USE OF MULTIENZYMIC MICROBIAL STIMULANT FOR MUNICIPAL WASTEWATER SLUDGE ODOR CONTROL

A paper written and presented by Ben D. Parker

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A paper written and presented by Ben D. Parker, P.E. of the Dallas Water Utilities at the WEFTEC '96 Water Environment Federation 69th Annual Conference and Exposition in Dallas, Texas on October 5-9, 1996

ABSTRACT

The purpose of this project was to investigate the effectiveness and cost associated for other products and delivery systems designed to utilize the endemic bacteria in the sludge. The product should condition or assist the bacteria in metabolizing the nutrients in such a manner that the usual odors associated with the process would be suppressed or not allowed to develop. Biological tests of this nature are difficult to establish and evaluate, and the results would be subjective since the dynamics of the system had too many variables.

KEYWORDS

Facultative bacteria, cell growth accelerators, anaerobic fermentation, anaerobic respiration, enzyme, Xeronine.

INTRODUCTION

Classic odor control measures for municipal wastewater treatment facilities has typically been from a mechanical approach by the use of chemicals and expensive delivery systems. The chemicals are usually of a hazardous nature and require expensive storage facilities and represent a major liability to the facility in terms of exposure to the employes and community. The Central Wastewater Treatment Plant, located a few miles South of the immediate downtown area of Dallas, Texas, in an attempt to find a viable alternative to potassium permanganate, started a full scale pilot test of various products designed to control the production of annoying odors at Dallas' other wastewater treatment facility where the sludge from the Central Plant is ultimately disposed of by depositing into a dedicated monofill.

PROCESS DESCRIPTION

The City of Dallas has two major wastewater treatment facilities which treat municipal and industrial wastewater produced by the residents and industries in the City and some of the adjoining suburbs.

The sludge produced at the Central Wastewater Treatment Plant is a blend of primary and waste activated sludge. Approximately two (2) million gallons per day of three percent (1%) solids is blended in a two (2) million gallon sludge holding tank which has mechanical mixing and is transported by a thirteen (13) mile long, eighteen (18) inch diameter pipeline to a holding cell at the Southside Wastewater Treatment Plant. The sludge is pressed to remove a majority of the liquid and is then deposited in a monofill specifically designed to receive municipal sludge. Approximately five thousand, three hundred (5,300) pounds of potassium permanganate was injected daily as the sludge is pumped to the Southside Plant and as the sludge entered the Central Cell at the Southside Plant.

Odors from the Central Cell at the Southside Plant have been a problem since the area around the plant is a mixed rural community and a vocal neighborhood association have developed. The City of Dallas has tried to become pro-active with regard to odor complaints.

TEST SETUP AND PARAMETERS

A three phase test was developed to establish the microbial population and reduce the possibility of offensive odors from being generated at the Central Cell at the Southside Treatment Plant.

Phase I would involve determining the injection points and feed rates to develop the microbe populations and acclimate the microbes in the sludge holding tank at the Central Plant. A reduction of odors and/or hydrogen sulfide would indicate when the microbe populations were being established in sufficient quantities to begin Phase II.

Phase II would begin by turning the potassium permanganate feeder at the Central Plant off to allow the potassium permanganate to be flushed out of the thirteen (13) mile pipeline. The dentention time in the line was calculated to be approximately twelve (12) to sixteen (16) hours. Test and experience had proven that the potassium permanganate was being depleted before the sludge reached the Central Cell at the Southside Plant and hydrogen sulfide concentrations around the Central Cell were above desired levels. To measure concentrations and document any changes in Hydrogen Sulfide concentrations, a floating gas sampler was made out of a truck tire intertube with a sampling port which could be attached to a gas monitor to measure actual concentrations. Phase III would begin when a physical change in the Central Cell could be observed. This change could be either a reduction of hydrogen sulfide being liberated from the surface of the Central Cell or a reduction of the volatile solids.

Phase III would begin by turning off the potassium permanganate feeder at the Southside Treatment Plant's Central Cell. This would allow the microbes to enter the cell and being absorbing energy from the exposure to oxygen and sunlight. At this time the test would only continue for a two week period and hydrogen sulfide levels and volatile solids would be monitored for changes.

THEORETICAL MICROBIAL MECHANISMS

Normally decomposition of domestic wastewater causes odors that are general through microbic action. This decomposition is the conversion of organic matter to lower forms of more stable compounds. These compounds contain large quantities of carbon, hydrogen, oxygen and sulfur. Sulfuris found in domestic, commercial and industrial wastewater in the form of sulfate, sulfides, sulfites and organic sulfur. Sulfate concentrations in untreated domestic wastewater can vary from a few parts per million to hundreds of parts per million. They are found in many forms of dissolved sulfides and insoluble metallic sulfides. The sulfide ion is essentially absent over the pH range typically observed in domestic wastewater.

