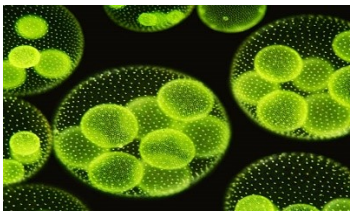
Powell Water

Proposed New Discharge Limits…. Optimizing Your Existing Lagoons Can Be the Answer!

2027 might seem like a long time down the road, however, now is the time to start planning for the stricter discharge limits proposed by the Colorado Department of Public Health and Environment, Water Quality Control Commission. As many of you know, starting in 2027 new discharge limits are proposed for parameters such as ammonia, arsenic as low as 0.02 ppb and phosphate as low as 0.025 ppm. Rural Colorado towns that are currently using lagoons for wastewater treatment will be faced with the prospect of being forced to abandon their lagoons and convert to mechanical systems that are often unaffordable and too expensive to operate. However, even mechanical systems will be challenged to reach these new standards. By optimizing your existing lagoons now, you can meet these changes head on with a sustainable solution. The future is now with Powell Water Micro Algae Systems (PWMAS)!

Powell Water Micro Algae Systems (PWMAS) patented system has combined nature and mechanical elements, using nature's microalgae as an oxygen generator for the existing bacteria population in a lagoon, and Powell Water Electrocoagulation as the tertiary treatment. Using the combination of these technologies, a lagoon system can achieve its new 2027 discharge limits, keep CAPEX & OPEX affordable, as well as reduce or eliminate cyanobacteria, duckweed, odors, and sludge from the overall system.



The PWMAS provides lagoon aeration via microalgae (biological oxygen generators driven by photosynthesis) that greatly improves wastewater treatment compared to both non-aerated and aerated discharging lagoons and can be done at a much lower lifetime-cost compared with mechanical surface aerators. A robust, specifically selected, and diverse community of microalgae is used for aeration of a wastewater lagoon. PWMAS uses a symbiotic relationship between microalgae and the bacteria, where microalgae produce dissolved oxygen into the wastewater during photosynthesis to provide oxygen to the bacteria which break down organic waste. The bacteria, in turn, provide carbon dioxide for the microalgae to continue to grow and produce more oxygen. The microalgae and bacteria will out-compete the cyanobacteria and duckweed for nutrients, thus starving the

cyanobacteria and duckweed that forms a surface mat on most lagoons. The microalgae utilized by the PWMAS disperses evenly within the top 18 inches of the lagoon, providing 100% available oxygen (opposed to the 21% oxygen provided by mechanical aerators) for the naturally occurring bacterial population that removes the incoming waste product --also known as five-day biochemical oxygen demand (BOD5). Dissolved oxygen levels in the primary lagoon can run as high at 20 ppm during the day.

Mechanical aerators for lagoons have a high intial cost, often require expensive repair, and can be the highest energy requirment for a lagoon system. The PWMAS eliminates the cost of mechanical blowers, resulting in up to 90% electrical savings.

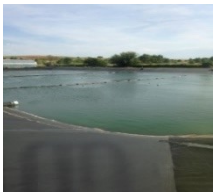
Every structure and supporting piece of equipment included in the PWMAS is used to maximize the growth of the microalgae and the naturally occurring bacteria, therefore, maximizing overall wastewater treatment. The PWMAS includes a systems control facility for the production and continuous distribution of the site-specific microalgae and problem-specific bacteria, if necessary, as well as Powell Water Electrocoagulation (EC) as tertiary treatment. The following is a description of these major components of the PWMAS

Systems Control Facility

A microalgae growth center is built near the primary lagoon to house the site-specific microalgae growth incubators. This system control center provides a protected environment, containing spectrum-specific lights designed for season and site-specific microalgae growth. Optimally, the growth tanks will receive light for approximately 22 hours per day, either by sunlight or targeted light spectra.

The growth tanks receive recovered sewer water from the sewer local municipal water supply. This water is filtered to remove any particulate matter and residual chlorine that may be harmful to the system equipment and/or microalgae.

In addition to the lighting, microalgae are supplied with nutrient-specific microalgae food for optimal growth. Immersion heaters are installed to maintain the optimal temperature for microalgae growth. The microalgae waters from the growth tanks are continually gravity-fed to a common collection tank and then distributed to the primary lagoon. A site-specific mixing system and multiple weighted pipelines evenly distribute the microalgae throughout the lagoon. The

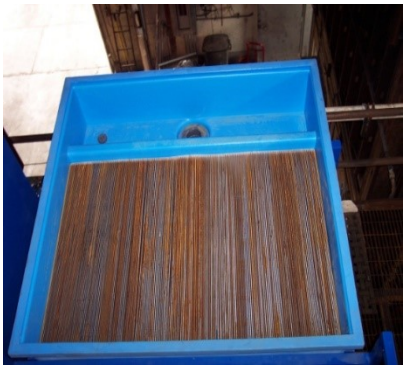


continual introduction of microalgae from the system control facility ensure that a high concentration of oxygen is maintained in the lagoons. The mixing system can be powered by solar panels if wanted. Fine bubble diffusers are placed one foot above the solids and thus create laminar mixing. The laminar mixing helps keep the digestible solids in suspension, and will keep the microalgae optimally exposed to the photosynthetic rays of the sun.

