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Lagoon Wastewater Treatment - Innovative and Sustainable Approach

In 1972, the United States Environmental Protection Agency (EPA), in response to the enactment of the Clean Water Act (CWA), started developing national water quality standards with specific wastewater pollutant limits. In conjunction with state environmental regulatory agencies, a permitting system identified as the National Pollutant Discharge Elimination System (NPDES) was created to implement the regulations governing the discharge of wastewater into public waterways. Thus, these events established the platform and standards that all entities discharging into waterways, such as small towns' wastewater treatment facilities, would be required to comply.

Historically, smaller towns and communities throughout the world have depended on wastewater lagoons as the most reliable and cost effective solution for dealing with the disposal of domestic sewage. In the United States, approximately 30% of permitted wastewater facilities are open lagoon systems. It is estimated that 40% of these facilities are in violation of the terms of their wastewater discharge permit, and an even higher percentage will not be able to meet future 2015 regulations currently being developed by the EPA.

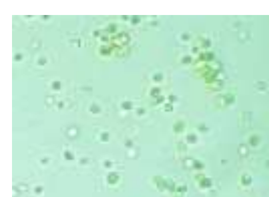
Municipalities are caught in regulatory crosshairs as federal and state agencies continue to require a higher level of treatment effort while funding sources are becoming less available. In addition, regulators tend to favor the replacement of lagoons with concrete and steel mechanical systems which are far more expensive to install and operate.

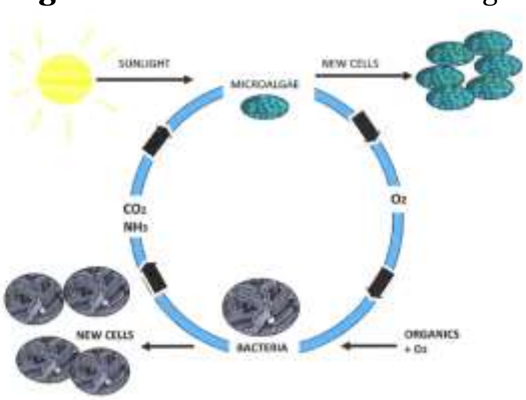
By retrofitting existing lagoon facilities with a properly designed biologically based treatment technology, it is possible to meet current and proposed regulatory requirements while meeting the budget constraints that are currently impacting the majority of wastewater utilities throughout the United States.

Wastewater lagoons, whether municipal, industrial, or agricultural, are designed and built in various shapes and sizes depending on land availability and the amount and type of wastewater being treated. While there are several important factors required for the successful operation of a wastewater lagoon, the most important element involves the provision of pure oxygen in sufficient amounts and at the correct location throughout the treatment process. A summary of the different methods used to infuse oxygen into the treatment process follows:

Natural aspiration, better identified as a facultative, stabilization, or maturation lagoon, depends on natural weather conditions, requires longer hydraulic retention time, and substantially more land. Small amounts of oxygen reach only the upper two inches of the water surface, resulting in little benefit towards aerobic digestion and more odor and sludge buildup.

Mechanical aeration using surface aerators, small/large bubble diffusers, or rotating wheels provide a very limited amount of oxygen into the lagoon water, resulting in significant costs and inefficient use of expensive energy.





Biological aeration in a wastewater lagoon occurs by introducing microscopic, multi-species, single-cell, and oxygen producing algae into the primary cell of a lagoon system. When these microalgae are exposed to sunlight, cultivated and then metered into a wastewater lagoon, and mixed with fine-bubble diffusers, a uniform, two foot layer of pure oxygen is developed and becomes available immediately and directly to the aerobic bacteria which are responsible for the digestion of organic solids. A symbiotic relationship occurs naturally between the microalgae and microbials. The microbials create carbon dioxide (CO_2) that is utilized by the microalgae. The microalgae in turn create oxygen

(O_2), satisfying the energy needs of the bacteria. This establishes a naturally-occurring system that responds to the variable needs of a lagoon, initiating, perpetuating, and maintaining the process of rapid aerobic digestion. Below is a table comparing the amount of oxygen produced by these various aeration methods. Clearly, biological aeration is the efficient, economical, and sustainable solution for a small town's wastewater lagoon system.

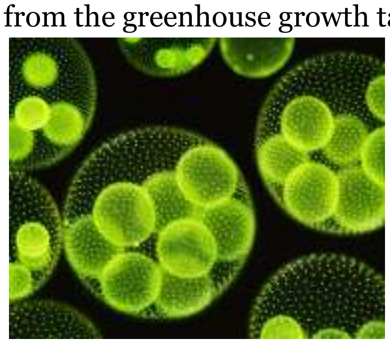
Summary of Oxygen Generation Rates

Type of Aeration	Available Oxygen
1. Natural Aspiration	Almost No Value
2. Mechanical Aerators	2.1 lbs. O_2 /hp / hour
3. Diffuser Plates	4.1 lbs. O_2 /hp / hour
4. Algae Wheel	4.9 lbs. O_2 /hp /hour
5. Biological Aeration Using Microalgae	**12.0 lbs. O_2 /hour**

This robust patented system is a biologically-based oxygenation technology that can consistently control the environment within a lagoon system. Its major components are a biological control center, a microalgae distribution system, and a final disinfection and nutrient reduction component.

