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Association of Water Technologies

Associated Laboratories, Inc.
Member

Project: Bio-Regen$_{TM}$ Animal: Hog Lagoon Program

Date: May 14, 2004

Objectives:

The purpose of this project is to provide a wastewater lagoon treatment solution which minimizes the potential for odor-causing compounds to become airborne. This document outlines a treatment program using the product Bio-Regen Animal to effectively reduce odor causing compounds created by non-beneficial microbes, as well as to determine the ability to reduce pump out sludge in a hog lagoon.

Product: Bio-Regen Animal

Bio-Regen products combine the purely unique properties of Carboxx$_{TM}$ with carefully selected, stabilized microbes to create a specialized and effective charged reaction. Carboxx is a natural, supersaturated highly soluble, High Reactivity Humic Acid (HRHA) from a family of broad based humates. The HRHA component of Carboxx is a low ballast, low ash solution which is rich in Quinone, Carboxyl, Phenol and Amino groups with condensed aromatic structures representing a high reactivity potential. Carboxx contains 98.5% HRHA, providing the ideal natural environment for accelerated decomposition of complex organic matter.

The stabilized microbe package specific to the Animal Waste product have been engineered to address the complex environment found in manure specific waste streams. These microbes have been targeted to break down organic compounds such as Ammonia, H2S, Nitrates, Mercaptaines and other odor causing compounds.

What are the primary odor causing compounds associated with swine production?

Over 168 chemical compounds have been identified in the air within swine confinement buildings (Mackie et al., 1998). Some of the main odorous compounds are ammonia, sulfur-containing compounds (H_2S), amines, volatile fatty acids, indoles, skatoles, phenols, alcohols, and carbonyls. Many of the odorous compounds are a result of anaerobic microbial decomposition of manure and wasted feed.

Two odorous compounds that receive a great deal of attention are ammonia and hydrogen sulfide. There are two forms of ammonia in solution: NH_3 which is a non-ionized gas and NH_4 which is the ionized form. The relative proportion of each depends upon the pH. In addition to being an odor problem, ammonia gas is increasingly being considered an environmental problem because it tends to be oxidized by various oxidants in the air to produce nitrous oxides, which are irritants to the eyes and respiratory tracts. Below are the effects of various NH_3 levels (Irvine et al.: 2002)

Ammonia level in ppm	Resulting conditions on Humans
0 -25	Minor irritation of the eyes and respiratory tract
25	Permissible exposure limit (OSHA)
25-100	Swelling of the eyelids, conjunctivitis, vomiting, irritation of the lungs and throat
100-500	Concentrations are dangerously high, irritation becomes intense. Death can result highly concentrated prolonged exposure

Hydrogen Sulfide (H_2S), which is produced by anaerobic microorganisms that convert sulfate in manures to sulfide, is considered the characteristic odor of livestock urine. It is a highly toxic and malodorous gas that can reach levels that are threatening to livestock and humans. One time exposure to 2000 ppm has proven fatal to humans. In addition, animals exposed to low doses may become more susceptible to pneumonia and respiratory diseases.
Toxicology (Irvine et al.: 2002)

OSHA Ceiling	20 ppm
TLV/TWA	10 ppm
TLV/STEL	15 ppm
TLV/IDLH	300 ppm
NIOSH Ceiling	10 ppm/ 10 minutes
EVACUATION	> 65 ppm

Background Data:

As stated above, the two odorous compounds that are mainly associated with hog manure are Ammonia (NH_3) and Hydrogen Sulfide (H_2S). For this reason Guardian CSC has focused its quantifiable data around these two compounds. Other forms of qualitative measurements exist, however, due to high costs and often irreproducible results the trial has been focused around the reduction of NH_3 and H_2S in and around the facility.

To determine a baseline, data was collected over a two day period prior to the inoculation of the lagoon with the Bio-Regen Animal Product. The scope of this data was to determine areas of high concentrations of H_2S and Ammonia. Air samples were taken every hour at multiple locations in and around the barn to determine the optimal locations to take samples for the duration of the study. The following 14 locations were tested weekly for the duration of the study.