Powell Water Electrocoagulation (EC) - Tertiary Treatment and System Redundancy

What is Powell Water Systems Electrocoagulation? It is an advanced and economical water treatment technology:

The Powell Water electrocoagulation can produce economical and sustainable wastewater treatment anywhere in the world.



A direct current is applied to the first and last metal blades in the system, using the liquid as a conductor and allowing the current to pass freely throughout the chamber. This results in a flood of electrons into the water, neutralizing charged particles and causing them to precipitate out of solution. The blades react to the current by releasing charged metal ions that act like chemical coagulants. Powell Water electrocoagulation produces economical and sustainable wastewater treatment in installations ranging in scale and configuration locally and globally.

During times of upset conditions in lagoon systems such as ice, illegal dumping of pesticides, or a build-up of fats, oils, and grease (FOG), electrocoagulation is used to ensure towns and industrial lagoons are kept in compliance. Electrocoagulation (EC) is also added as the final inactivation step in the PWMAS, eliminating chemical/UV or other disinfection processes. Electrocoagulation is effective in removing 99+% or a 4-log removal of fecal coliform. EC also provides a high removal rate of PHOA/PHOS, emerging contaminants, pharmaceuticals, personal care products, viruses, arsenic and phosphorous.

Other Benefits Using the PWMAS

Removal of PFOA, PFOS

Powell Water	PFOA Liquid ng/l (ppt)	% Removal Liquid	PFOA Solids ng/l (ppt)	PFOS Liquid ng/l (ppt)	% Removed Liquid	PFOS Solids ng/l (ppt)
Landfill Leachate as Received	1,540			421		
Electrocoagulation + Processing Aid	3.97	99.74	70	2.36	99.94	20

Powell electrocoagulation reduced PFOA and PFOS below proposed discharge limits for water and coagulated solids with the use of iron blades and hydrogen peroxide. By destroying the fluoride carbon bond, the environment is protected from PFOA and PFOS contamination. Costs for PWMAS treatment that meet MCL-TCLP criteria are considerably less than comparable treatments which only capture PFAS for final expensive destruction through incineration, encapsulation, or deep well injection. The Powell electrocoagulation system can be permanently installed or placed on skid mounted trailers for treating water on a short-term basis.

Removal of Microbiological Contaminants and Estrogenic Endocrine Disruptors

Powell Water	PMMoV (copies/ml)	Phage, *E. coli* (Pfu/ml)	Phage, *B. subtilis* (Pfu/ml)	Fecal coliforms (CFU/ml)	Enter-cocci (CFU/ml)	HPyV (copies/ml)
Before EC	60,100	12,800	2,220	1,000,000	1,000,000	100,000
After EC	Below detection	Below detection	Below detection	Below detection	Below detection	Below detection

Hope for the Future

Round Mountain Water & Sanitation District in Westcliffe, CO has been struggling with an inefficient and overloaded wastewater lagoon system for decades. Finding themselves in a dire situation to remedy the treatment needs of its growing community but lacking the funds and grant support of larger municipalities to build and operate a state approved $14 million mechanical plant designed to meet the stringent discharge limits of a compromised receiving body of water, a PWMAS offers hope. Research is currently being conducted to prove to the state that this is a viable solution for the challenges that Round Mountain and hundreds of small treatment facilities around the state face. In Round Mountain's case, the estimated installation cost of the PWMAS is only one-quarter of the cost of a mechanical treatment plant, allowing them to meet proposed discharge limits and sustainably offer high quality treatment to their communities without the threat of insolvency or bankruptcy.

Conclusion

Optimizing your wastewater lagoons for the future with The Powell Water Micro Algae System (PWMAS) has distinct and economical advantages over mechanical systems. PWMAS is a patented and engineered process that will efficiently and economically allow you to strengthen and support your existing lagoon systems to thrive and reach future discharge standards. In addition to meeting required regulatory standards, PWMAS will reduce odor, reduce sludge accumulation, reduce OPEX, and will perform with far lower costs and lower environmental impact than a traditional mechanical system. Most PWMAS can be operated with only 1 operator per shift, again resulting in significant savings in manpower expenses. Because of the PWMAS' simple design, operator training is straight forward, and the entire system is less complex than mechanical systems.

You do not need to abandon your lagoons! There is hope. Enhancing your existing lagoons is the sustainable and economical solution for now and for the future!

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