

## **WASTEWATER LAGOONS – A NEW AERATION CONCEPT**

by

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The use of wastewater treatment lagoons, or stabilization ponds, is a common practice for rural municipalities and industrial facilities. Through the years there have been numerous designs for these 'sludge settling basins,' ranging from facultative, partial aerated, and fully aerated systems. But the primary reason for these systems is to utilize relatively shallow earthen ponds, or lagoons, for the purpose of sludge settling and stabilization. Over the years, the technologies for these lagoons has changed little except to line them to protect groundwater from contamination and the addition of multi-celled lagoon systems for the purpose of adding mechanical oxidation for quicker treatment and effluent water polishing.

The other things that have changed are the encroachment of growing populations and plant expansions that often pose problems for both the lagoons and the populations around them. Noxious odors, which are caused by the insufficient digestion and buildup of the sludge on the bottom of aerated lagoons, become a primary problem. Space limitations become a major problem as populations grow, and new, or larger, cells are required in the lagoon system. Finally, the efficiency of these lagoons is dependent on a myriad of conditions that range from environmental to design limitations. Sludge reducing bacteria populations must constantly be assessed, sludge depth and water temperatures are usually in constant flux and aeration equipment and the energy to run them is expensive and causes ever increasing maintenance and maintenance costs.

### The Lagoon Aeration Process

In the more advanced waste lagoon systems there is an aeration process that is supposed to –

1. Provide oxygen to aerobic bacteria that convert and oxidize the organic material in the wastewater.
2. Provide mixing in order to distribute dissolved oxygen and bring aerobic organisms into contact with organic sludge.
3. Provide enough mixing to allow solids to become suspended for quicker digestion and oxidation by the aerobic bacteria. If this does not take place, solids will build up on the bottom, eventually requiring the very expensive process of sludge removal from the lagoon bottom.

Over the years the methods of aerating these lagoons has changed little. The primary aeration techniques used for earthen waste lagoons are:

- Hose bubbler systems that utilize large, housed, industrial blowers.
- Diffused air grids that also utilize large industrial blowers.
- Low horsepower spray aerators.
- Paddle-wheel, or brush, aerators.
- Large circular surface mixers.
- Floating air induction aerators.

- Solar powered mixers.

There are other less-used technologies found in waste lagoons for the purpose of providing dissolved oxygen and mixing, but these are so seldom used that they will not be addressed here.

The primary positives and negatives of the above listed aeration technologies are-

- Hose bubbler systems are very common in lagoon aeration because of their relatively low initial cost, and initially they seem to work fine. But, the blowers required to drive these systems are very expensive to operate and maintain; the hoses themselves require occasional replacement for optimum efficiency, and finally, but most importantly, their inefficiency in mixing and getting dissolved oxygen into the sludge, especially in older lagoons, allow for sludge buildup and the eventual cost of sludge removal.
- Diffused air grids are used in an effort to make the waste lagoon work like the extended aeration process commonly used in urban municipal wastewater systems. These are expensive installations, especially when manmade liners are utilized. The blowers are very expensive to operate and maintain, and finally, the diffusers used cannot be located as efficiently as extended aeration designs because of their cost and expense of sludge removal when sludge depths rise above the diffuser heads.
- Spray aerators are inexpensive to install and do not use much energy, but their efficiency in providing mixing and dissolved oxygen to the sludge is minimal.
- Paddlewheel, or brush aerators, are simple and inexpensive to install, but they are quite expensive to operate and their continual maintenance requirements are costly. These aerators do move water, so they will mix bottom sludge, but their cost of operation is always their major drawback.
- Large surface mixers, or aerators, were initially introduced in extended aeration plants in the first half of the 20<sup>th</sup> century, and are primarily used in large industrial waste lagoon systems. They are very expensive to acquire, and take large amounts of energy to run. But these aerators, if properly designed, do mix the bottom sludge and will allow dissolved oxygen to provide the oxidation of suspended solids that is required to reduce solids buildup on the lagoon bottom.
- Floating air induction aerators do move water well and they do add dissolved oxygen somewhat efficiently, but they are restricted to deeper and lined lagoons. They also possess an inefficient water moving capability so many are required for even small lagoons.
- Solar powered mixers are the newest entry to the lagoon aeration market. But, due to the very low amount of energy available, via solar panels, effective mixing, especially in older lagoons, is deficient. They are very costly and soon require as much maintenance as other devices mentioned above.

