a landfill (containing SRB) that had hydrogen sulfide odor issues. The leachate resulted in strong active SRB colonies within the SRB reactor. Nitrogen gas was continually passed through the containers to eliminate any oxygen that could suppress hydrogen sulfide production and to provide a gas flow in which hydrogen sulfide produced in the reactors could be measured. Various levels of **ZymeOut™** were then added to selected containers and the hydrogen sulfide levels were monitored in the nitrogen stream from each of the containers over time. Low levels of **ZymeOut™** at 0.01% (100ppm) to 1.0% controlled SRB growth and stopped hydrogen sulfide production for one day to greater than 90 days (completion of the test). The control reactor had H2S levels from 250 to > 800ppm which was the detection limit on the H2S sensing instrument.

In addition to the above testing, in the same reactors, 500 ppm of a 10% solution of sodium hypochlorite was added to one of the reactors. An identical amount hypochlorite was added to the other reactor, along with about 500 ppm of **ZymeOut™** (labeled as EC in the figure). The hydrogen sulfide levels measured in each reactor over time are presented in the figure below. The reactor with the **ZymeOut™** went to zero H2S production over about 8 days, and stayed at zero for greater than 8 days thereafter. The reactor with bleach alone required another identical dose of hypochlorite, which only suppressed H2S production for less than 1 day. It is clear from the figure that the **ZymeOut™** can work cooperatively with biocidal compositions such as hypochlorite to effectively extend the useful lifetime of inexpensive biocides.

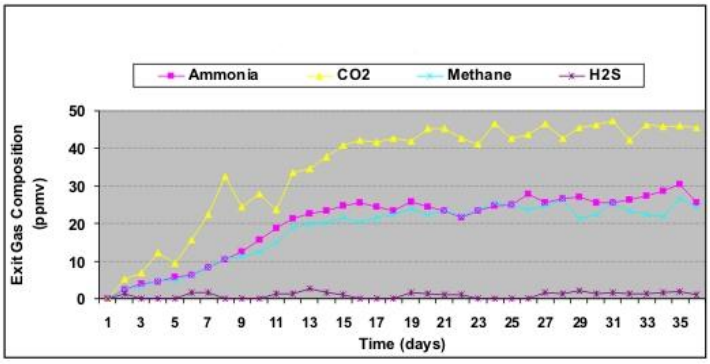


This data shows how ZymeOut™ works to expose the bacteria that are "hiding in the slime layers" so that the biocide can be extremely effective. The hypochlorite does not work alone. Repeated doses cannot penetrate the slime layers.

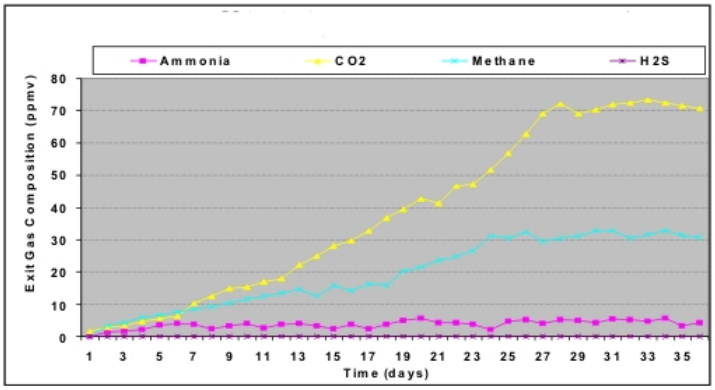
Lab Study 3

The following experiments were conducted in 50 mL test tubes with 30 mL of wastewater. Each test tube was equipped with a tube fitted to a fritted glass piece to disperse the injected gas into small gas bubbles. The exit gas from each tube was monitored and gas composition was analyzed using a gas chromatograph.

Untreated Wastewater



Less than 3ppm ZymeOut™



These results showed that less than 3 ppm **ZymeOut™** eliminated the formation of hydrogen sulfide, inhibited the formation of ammonia from about 25 ppmv to 5 ppmv, and increased methane production from about 24 ppmv to 31ppmv in the wastewater under anaerobic conditions

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