(2) Feed areas inside the barn, (2) 10 feet back from barn level exhaust systems, (10) 1 foot from lagoon exhaust fans. (Total of 12, Diagram 1)

An aqueous sample was taken from the pit every week and analyzed by B&H labs, a national third party laboratory. The samples were tested for:

TSS(mg/L), Percent Solid, VOC(mg/l), BOD(mg/l), COD(mg/l), Total Phosphorous(mg/Kg), Total Potassium(mg/Kg), Nitrogen(mg/Kg), and Dissolved Oxygen(mg/l).

Average measurements of NH_3 and H_2S for the above locations prior to inoculation are as follows:

AVERAGE NH_3 READINGS

Feed areas	14.55 ppm
Rear Exhaust	7.7 ppm
Lagoon Exhaust	9.95 ppm
Ambient Temperature	30.4 F
Internal Temperature	66.7 F

AVERAGE H_2S READINGS

Feed areas	2.8 ppm
Rear Exhaust	1.0 ppm
Lagoon Exhaust	1.4 ppm
Ambient Temperature	30.4 F
Internal Temperature	66.7 F

The above readings are an average of all readings taken at each location with the two highest and lowest values extracted. Due to the low ambient temperature at the beginning of trial the NH_3 and H_2S readings are significantly lower than during the periods of higher ambient temperatures when the odor becomes a problem. This is demonstrated in Graph One where week 6 data from the control barn shows NH_3 concentrations of 28.55ppm at 49 degrees F. Therefore, these areas

have been continuously tested at the control location of the same structure using no lagoon treatments.

Hardware and Installation: Lagoon system

Hardware installed:

2 24 hour timers with 110 v output
2 Actuator Valves
2 6 gpd pulsafeeder pumps
12 .25 gpm flow restrictor nozzles
1 65 gallon mix tank

The lagoon feed system consists of a 65 gallon mix tank that is made up once a week with the 5 gallons of Bioregen Animal Waste and 45 gallons of water. This batch is then pumped continuously into two separate lines. (One for each room, Diagram 2) Five times a day the 24 hour timers initiate the actuator valves to open for 1 minute flushing and distributing the product with water pressure through the 12 flow restrictors into the lagoon. The product is distributed into room one lagoon through the 6 flow restrictors at 5,10,15,20,23.45 hours and room two lagoon at 2,7,12,17,22 hours.

Dosing Program

Based on a total volume of 800,000 gallons pumped out three times per year, an average monthly lagoon volume of 200,000 gallons will be used for dosing. To arrive at the appropriate concentration of Carboxx and microbes, the following calculations are used.

1 gallon = 3800mL
Bio-Regen Concentrate = 5.263×10^6 cfu's /mL
Monthly Manure Volume = 200,000 gallons (normalized)
Bio-Regen to be added per month = 19 gallons

Bio-Regen will be applied through the above feed system at a rate of 7.2 gallons per day of batch product from the containment, or 5 gallons of neat product per week.

Scope:

Guardian CSC will collect data weekly over a three month period with Bio-Regen Animal Waste applied solely to the waste lagoon. Efficacy of the trial will be determined as reduction in H_2S and Ammonia verses the levels read at the control location. This will take the uncontrolled variable of ambient temperature out of the equation.

If further odor reduction is needed, Guardian CSC will supply another set of options concerning aeration of the waste lagoon and /or a number of styles of misting systems to eliminate the airborne aromatics and hog dander.

Results at 10 weeks:

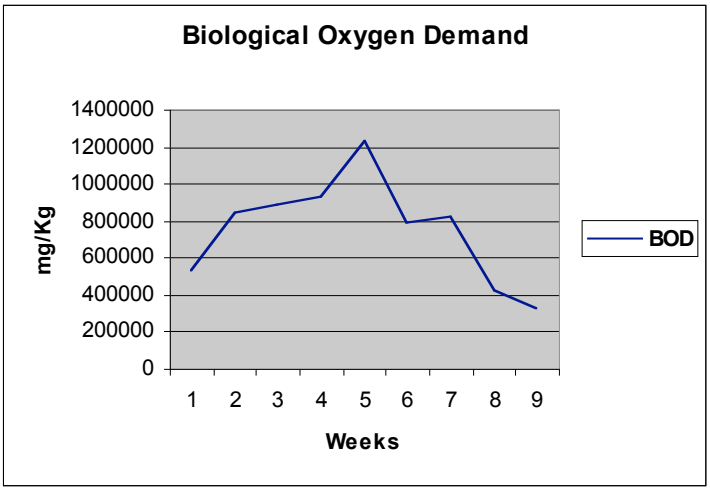
The results can be broken down into four categories:

