Advanced Aeration INC.

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Aeration of Animal Wastes – Hog Lagoon - A Case Study

Introduction

Vacuum Bubble® Technology (VBT™) creates micro bubbles of air that are neutrally buoyant. The bubbles are created under a partial vacuum and, as a result, the internal pressure of the bubbles is lower than that of the surrounding water. Consequently, the bubbles collapse to an average dimension of 0.25 mm in diameter. Because of their small size and neutral buoyancy, the bubbles remain in the water for many minutes. These micro bubbles increase the oxygen transfer potential in the water which, in turn, enables aerobic bacteria to consume the organic waste in the water.

The Study

Aeration is an effective, efficient method of animal waste management. In aerobic systems, increased amounts of oxygen are made available for digestion of organic matter in the animal waste management system. Aerobic bacteria consume organic wastes and reduce or eliminate odor. Aerobic digestion rapidly reduces sludge volume and organic material from the animal wastes. Aerobic top water used for flushing hog houses or for irrigation is cleaner than wastewater resulting from an anaerobic system.

Newman Environmental Solutions, Inc. (NESi) designs aeration systems for the management of animal waste. These aeration systems may be used in conjunction with an animal waste lagoon, waste pit, in-house, or incorporated with the addition of other waste holding container(s). These systems are also suitable for use in human waste disposal plants - even in septic tanks. The NESi aeration systems can be retrofitted on existing lagoons or as a temporary installation. The purpose of these systems is dependent upon the needs of the customer. The system may be a

totally integrated one which reduces sludge buildup and odor or only for the control of waste-processing odors.

Aerobic digestion which results from aeration is a biological process. Oxygen is added in suspended form throughout the animal waste medium. Most animal waste lagoons, just like a human septic tank, utilize the process of anaerobic digestion to break down the organic wastes. Where this anaerobic digestion process has been in place, the waste management system is converted to an aerobic digestion: aerobic digestion is complete in less than a week rather than the approximate 60 days for anaerobic digestion of waste (1)

The vacuum bubble aerators used in the NESi aeration systems are also more efficient than other, more conventional aerobic systems. The vacuum bubble aerators used by NESi have the oxygen transfer efficiency (OTE) of over 90% contrasted with the 15-18% OTE of other aeration devices (2). These vacuum bubble aerators produce very small bubbles (0.25mm) that remain in suspension at least 10 hours. The air encapsulated in such small, suspended bubbles functions as dissolved oxygen. Other than to produce air bubbles, the purpose of these aerators is to circulate oxygen evenly, so aerobic digestion occurs throughout the waste medium.

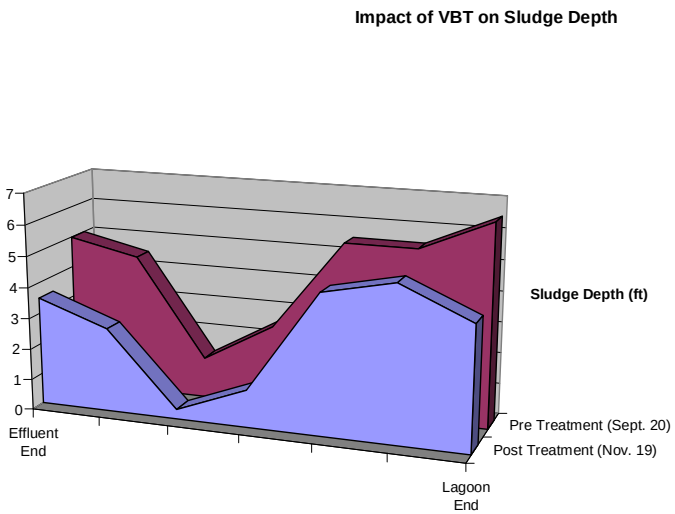
Biochemical Oxygen Demand (BOD) is a measure of organic waste in water. Each 1,000 pounds of swine produces approximately 2.1 pounds of BOD in organic waste daily. Digestion of one pound of BOD in swine wastes requires approximately two pounds of oxygen. The more oxygen added throughout the swine waste, the more effectively the organic waste is digested. The vacuum bubble aerators used by NESi produce much smaller air bubbles than those produced by other aerators - 0.25 mm in diameter compared with 4 mm for other aerators. The small bubbles, acting as dissolved oxygen, are circulated evenly throughout the waste and remain in suspension approximately 10 hours. This allows more digestion to take place as more surface is exposed to the air bubbles.

