AMERICAN STRUCTUREPOINT INC.

Cost-Effective Treatment Using Lagoons

PERFORMANCE OPTIMIZATION

DECEMBER 2013

Across the US, most wastewater treatment lagoons are found in small and rural communities. Lagoons are well suited for small cities and towns because they can cost less to construct, operate, and maintain than other systems. Lagoons come in many varieties and historically have played an important role as natural wastewater treatment systems.

Lagoons operate by degrading wastes through various microbiological populations, and technology is becoming advanced with the development of innovative and alternative enhancements. This white paper provides general information on typical lagoon systems and offers some performance optimization techniques to help communities meet regulatory compliance.

Types of Lagoon Systems

Lagoon systems are generally classified into three types: anaerobic, facultative, and aerated. Multiple cell lagoon systems often use two or more of these types to provide for adequate treatment. Each type is described as follows:

Anaerobic

The word anaerobic means "without oxygen" and describes the conditions inside this lagoon. These lagoon systems are typically used to treat high strength wastes, such as animal wastes from dairy and swine farms, and are often the first stage in a multiple stage treatment system. They are typically designed to hold the wastewater for 20 to 50 days and are deeper than other lagoons (i.e., 8 to 20 feet deep).

Inside an anaerobic lagoon, solids in the wastewater separate and settle into layers. The top layer consists of grease, scum, and floatables; this layer keeps the oxygen out and a majority of the odors in. The anaerobic bacteria thrive in this environment to treat the wastewater. Over time, solids that either cannot be treated (inorganic), or are not treated due to the short detention time, accumulate and must be removed. The wastewater that leaves an anaerobic lagoon always requires further treatment.

Other typical design criteria: organic loading 220 to 2,000 pounds BOD per acre/day, temperature greater than 75 degrees Fahrenheit.

Facultative

Both anaerobic and aerobic conditions exist in a facultative lagoon. Other common names for these types of lagoons are stabilization ponds, oxidation ponds, photosynthetic ponds, and aerobic-anaerobic ponds. They are most commonly used to treat wastewater from small communities or individual households and developments.

Three layers exist in a facultative lagoon; the top layer is an aerobic zone, the second layer is a facultative zone, and the third layer an anaerobic zone. In the aerobic zone, aerobic bacteria use oxygen from air, algae (photosynthesis) and agitation of the surface due to wind and rain to treat the wastewater. This zone also serves as a barrier for odor control. The facultative second layer contains bacteria that can function in both an anaerobic and aerobic environment to treat the wastewater. The bottom or anaerobic zone contains no oxygen and contains a sludge layer at the bottom of the lagoon. Anaerobic bacteria, sludge worms, and microscopic organisms treat the wastewater in this layer.

Typical design criteria: detention 20 to 180 days; depth 4 to 8 feet; organic loading 10 to 100 pounds of BOD per acre/day; temperature above 68 degrees Fahrenheit.

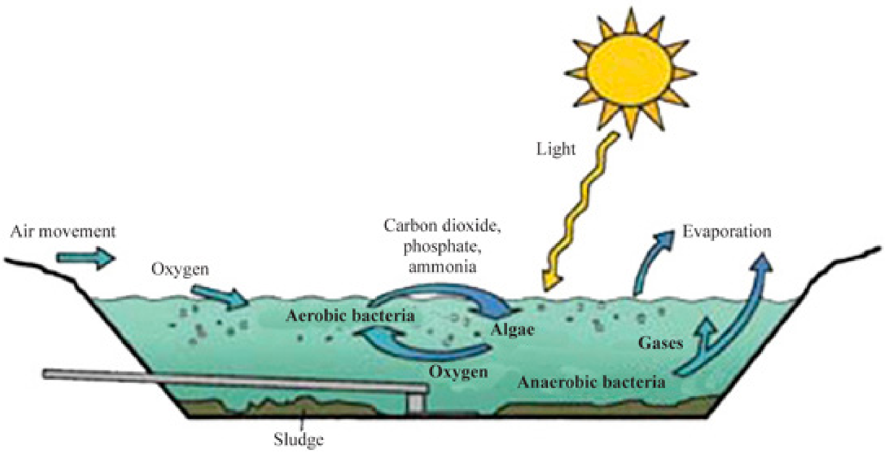
Aerobic

Aerobic lagoons are an extended aeration activated sludge process without sludge recycling. These systems are very common in small communities and use aerators to provide oxygen and mix the contents. They are either completely or partially mixed depending upon the degree of mechanical aeration provided. Facultative lagoons are often converted to partially mixed aerobic lagoons to improve treatment. These type of lagoons require energy for mixing/aeration, but the energy requirement is normally less than other mechanical systems.