1. Reduction in Ammonia (NH_3)
2. Reduction in Hydrogen Sulfide (H_2S)
3. Reduction in Nutrients
4. Reduction of NH_3 in correlation with Bio-Regen use

1. Reduction in Ammonia (NH_3)

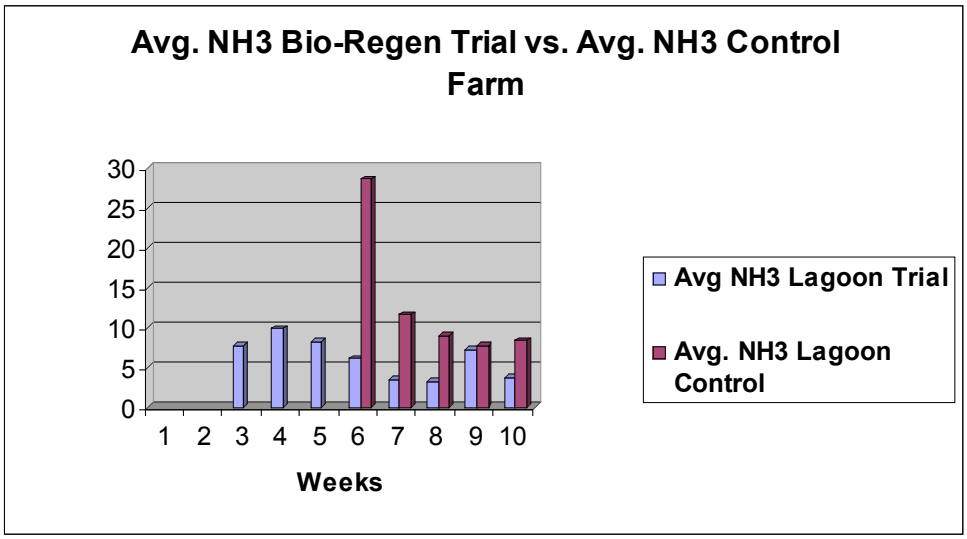
Bio-Regen Animal Waste works through the symbiotic process between the rich unbound carbon sources (HRHA) and the exponential regeneration of microbes to speed up the process of natural decomposition of organic molecules. Graph One shows the addition of these microbes and the homeostasis that was developed around week four. From week four, the microbes have been in a constant state of regeneration causing rapid decomposition of the organic compounds found in the lagoon.

Graph One:



This rapid decomposition working on organic compounds is the means of action for the degradation of ammonia. As seen in Graph Two the microbes initially rapidly degrade the Nitrate into Ammonia. This will cause an initial increase in the Ammonia levels as the microbes work to decompose the large mass of nutrients in the lagoon. However, once they have established themselves throughout the lagoon (week 4-5), the microbes cause the reduction in Ammonia shown from week four to the present. Breakthrough occurred at week nine. This breakthrough is an important data point. At some time between weeks eight and nine the pump supplying Bio-Regen Animal to the lagoon lost prime. Due to this event, 2.8 gallons of neat product was feed instead of the recommended 5 gallons. This is a significant data point showing the correlation of NH_3 reduction vs. Bio Regen use (section 4).