The biological control center provides for the incubation of the patented, microscopic, single-cell algae which are continually introduced into a wastewater lagoon. Components of this biological control center are a greenhouse, microalgae culture tanks, filtered fresh water source, growth light system, immersion heaters, distribution tank, microalgae feed supply system, distribution manifold, and a purge system. By controlling the environment within the lagoon system, specific treatment outcomes can be developed for the individual lagoon cells. This allows for increased control of the lagoon system that results in superior effluent discharge quality.

The microalgae distribution system is a patented delivery system that conveys the microalgae to the lagoon. It connects the distribution manifold, located within the biological control center, to a grid of fine bubble diffusers located within the lagoon cell. Circulation of the microalgae and bacteria culture within the lagoon is enhanced by diffusers installed at the same distribution points as the weighted distribution lines from the greenhouse growth tanks. These diffusers create a laminar mixing that allows more microalgae to be exposed to sunlight, thus increasing the efficiency of sunlight exposure by up to 200%. This distribution system disperses more pure oxygen into the lagoon, creates an 18" to 24" biomass of microalgae that provides the bacteria continual exposure to both the oxygen from the microalgae and to the BOD and TSS within the wastewater. Additionally, microalgae consume 1.6 to 2.0 times their mass of carbon dioxide in the form of bicarbonates. (Example: 1 lb. of microalgae consumes 1.6 to 2.0 lbs. of carbon dioxide).



The final Nutrient Removal Component (NRC) and rogue illegal dumping– A Powell Water Systems, Inc. electrocoagulation (EC) is added as an effective removal process in reducing 99+% of fecal coliform, eliminating the chemical and UV disinfection process and is effective in further reducing nutrients and to act as an emergency backup treatment in the event of the illegal dumping of gas and oil products, pesticides, etc. that may get into the system**.**

Within the wastewater industry, the EPA encourages the development of innovative technology. There are six specific criteria which define "Innovative Technology". To qualify for approval and funding as an "Innovative Technology", a wastewater treatment methodology needs to meet only one of the criteria listed below. This biological system meets all six of these published criteria.

1. Life cycle costs are reduced by 15% compared to existing facilities.
2. Energy requirements are reduced by 20% compared to existing facilities.
3. There is an improvement in reliability and a decreased level of operator attention and skill levels compared to existing facilities.
4. Treatment provides for better management of toxic materials compared to existing facilities.
5. There are increased environmental benefits compared to existing facilities.
6. The technology represents improved benefits of joint municipal and industrial wastewater compared to existing facilities.

In addition to being an innovative technology, **this biological system** clearly attains the goals of the EPA Clean Water Infrastructure Sustainability Policy, 2010 which states:

"Drinking water and wastewater systems should use robust and comprehensive planning processes to pursue water infrastructure investments that are cost-effective over their life cycle, are resource efficient, and are consistent with community sustainability goals. Systems should also employ effective utility management practices, including consideration of alternatives such as natural or "green" systems and potential climate change impacts to build and maintain the technical, financial, and managerial capacity necessary to ensure long-term sustainability."

As stated earlier, it appears that the political tide is towards eliminating lagoon systems that require upgrades and force small towns into purchasing and maintaining concrete and steel mechanical wastewater treatment facilities. Capital (CAPEX) costs for this system is 4-5.5 times less than traditional mechanical systems and operating and maintenance (OPEX) costs are 3-5 times less than traditional mechanical systems.

Most importantly, this biological system:

- Will meet current and future discharge requirements.
- Will uses 45% - 85% less power than alternative systems.
- Will meet the criteria for a "green" and "innovative" funding.
- Will cost (CAPEX) 30% to 60% less than mechanical systems with 2 to 3 times longer useful life.

- Will easily expand for additional capacity.
- Will be “operator friendly”.
- Will be more adaptable to future technology than mechanical systems.

Because of the lower costs of this system as well as significant energy savings, there are three very clear economic opportunities for any state:

1. More communities can achieve compliance with available funding, and likely without increasing fees or bonding.
2. Decreased electrical load on the cities' largest consumer of power presents cost savings to the municipality, the consumer, and ultimately, to the power supplier.
3. This patented system is a clear method for compliance with State Green House Gas (GHG) and renewable initiatives.

Implementation can provide a very clear opportunity to take a leadership role in sustainable community stewardship during very difficult economic times.

Mr. Sundine has more than 40 years of experience in the horticulture, wastewater, and environmental fields. Mr. Sundine graduated from Colorado State University with a degree in Horticulture. He is President and Chief Technical Officer of Sundine Enterprises, Inc., a soil and water consultancy company. He is a specialist in both natural and mechanical water and wastewater remediation, insitu bioremediation, erosion control, soil amendments, biological oxygen, microalgae and weed control, oil patch production water and industrial reuse and reclamation, and animal waste remediation. His specialty and experience is in the application of electrocoagulation used for the destabilization of contaminants in aqueous solutions. Electrocoagulation kills bacteria, viruses, and personal care products and is used in place of lime softening, chlorine, UV, and ozone. Mr. Sundine has extensive experience with the marketing of products for both start-up companies (Innova Corporation) and for established companies (Sumitomo Corporation of America). Mr. Sundine is the national expert on Isolite®CG, a porous ceramic used in both bioremediation and the green industry. He has developed technical training and educational programs, and providing necessary research and development protocol for a variety of soil and water related studies.

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