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Wastewater Experts

Managing Ponds for BOD Reduction and Odor Control

A large number of food processors utilize ponds to treat their wastewater. Most of the time these ponds are aerobic in which they use oxygen to degrade the wastewater biological oxygen demand (BOD). Fruit and vegetables contain a high amount of simple sugars and other organic compounds that when exposed to water are released into the water stream. These organic compounds require oxygen to degrade them to carbon dioxide and water. This sounds very simple yet many ponds have difficulty in achieving a sufficient level of BOD reduction and therefore generate offensive odors. This article helps to define the proper method of pond management to reduce the odors from pond systems.

Treating wastewater is an expense to all food processors. The local regulatory agencies require the level of treatment required for each facility. These regulators are usually the Regional Water Control Board as well as the Air Quality Districts. For ponding systems, the Water Board requires a permit to operate the ponds. The permit defines the level of 'treatment' required prior to final discharge whether for percolation (direct seepage into the ground), evaporation, or irrigation (indirect seepage into the ground). The limits on Percolation ponds are governed by the risk of infiltration and possible effects to ground water quality. In addition, if a percolation pond does not have a sufficient amount of BOD reduction of the insoluble BOD, then the percolation rate of the ponds can be decreased (pond plugging). Evaporative ponds are usually lined and require a larger surface area than percolation ponds. Ponds that have a final discharge to land such as an irrigation system are usually permitted based on a fixed quantity of BOD/Day/acre irrigated. Similar to percolation ponds, the limit is due to the risk of too much BOD applied to the soil which creates a slime layer just under the soil and subsequently decreases the percolation rate of the land. Regardless of the pond design, they are biological systems that need to be operated properly. If they are not, odors will increase and the regulatory agencies as well as local neighbors will require proper pond operations.

BOD is simply a measure of the amount of oxygen that is consumed over a period of 5 days. The procedure performed in a laboratory also requires a measured amount of wastewater mixed with a measured amount of microbes that 'eat' the sugars and other organic molecules. The amount of oxygen consumed is measured and there is a resultant level of BOD in parts per million (mg/l). Fruit and vegetable wastewater contains soluble (dissolved) and insoluble (particles) BOD. The soluble BOD is readily degradable by a healthy microbial biomass in a pond system. The insoluble BOD requires more time to degrade.

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There are two types of digestion, aerobic and anaerobic. Basically aerobic digestion is the addition of oxygen to the wastewater and the oxygen is consumed by the microbes (bacteria) as the BOD is broken down into carbon dioxide, water, and inert biomass (sludge). Anaerobic digestion is the digestion without oxygen. The reactions are different and there is a generation of methane gas and odor causing sulfide compounds. The type and style of ponds are dependent on the constituents that need to be degraded. For Fresh Cut processors, the design is usually for aerobic digestion followed by a combination of aerobic and anaerobic digestion in the same pond, also called a facultative pond. The aerobic top part of the ponds has a measurable dissolved oxygen level (D.O.) and the bottom part is undergoing anaerobic digestion with no D.O. Ideally, given sufficient sunlight, the final pond will have a population of algae (causing a greenish color) that provides dissolved oxygen to the water through photosynthesis. This is natures free oxygen source for ponds and indicates that a pond has achieved a good level of BOD reduction.

The odors from ponds come from the anaerobic digestion of the wastewater. The odor is typically septic smelling and there is often a noticeable amount of bubbles at the pond edges, called offgassing. This gas rises quickly into the air and carried downwind from the ponds. When this happens, the regulatory nightmare begins as the complaints from the local area are reported. Often the regulating agency is required to document these complaints and if a sufficient amount are documented, then a monetary fine can be imposed on the processing facility. There are several steps that should be taken to reduce these odors or the chance of odors.

First off, reduce the BOD going into the ponds. Implement in plant procedures that stop food from getting in the wastestream. Simple tricks are: install grating on the floor drains that have smaller openings that the cut fruit or vegetable, require employees to pick up all material that has dropped out of the process and throw into a dumpster, clean equipment by hand to remove food chunks and particulate and throw into a dumpster prior to the sanitizing procedures.

