Alfalfa irrigated with untreated (top) and treated (bottom) manure water.

WWTP sludge reduction

Sludge management is a key factor in the design and operation of a variety of wastewater treatment systems. Municipal wastewater treatment plants (WWTPs) that use aerobic treatment processes (e.g., activated sludge) to stabilize wastewater produce clean water, which is discharged to the environment, and sludge, which needs to be dealt with as part of the treatment process.

By Chuzhao Lin

Agricultural applications offer municipal solutions and strategies

ARTICLE SUMMARY

Challenge: Sludge periodically needs to be removed—a task that can be both complex and costly.

Solution: Waste lagoons often are employed by the agriculture industry to reduce sludge, but can be applied to municipal WWTPs effectively as well.

Conclusion: A combination of surface aeration and microbial mix can boost waste lagoons' ability to store and treat high-strength wastes.

Aerobic & Anaerobic Treatment Options

Broadly speaking, liquid waste can be biologically treated either aerobically or anaerobically. Aerobic systems employ oxygen to facilitate microorganisms to break down organic wastes into carbon dioxide and water. This approach, while efficient, can produce large amounts of sludge that are problematic and need further intervention.

In general, sludge is a combination of microbes and biomass that grows as it feeds on the large amount of energy available in the wastewater. Sludge takes up volume in wastewater treatment systems and periodically needs to be removed, resulting in increased operating costs and complexity.

Anaerobic systems, on the other hand, work in the absence of oxygen. They produce carbon dioxide, water and methane, which can be readily converted into energy. They also tend to produce less sludge than aerobic systems for a variety of reasons. One major factor is that the energy available in the wastewater is preserved in methane gas, resulting in a reduction in the energy available for the microorganisms to create biomass. This ultimately results in less sludge.

Aerobic treatment systems generally are used for lower-strength wastewater, such as residential and municipal wastewater. Anaerobic systems are employed for high-strength wastes, such as food wastes and animal manure. Anaerobic systems also can be used to process the sludge produced by an aerobic system. Additionally, combinations of both technologies can be used to efficiently treat wastes. Typically, the decision is based on economics. If there is sufficient motivation to reduce solid waste disposal cost and create energy through the conversion of biogas, then this approach can be ideal.

Reducing Sludge to Reduce Costs

Many larger municipal WWTPs use an anaerobic system (e.g., an anaerobic digester) to reduce sludge. Some also dewater the sludge to reduce sludge volume before taking it to a landfill, while others periodically truck the sludge to a central processing facility. These approaches all are costly.

There is another option that offers cost-effective yet efficient reduction of sludge volume: waste lagoons. In the agriculture industry, waste lagoons often are used to store and treat animal wastes. Municipal WWTP sludge is similar to animal wastes and other high-strength organic wastes; in this application, waste lagoons can be an inexpensive alternative to sludge management with the potential to combine the best features of two systems: efficient waste treatment and less sludge production.

Open to the atmosphere and the elements (e.g., wind), the surface layer of a waste lagoon normally contains sufficient dissolved oxygen (DO) to allow aerobic microbes to thrive. Underneath the surface layer, the microbes use up DO and the waste lagoon becomes anaerobic. Waste sludge produced from the aerobic process sinks down to the anaerobic layer for further anaerobic treatment to reduce sludge volume.

In waste lagoons holding high-strength wastes, the aerobic layer is greatly reduced. Introducing surface aeration and aerobic microbes alleviates the problem of an overloaded waste lagoon. Both the surface aeration and aerobic microbes act to restore the aerobic layer that provides an odor cap for the lagoon. A healthy aerobic layer has the capability to work synergistically with the anaerobic system underneath. With the addition of surface aeration and aerobic microbes,

the restored aerobic layer can siphon off the excess volatile fatty acids. When all steps of the anaerobic system are balanced, solids/sludge will get digested and foul odor will be minimized.

Many rural communities already use waste lagoons to treat domestic wastes. Effluent from the waste lagoons generally meets standards and is discharged to surface water. Due to the mostly aerobic nature of these community waste lagoons, however, some have sludge problems or odor issues when the lagoon is overloaded. When waste lagoons are used for sludge reduction purposes, it is more than likely that odor will become an issue. Thus, surface aeration (and possibly microbes) will be needed.

As for the effluent, there are two options. One is to cycle the effluent back to the activated sludge processing unit to polish off any organic component to meet the discharge standard. The other is to use the treated effluent for land application, just like in the agricultural industry. The latter option also has the added potential for municipalities to save on the costs of fertilizers for their recreation fields and the like.

Case Study: Wagner Dairy Waste Lagoon

Wagner Dairy of Wisconsin produces more than 13 million gal of waste per year. The waste is stored in a 6-million-gal lagoon after a 500,000-gal settling pond. Because the dairy is located in close proximity to several neighbors and generates a large volume of waste, it became apparent that the waste lagoon was too small to effectively handle the amount of waste produced.

Three times a day, 300,000 to 400,000 gal of recycled wastewater is used to flush the barn floor. This water is extracted near the surface of the large waste lagoon, and it is essential that there be a minimal amount of solids in this recycled wastewater.

Prior to introducing surface aeration and a microbial mix to the lagoon, thick recycled wastewater caused slippery barn floors and animal injuries. In addition, foul odor was a constant problem with neighbors. During the annual spring and fall pump-outs, when agitation was a must, the additional odor caused even more neighbor complaints. This prompted Wagner Dairy to seek a solution and ultimately resulted in the installation of a surface diffuser and the weekly addition of a microbial mix.

Since making the enhancements to the waste lagoon, Wagner Dairy has seen a dramatic reduction in odor and has had virtually no neighbor complaints. Because the resulting recycled water is cleaner, barn floors washed down with it are no longer slippery and animal injuries due to related falls have been eliminated. Bottom sludge in the lagoon is greatly reduced and no longer poses a problem, and the farm has been able to eliminate agitation of the lagoon during seasonal pump-outs.

Instead, the dairy uses a variable-speed hydraulic pump at a low setting to draw out the bottom sludge as needed. The added bonus to the dairy is that it has been able to comply with its nutrient management plan and save money at the same time. Now, only nutrient-rich bottom sludge needs to be hauled away and cleaner lagoon top water can be used to irrigate nearby farm property. Crop yields increase from lands irrigated with treated lagoon top water.

Conclusion

In summary, a combination of surface aeration and microbial mix can restore and enhance the capability of waste lagoons to serve as both storage and waste treatment facilities for high-strength wastes. Sludge from municipal WWTPs is a high-strength waste that can be processed in a waste lagoon, reducing sludge volume inexpensively. This way, rather than disposing of the sludge as solid waste, lagoon top water can be land applied as fertilizer or recycled back to the WWTPs for further treatment before discharge.

As sludge disposal costs keep climbing, this inexpensive alternative waste treatment strategy is worth a look. Proven to be effective in animal waste storage and treatment facilities, the waste lagoon is well suited to reduce sludge volume generated from municipal WWTPs and the associated sludge disposal costs. WWD

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