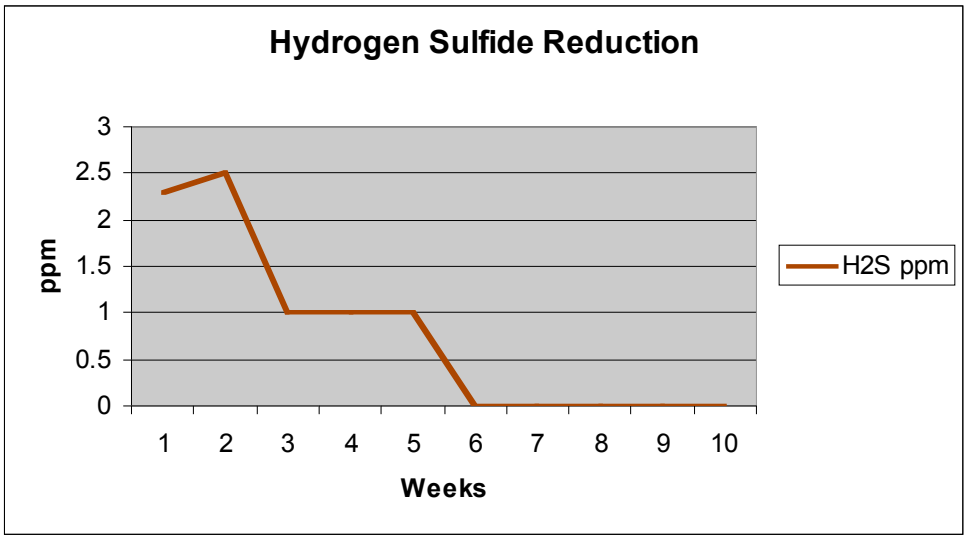
Graph Two:



2. Reduction in Hydrogen Sulfide (H_2S)

As described above Bio-Regen Animal aggressively decomposes organic matter. As shown in Graph Three, the addition of the Bio- Regen Animal product has successfully broken down the sulfate molecules in the wasted feed and characteristic of hog urine. The Bio-Regen product has successfully eliminated the presence of H_2S in and around the lagoon environment.

Graph Three:

