Lagoon Aeration
BOD Reduction
Mixing & Equalization
Energy Savings
Sludge Reduction
Ammonia
Phosphorus

Aerator Conversion Nets Lower Energy Costs, Eliminates Surcharges, & Enhances Lagoon Performance

A food processing facility in Wisconsin discharges the plant's effluent into a wastewater treatment lagoon system for the reduction of BOD, Phosphorus, Ammonia (NH_3) and TSS prior to discharging to the local wastewater treatment plant. The facility discharges ~75,000 gallons/day with BODs ~350 mg/L. The lagoon is very large 640' x 246' with an operating depth of 9' to 10' with sufficient retention time for biological processes. A hanging curtain baffle provides for an area of quiescence on the discharge side to reduce TSS and divides the lagoon. The lagoon originally was equipped with five (5) 15-hp high-speed floating impeller-type aerators [AireO2] and three (3) 20-hp [AireoMix] draft tube surface aerators for a total of 135 connected horsepower. While these aerators were able to mix and recirculate liquids in the lagoon they were ***not*** capable of adequately influencing the biological treatment for organic reductions to include nitrification. Additionally, there was an increasing sludge accumulation of almost three feet (~32") or > of varying thickness [>3% solids] throughout the lagoon. In this configuration the facility was not able to meet their discharge permit limits issued by the pretreatment coordinator at the local publicly owned treatment works (POTW) and was subject to surcharges for excess BOD, TSS and Phosphorus.

As a result of not being in compliance with their discharge permit the facility was being surcharged for BOD in excess of 200, and TSS >100. They began to look for alternative treatment solutions to bringing the facility into compliance, as surcharges were approaching $70,000/year. The company's staff engineer responded to a direct mailer that he had received from a Venturi Aeration, Inc. distributor for a venturi aerator device that appeared to have all the performance features necessary to support and enhanced the biological processes in the lagoon:

1. BOD Reduction through high oxygen transfer,
2. Mixing and equalization
3. TSS resuspension for digestion
4. pH adjustment (non-chemically) by stripping CO_2
5. Ammonia (NH_3) reduction and Nitrification
6. Sludge reduction

The Venturi Aeration, Inc. representative looked at the dissolved oxygen requirements and determined that four (4) medium sized venturi aerators would be required for this lagoon since the BOD loadings were not significantly high. He devised a plan of action that would be implemented in two phases. Initially, add only two venturi aerator units to the lagoon in the first year, and then as the floating aerators needed replacement, add two additional venturi aerators on the opposite side of the lagoon and discontinue use of all the AireO2 and floating surface aerators completely. The first two-venturi aerator units would have 15-hp TEFC motors with a combined flow rate of 1100 gpm. They were installed on the East Side of the lagoon in 2001. The Venturi Aeration, Inc. rep installed a unique suction piping configuration that would rest on the bottom of the lagoon, but have the actual screens on the suction piping rise up off the bottom. The suction would pull in the lighter weight, fluffy sludge for resuspension into the pump.

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Suction Piping into Gorman-Rupp pump & Venturi unit

With suction from the bottom of the lagoon, the most anoxic liquids are pulled into the venturi aerator units achieving a high oxygen transfer. This high oxygen transfer is due to the "two-film theory" of oxygen transfer which postulates that it is always easier to add dissolved oxygen into a liquid which is void of DO, than it is to add DO to a liquid which is already "partially oxygenated." There is greater resistance to oxygen transfer when the liquid is partially oxygenated which reduces the effectiveness of any aerator's performance. Therefore, using liquids from the bottom of the lagoon and an offset discharging below the surface ensures not only a high oxygen transfer but also very good mixing and equalization. In this manner the lighter sludge layer is resuspended where it is made available for aerobic digestion and it continuously exposes more surface area of the heavier sludge for microbial degradation. Digesting the sludge blanket also increases the retention time in the lagoon prior to discharge by making more volume available for the liquids.

Due to the depth of the sludge (6' below the surface air/liquid interface) the AireO2 units and the floating surface aerators were not effectively resuspending the sludge for digestion, but rather they allowed the sludge to accumulate on the bottom. The bottom 22" of sludge was >3% solids while the next 12" was a slurry varying between 1 to 3% solids. The sludge was occupying 25% of the lagoons total volume.

Energy Savings:

In the first year, the added two venturi aerator's brought the facility into compliance. Phase Two was implemented in 2003. This was the addition of two (2) Model VA-600 venturi aerators and two (2) Gorman-Rupp Model 84A52B direct-coupled pumps with 20 hp TEFC motors. The additional horsepower allowed the Gorman Rupp units to pump at a higher capacity, i.e. 600 gpm each. With all four (4) venturi aerators operating at the same time the eight (8) surface aerators could be discontinued. Therefore, there were energy savings due to less operating horsepower [70 hp vs. 135 hp].

65 hp (reduction) x .746 = 48.5 kW/hour
48.5 kW/hr x 24 hours = 1164 kW/day
1164 x $0.060 = $ 69.84/day savings
69.84 x 31 days = $ **2165.00**/monthly energy savings (estimated based on a blended utility rate of $0.060 cent per kW Hr)

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Gorman-Rupp 84A-series with Four Inch (4″)
Model VA-600 Venturi Aerator

A concrete pad was poured on the dike of the lagoon to support the pump and a unique bracket support system was attached to the same concrete pad for the suction and discharge piping.

Results:

With all four venturi aerator systems in operation the facility is in compliance with their discharge permit. BOD levels average 35, TSS 70, Ammonia <1.0 mg/L, Phosphorus <3 mg/L, Nitrate <1.0 mg/L. Because the venturi aerator is consistently stripping the carbon dioxide generated by the aerobic bacteria, the pH is buffered non-chemically. The facility's discharge pH averages 8.0 without the addition of alkalinity. The sludge blanket has been reduced to almost zero on the "aerobically treated" side of the baffle, while in the quiescent zone there is only an average of 4" of sludge <3% solids.

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Venturi Aerator unit shown with the surface aerators that were discontinued in the background. Because of the unique suction piping and discharge configuration there is better mixing and equalization of the contents of the lagoon. This installation also has a subsurface discharge of the venturi aerator treated liquids, which allows the entrained “macro-bubbles” to rise like a diffusers, but unlike a diffuser there is a high Reynolds number associated with the high degree of turbulence in the discharge piping which increases oxygen transfer. By pushing out the “entrained” micro bubbles horizontally, they travel a greater distance (up to 75-100 feet) than the rise of a bubble from a diffuser (in this case it would be only 9 ft). This subsurface discharge is ideal where there is not a requirement for CO_2 stripping to raise pH.

Suction Pipe for the Venturi Aerator prior to submergence is shown along with one of the 15-hp AireO2 floating surface aerator units that were discontinued. Having the venturi aerators on the shoreline makes for easy maintenance of the pump and provides for increased operator/ maintenance safety. If the AireO2 unit flips over in high winds the operators need to launch a boat to right it. This risk factor is eliminated with the venturi aerator units positioned on the shoreline. Further, submergence of the motor when the AireO2 unit flips over will require that it be replaced. This adds to additional operating costs. The intake into the unique suction piping for the venturi aerator units can be set at different elevations for use in facultative lagoons when an anoxic zone is required for sludge reduction anaerobically.

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