Once the BOD is in the wastestream, there are several methods to remove some of the BOD, especially the insoluble BOD. The cheapest method is with the use of screens. Screens come in many designs including: parabolic, rotary, and shaker types. A proper sized and operated screen can remove up to 30% of the BOD. The next step is to use a gravity separator or a dissolve air flotation (DAF) unit. Fruit and vegetable waste tends to be neutrally or slightly positive buoyant and this is why gravity separators and DAFs are most common. A properly operated gravity separator can remove an additional 10-25% of the insoluble BOD, and a DAF can remove an additional 15-35%. An added benefit of a DAF upstream of an aerobic pond is the addition of air into the wastestream (part of the dissolved air process) which can actually raise the D.O. of the wastewater several parts per million. A last step prior to the discharge to the pond system is the

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usage of coagulants and flocculants. A good coagulant/flocculant chemistry enhances the removal efficiency of a screen, gravity separator, or a DAF by as much as 50% over their nonchemical BOD removal efficiency.

Once the wastewater is in the pond, there are several items that need to be considered. For the proper degradation of BOD to occur, the pH needs to have been adjusted to near neutral (pH @ 7.0) for acidic wastewater. The reason for this is the aerobic degradation of wastewater consumes alkalinity. As the alkalinity is consumed, the pH starts to decrease. As the pH decreases below a pH of 6.0, the microbes that are responsible for the carbonaceous degradation of BOD start to die in low pH conditions. In addition, as the pH drops to and below 6.0, the sulfide compounds become more soluble and will cause an increase amount of offgassing and subsequent odors.

Since oxygen is required for BOD reduction, it is extremely important to quantify the aeration horsepower with the BOD loading to the ponds. The manufacturer of the aerators will have actual oxygen transfer efficiency information, but in general BOD requires 2 lb of oxygen to degrade 1 lb of BOD. Sample and determine the total BOD in lb/day (lb/day BOD = flow in gal/day x BOD in ppm x 8.34lb/gal). The type of aerator used will have a simple mathematical conversion to convert the aeration horsepower to lb oxygen. If the aeration horsepower is low from the calculations based on the BOD loading, verify by conducting dissolved oxygen measurements across the ponds. The initial aerobic pond needs to have a D.O. level of at least 2.0 ppm, but again, this varies with each pond system. The measurement will confirm if there is sufficient aeration horsepower for BOD reduction. Remember, if the D.O. is low, then there will be anaerobic digestion and odors. It is important to note that aeration not only adds oxygen to the wastewater, but also mixes the influent BOD with the microbes allowing the resulting BOD reduction.

There is an important relation between the amount of BOD and the micronutrients for BOD degradation. This ratio is 100 ppm BOD requires 5 ppm of nitrogen, 1 ppm of phosphorus, and 0.5 ppm of iron. A simple lab test will determine if there is a deficient amount of a micronutrient that might be causing some of the BOD reduction limitations.

Lastly, temperature is very important for the reactions to occur. As the temperature decreases, the microbes decrease in activity, the chemical reactions take longer, and therefore, the reduction in BOD decreases. Conversely, as the temperature increases, the solubility of the oxygen in water decreases.

There are some great advances in the tools that an operator can use in addition to the monitoring of the D.O., micronutrients, and pH. This is the addition of microbes to increase the microbial population in the ponds. Sometimes the microbe population is effected by a low pH or a toxic shock from large amounts of sanitizing chemicals

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(chlorinated caustics, quartenary ammonia, etc.). The addition of microbes increases the microbe population quickly (hours) as opposed to natural repopulation (days). The addition of these microbes can increase the BOD reduction by 30% in just a few days. In addition, if a ponding system is near capacity, microbes are an inexpensive way to increase the capacity of the ponds and therefore the processing facility capacity.

About the Article
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