The bacteria use the available oxygen in their environment as a source of energy. This process occurs in a condition which is known as an aeraobic environment. When the aerobic bacteria consume all available oxygen and no method of replenishing the oxygen is provided then these microbes will die. The aerobic bacteria then will become a food source for the bacteria that exist in the absence of oxygen. The process which continues without oxygen is known as an anaerobic environment.

A specialized group of microbes that are capable of existing in either aerobic or anaerobic environments are known as facultative bacteria. These bacteria are chemotrophs and can generate their own energy byeither fermentation or by respiration.

Recently the use of enzymes and cell growth accelerators have been tested in animal waste oxidation ponds, pulpwood waste treatment, municipal wastewater collection systems and municipal wastewater treatment plants. The test indicated that benefits from grease removal, solids reduction and odor control could be achieved but very few full scale pilot programs to document odor control have been initiated. New discoveries have been made in the importance of specific enzymes with regard to converting specific microbial processess. Normally bacteria in domestic municipal wastewater sludge break down the nutrients by an anaerobic fermentation process where sulfates are used as terminal electron acceptors. This process produces the offensive odors which cause public complaints. The use of the enzyme "Xeronine", a cell growth accelerator which was developed by the University of Hawaii, has been proven to cause a shift from the anaerobic fermentation to an anaerobic respiration. This shift permits more nitrates to be used as terminal electron acceptors than sulfates and thus significantly lower levels of sulfides appear to be produced. The respiration processes allow the facultative anaerobes, which appear to be a major contributor in this process shift, to have a greater growth rate.

TEST DYNAMICS

The test began by the introduction of five (5) gallons of full strength bio-stimulant to the Sludge Holding Tank and setting three metering pumps on injection points. These injection points were selected by the product supplier and the particular sites were chosen with consideration to nutrient concentration and detention time to the Sludge Holding Tank. Through personal observation of the daily operations of the plant, a determination was made to add one additional injection site and relocate another to permit better mixing of the product with the waste activated sludge. Hydrogen Sulfide levels in the free air space above the sludge in the Sludge Holding Tank were observed but minimal effect could be measured. An unexpected equipment failure caused the test to be advanced to Phase II when the potassium permanganate chemical feeder at the Central Plant required corrective maintenance. A definite reduction of hydrogen sulfide levels was measured at the Central Cell at the Southside Plant and Phase III of the test was initiated. Hydrogen sulfide levels measured from the surface of the sludge in the Central Cell were significantly lower and that it was observed that the Central Cell had a similar smell of a healthy activated sludge aeration basin rather than septic raw primary sludge.

A second test was performed with another product designed to promote the growth of the facultative bacteria. The same feed points were established and feed rates were adjusted to simulate the various differences of the two products. The product performed similarly, however, due to potential problems with the neighborhood association, a shortened test was performed and feed rates were not defined as precisely.

SUMMARY

The use of multienzymatic microbial stimulants is an innovative technology and has more hidden benefits that should be considered when comparing the product with established industry practices. The odor control that was achieved in this test was not absolute. There were odors present but at greatly reduced levels. The normal hydrogen sulfide levels for the Central Wastewater Treatment Plant Cell at the Southside Plant was between 25-35 ppm using potassium permanganate but during and for several days after the test was over levels remained in the range of 6-10 ppm.

The products tested were found to be non-hazardous and because of its concentrated form could be fed from one 55 gallon drum for several days. Previous six or more drums of potassium permanganate were emptied daily and because of the hazardous contents, steel recyclers were reluctant to take the drums.

The chemical properties of potassium permanganate made it necessary for the feeding system to be completely rebuilt every two years at a cost of several thousand dollars. The dispensing pumps used for the enzyme were approximately $200 each and were easily picked up by one hand. Calibration could be achieved in less than 10 minutes over a wide range of feed rates.

CONCLUSION

The wide variation of problems associated with odors requires a very exhaustive investigation to determine the sources and causes. Industry standards in odor control and prevention have had failures and successes. Without full scale test in a dynamic system, unexpected problems are more likely to develop into operational nightmares. The importance of testing and independent evaluation cannot be stressed strongly enough. Each situation presents a unique set of conditions and operating problems. The products tested for this report were developed from reputable institutions with well established reputations.

The product BYO-GON PX-109 performed the best but must be stored in conditions that require freeze protection in the colder months and should be protected from elevated temperatures and direct sun light in the warmer months and has a medium shelf life.\

The Probiotic Solutions, BIO Energizer, achieved the shift from the anaerobic fermentation to the anaerobic respiration but appeared not to have the ability to reduce the hydrogen sulfide to the lower levels as the previous product. This could be attributed to the variation in the characteristics of the sludge available since the test were not run simultaneously.

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