### A New and Better Lagoon Aerator

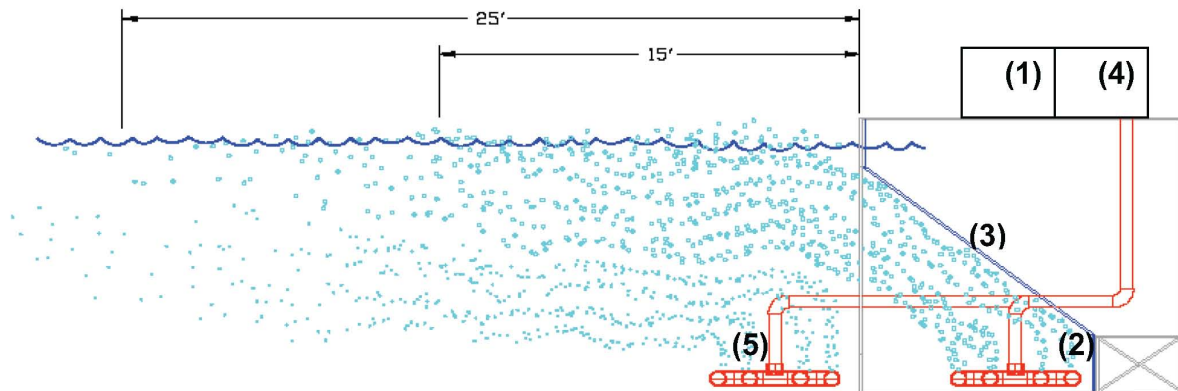
The idea of 'blended aeration' was conceived in 2004 in order to improve the aeration and growth conditions of fish being raised in earthen ponds. The idea of the blended aerator was to allow the fish to return to its genetically coded preference of living in moving water. Moving water provides the organisms that live there with –

- A flow that usually cleans the bottom of noxious sediments.
- The ability of the fish to get to the bottom to scavenge for food.
- A relatively constant level of dissolved oxygen throughout the water column.
- And, recent studies have identified that a fish that swims into a current experiences a more efficient food conversion ratio.

One concept that must be recognized in attempting to understand the blended aerator is that water is a very heavy natural material. Once a measure of water begins to move, it is very hard to stop and will take a long time to do so on its own. During the process of moving, the water will naturally fall to the lowest level it can reach, normally moving anything lighter than itself in the process – like sludge.

It was only natural that the wastewater lagoon market became a target for the Reliant Water Technologies', patented, Model WQA Blended Aerator. When recognizing the problems that municipal and industrial wastewater facilities face today, with reduced budgets and increasing populations, lagoon aeration is an area where technology can convert to monetary savings.

Basically, the Model WQA uses one 1 ½ HP regenerative blower to move over 9 million pounds of water through itself in a 24 hour period. Once that surface water begins to move it will fall to the bottom, on a continual basis, bringing the bottom sediments, or sludge, into the water column where the nutrients will oxidize and aerobic organisms will thrive. A second 1½ HP regenerative blower feeds into 8 industrial grade fine bubble diffusers for the addition of over 10 lbs of dissolved oxygen per hour, and this blower can be automatically controlled to turn on only when DO is required. The patented aspect of the Model WQA is the fact that the fine (DO producing) bubbles are trapped below the forward moving coarse bubbles, obtaining a residence time of over 20 feet at one atmosphere for excellent diffusion into the water. See Figure 1.



**FIGURE 1** -The key, and patented, elements of the WQA is its two regenerative blowers, each connected to a set of bubble forming diffuser grids. The Phase 1 blower (1) runs 24 hours per day and feeds the rear-most diffuser grid (2) which allows large 1-2 cm. bubbles to rise quickly into a 45° baffle (3), pushing water at a velocity capable of moving over 9 million gallons of water per day. These large bubbles stay on the surface for up to 25' in front of the WQA. When the Phase 2 blower (4) is initiated, either manually or automatically, it feeds air to the industrial diffuser grid (5) located forward of the base of the WQA. The bubbles emitted out of the diffusers are approximately 1 mm in diameter. These small bubbles are kept underwater for up to 20' due to their inability to rise above the larger, faster and horizontally moving bubbles. The 20' of residence time for the small bubbles at, 1 atmosphere of pressure, allows for diffusion into the water.

Figures 2 and 3 provide visible proof of the amount of water movement provided by the Model WQA. At only 3 total horsepower of energy, the Model WQA is extremely efficient when compared to other lagoon aeration technologies. The number of WQA aerators to be used in a wastewater lagoon is dependent on the required BOD load, but a good rule of thumb under normal conditions is to consider 1 unit per 3 to 5 acres of surface water. This system requires 5 feet of water within which to float and will be successful in a lagoon up to 20 feet deep.

**Figure 2**



**Figure 3**



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