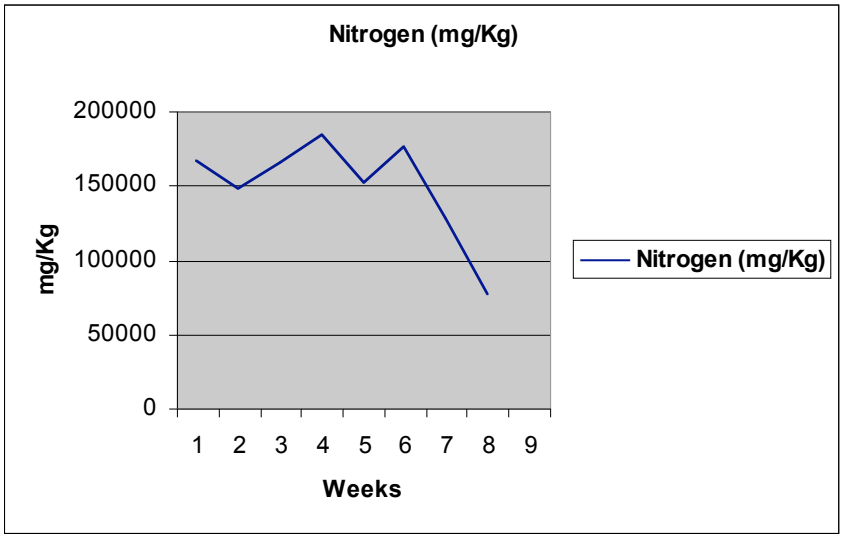


3. Reduction in Nutrients

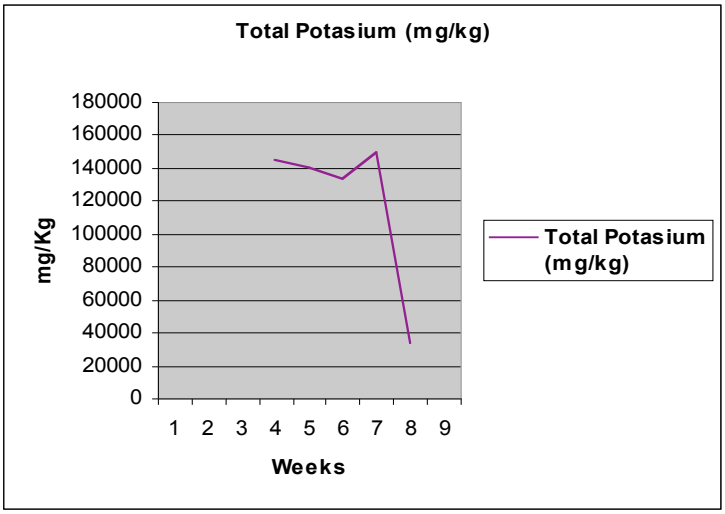
The Highly Reactive Humic Acid (HRHA) portion of the Bio-Regen Animal product has benefits that are two fold. First, as described above the unbound carbon source offers benefits to the rapid growth of the microbe colony. Second, they have the ability to bind chemical structures. The Carboxx portion of the Bio-Regen products containing the HRHA was first developed by Russian scientists to bind radioactive isotopes in the hopes of cleaning up brown sites relating to nuclear technologies. In this case, the HRHA binds the small chain organic molecules created by the microbial decomposition creating a dense nutrient rich sludge. In studies done with the land application of this nutrient rich sludge farmers have achieved a 25% increase in hay production and an increase in the protein content of this silage.

Graphs Four and Five show the reduction of these nutrients in the aqueous sludge layer.

Graph Four:



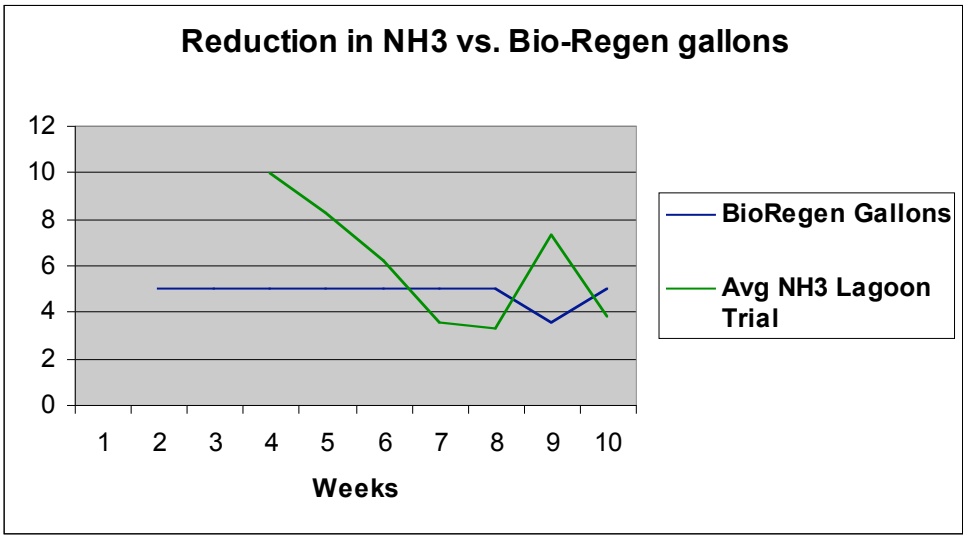
Graph Five:



4. Reduction of NH3 in correlation with Bio-Regen use

To show the need for the constant reintroduction of the active components of Bio-Regen Animal Waste, Graph Six will be used. Between weeks eight and nine the pump supplying Bio-Regen to the lagoon lost prime. Therefore, during this time period 2.8 gallons of bio-Regen was added to the system instead of the prescribed 5 gallons, showing breakthrough in ammonia with the introduction of half the Bio-Regen product. However, with the addition of the normal feed rate of 5 gallons per week during the period between weeks nine and ten the ammonia levels dropped back into range. This point is significant; showing the control of the ammonia level is in direct correlation to the use of the Bio-Regen Animal Waste product.

Graph Six:



Conclusion:

At the ten week mark of the trial the addition of the Bio-Regen Animal Waste product has shown a significant reduction in Ammonia and Hydrogen Sulfide, the odor causing compounds measured. The reduction of these compounds in the lagoon environment may have repercussions in the general health of the hog population in the farm. The addition of this product was done with an inexpensive, low maintenance feed design. Overall, by reducing the odor causing compounds with an environmentally friendly, organic product using a low maintenance, low cost feed system Guardian CSC rates the lagoon phase of the trial as a success.