Lagoons are well suited for small cities and towns because they can cost less to construct, operate, and maintain than other systems.

Both surface aerators and diffused aeration systems are used for these types of lagoons. More horsepower is typically required to completely mix a lagoon than to provide for the oxygen demand of the wastewater; thus, the use of partially mixed systems is more common to keep energy costs minimal.

Typical design criteria: detention 3 to 30 days (20 days is common); depth 6 to 15 feet; organic loading 30 to 300 pounds of BOD/acre/day; aeration 6 to 10 horsepower per million gallons capacity (depends on loading, i.e., use approximately 1 to 1.5 pounds of oxygen per pound of BOD applied); complete mixing use .75 horsepower per 1,000 cubic feet of capacity; partial mixing use .5 horsepower per 1,000 cubic feet of capacity; temperature above 68 degrees Fahrenheit.



Like all treatment systems, lagoons have their operational and maintenance problems that impact performance and regulatory compliance.

Common Problems/Solutions

Like all treatment systems, lagoons have their operational and maintenance problems that impact performance and regulatory compliance. The typical problems with possible solutions are:

Algae

Although algae is needed to some extent in facultative lagoons, excessive algae may lead to short-circuiting, blocked sunlight, odors, and effluent total suspended solids violations. Many options exist for resolving algae issues, including chemical addition, nutrient control, complete mixing of the lagoon cell, lagoon covers/coverings, and the removal of effluent suspended solids via filtration. Surface mixing can also impede algae growth since it reduces the penetration of sunlight.

Elevated Effluent Ammonia Levels

Aeration or additional aeration may be required. If surface aeration is used in a cold climate, chilling of the wastewater is likely occurring, which lowers the rate of nitrification. In this case, diffused or near-surface aeration may be needed to retain heat and allow nitrification. Sludge levels in the lagoon should be checked as ammonia is created from anaerobic digestion of the sludge layer.

Elevated Effluent BOD

As with elevated ammonia levels, additional aeration may be required. Check for short circuiting, which reduces the effective residence time and thus treatment capacity. Recycle may be needed to achieve regulatory limits.

Elevated Effluent Suspended Solids

See algae above. Also, reduction in mixing near the effluent or a settling lagoon should be investigated, as should exterior clarification/filtration if stringent regulatory limits are applied.

Odor

In an anaerobic lagoon, an inadequate top grease layer may be cause for odors in the early stages of lagoon use. Masking of these odors may be necessary while the top layer matures. Facultative lagoons may have odors during periods of seasonal "turnover" or if they are overloaded. Turnover is common due to temperature stratification. The odors should not persist for any length of time and could be temporarily masked using chemicals. If overloading is the problem, communities can consider converting to a partially mixed lagoon system.

Icing

Aerated lagoons may experience icing problems in cold weather climates if floating aerators are used. In such climates, the use of submerged aeration equipment should be considered.

If your community is facing challenges with your lagoon wastewater treatment system, American Structurepoint can help. Our utility infrastructure professionals are called to evaluate, design, and implement wastewater systems in the most cost-effective and environmentally conscious manner.

One of the significant challenges facing our clients in today's environmental climate is how to balance infrastructure expansion and maintenance needs with regulatory demands. American Structurepoint understands this process and is experienced at developing innovative, practical solutions.

If you have questions or would like to talk in more detail about your wastewater treatment options, contact Doug Ralston, PE, RIWP. Doug is a project manager in our Utility Infrastructure Group, and is a degreed chemist and licensed sanitary engineer. He was a principal author of Manual of Practice for Pretreatment of Industrial Waste, published by the Water Environment Federation (WEF) in 1994, and was responsible for rewriting the "Heavy Metal Removal" chapter contained in that manual. Doug is a also a charter member of the WEF Wastewater Plant Design Committee.

Douglas Ralston PE, RIWP
☎ 317.547.5580
✉ dralston@structurepoint.com

www.structurepoint.com

REFERENCES: EPA Innovative and Alternative Technology Assessment Manual; Pipeline, Spring 1997 Volume 8, No 2; EPA Wastewater Technology Fact Sheet: Aerated, Partial Mix Lagoons; EPA Design Manual – Municipal Wastewater Stabilization Ponds, 1983.