With the addition of aerators to a lagoon, as conversion to aerobic digestion from anaerobic occurs, the other changes occur. Within 24-48 hours, the odor is no longer noticeable. Testing

has found that there is a significant decrease in odor in the hog house as well as the lagoon wastewater and irrigation water.

Mixing occurs throughout the lagoon. It is visible on the surface, but this mixing is both horizontal and vertical. Prior to aeration, sludge is rather compact with the consistency of cold tar. With aeration, sludge becomes soft and mixes with aerated wastewater. This softened sludge could be easily pumped. As the sludge becomes less dense, mixing becomes more rapid and thorough. The nutrients which had settled within the anaerobic sludge mix with the wastewater, so nutrient levels may increase temporarily. As organic matter is being digested, however, nutrient levels decrease. The total suspended solids initially increase with the mixing, but then decrease with continued mixing and digestion. Sludge is reduced at an increasing rate with the addition of oxygen and mixing. The addition of sufficient oxygen for aerobic digestion of organic waste being added daily to the lagoon will also be enough to gradually reduce the amount of sludge in the lagoon.

With aerobic digestion, there is some decrease in the amounts of nutrients remaining in the wastewater. Neither anaerobic nor aerobic digestion will ever completely remove all nutrients in the lagoon water. About 80-90% of sludge is digestible, organic matter. An aerobically cleaned lagoon will have a thin layer of inorganic waste remaining on the lagoon bottom.



Cost of an aerobic system varies dependent on the requisites of the situation. Factors considered in determining the number and type of aerators used for a particular situation include: amount of BOD being produced daily, number and class of animals using the facility, type waste containment area, size containment area, and amount of residual waste (sludge). Electricity costs to digest the waste from 400 feeder hogs is about $2.50 per day. Electricity to produce enough oxygen to digest a pound of waste is less than 4 cents (3). If the price of the system (installation and electricity) were to be measured based on the cost of removal/digestion of a gallon of sludge, the cost is a little less than one cent per gallon. With this aerobic system, this price includes reduction of odor.

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(1) Using aerobic treatment, waste is "substantially reduced" within 6-8 hours as contrasted with equivalent digestion in 60 days of anaerobic treatment. [Thomas R. Campbell. Water and Its Impurities. Bouden, Hutchinson, and Ross, Inc., Stroudsburg, PA 2nd Edition, P. 256.]

(2) Texas Agricultural Extension Service SRAC Publication No. 371, July 1989. Even a small 1/15 hp aerator (used mostly in septic tanks) produces over 3 million bubbles per cubic foot of water producing more than 286 sq. ft. of surface area for oxygen transfer. Studies of oxygen
transfer efficiency (OTE) determine the effectiveness of aeration processes. This small aerator operates at 98.6% OTE. Forced air units, auger units and all other aeration devices measured are maximized at 15-18% OTE. A comparative study of aeration equipment found that a 4.9 hp paddlewheel (4 inch drum) only produced 3.1 O2/hp-hr and a 5 hp propeller-aspirator pump aerator produced less at 2.2 O2/hp-hr. The 3 hp aerators used by NESi produce a minimum of 6.59 lbs. O2/hp-hr at 93% OTE.

(3) The cost of using compressed air to digest a pound of waste would be about $1.20. Compressed air required for the digestion of one pound of BOD is 2,000 cu. ft. It only takes 128 cu. ft. of the Vacuum Bubble® air to digest a pound of BOD.