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Economical, efficient and effective mixing: Three approaches to controlling odor in wastewater treatment ponds

Long-distance circulators are different from any other reservoir equipment in that the adjustable intake takes advantage of the manner in which water forms thin horizontal layers in ponds, and allows a precise horizontal cross-section of water to be circulated throughout the entire pond footprint.

Solving odor problems in wastewater treatment ponds should begin with a few investigative questions: How was the pond designed? Has the operation of the pond changed over the years? What is the purpose and operational theory of each pond, and have ponds been added or closed? Why are odors apparent on some days and not others? Understanding these "hows" and "whys" will provide clues to successfully solving odor problems in a variety of wastewater treatment plants.

All organic material contains sulfur, a chemical element that is necessary to sustain life. Sulfur in the aerobic digestion process is converted to odorless sulfate in the presence of oxygen. Sulfur in anaerobic digestion becomes sulfide and exists in several forms, from hydrogen sulfide to mercaptins, or thiols. The odors associated with sulfides are equally as diverse, ranging from the smell of garlic to rotten eggs and worse. Wastewater treatment plant operators may rate the odors coming from their plants from mild to offensive, depending on the number of complaints received from nearby residents.

Operators have several options for trying to deal with pond odors, from increasing the aeration to applying chemicals to the water or perfume to the air. But often these solutions are expensive and not totally effective.

Another alternative—long-distance circulators or mixers—has emerged as an economical, effective solution for controlling odors in many wastewater ponds. These mixers are installed on the pond's surface and consist of a solar-powered or grid-powered motor, an axial flow impeller that pulls water up from the intake to the surface where is it spread out at 360 degrees, an adjustable-depth intake hose, and a power control system.

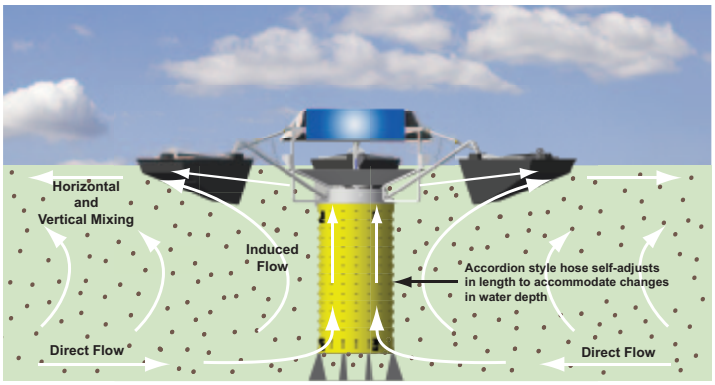

Figure 1. Keep an equalization pond well-mixed and aerobic. By keeping the solids and water thoroughly mixed, the solids move on to the plant instead of settling to the bottom.

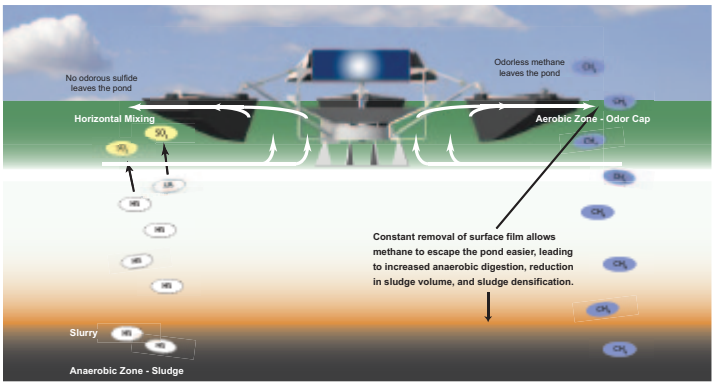

Figure 2. Odor-cap an anaerobic pond. Only the top two or three feet of the pond is mixed, effectively "capping" the anaerobic waters below.

Long distance circulators are different from any other reservoir equipment in that the adjustable intake takes advantage of the manner in which water forms thin horizontal layers in ponds, and allows a precise horizontal cross-section of water to be circulated throughout the entire pond footprint. This circulated zone can be indexed to the top of the pond, such as a setting to circulate just the top X feet of the pond, or the intake hose can be set to circulate the entire depth of the pond regardless of how full the pond is. This article discusses how this unique characteristic allows long distance mixers to control odors in three types of wastewater treatment ponds:

1) Equalization ponds

2) Anaerobic ponds

3) Deep storage industrial ponds

Equalization ponds: Keep the pond well-mixed and aerobic

An equalization pond in front of a wastewater treatment plant acts as a shock absorber by temporarily holding excess inflow during rain events until the water can go through the treatment plant.

For example, an equalization basin may be designed to hold eight million gallons of water when full at eight feet deep, but normally be operated with two million gallons in the pond at a depth of three to four feet, with one million gallons per day entering the pond and going through to the treatment plant. During a heavy rain, the equalization pond may quickly fill to the depth of eight feet and then, a few days later, be back down to three feet.

In this type of pond, without thorough mixing, the organic solids entering the pond will tend to settle to the bottom and, over time, the anaerobic digestive process at the bottom can create ongoing odor problems. But by keeping the solids and water thoroughly mixed, the solids move on to the plant instead of settling to the bottom, and the detention time of both the water and the solids is too short for the anaerobic process to ever pick up any momentum and create an odor problem.

In these ponds, the unique design of a long distance circulator, set with the intake hose all the way to the bottom of the pond, will automatically allow full mixing of the pond as it goes through these depth changes, without any adjustment being needed and without damaging the bottom of the pond in any way. (See Figure 1.)

Anaerobic ponds: Odor-cap an anaerobic pond

Some wastewater treatment ponds, such as waste sludge storage ponds in activated sludge systems, are purposely designed for anaerobic digestion and thus produce sulfides and odors continuously throughout most of the pond depth. To eliminate odors emanating from these ponds, operators can maintain an oxygenated layer of water at the surface of the pond, sometimes called an "odor cap." When sulfide gas bubbles rise toward the surface of the pond, they are instantly oxidized to non-odorous sulfate as they pass through the oxygenated odor cap.

A thin odor cap at the top of the pond, even one inch thick, is all that is required to neutralize sulfide odors. (See Figure 2.) But a thin odor cap can be disturbed by wind, which would then let odors escape, so usually it is best to have a one- to three-feet thick odor cap.

Some floating aerators, such as brush aerators, have a shallow mostly-horizontal mixing effect, and these are often the best type of aerator to use to create an odor cap on an anaerobic pond. However, because they generally send out a turbulent flow which reaches several feet deeper than desired, they can bring deep BOD (biochemical oxygen demand) material up into the odor cap zone, which causes oxygen depletion. For that reason, and also because these aerators push water in only one direction, oftentimes several machines are needed for each pond in order to supply enough oxygen to maintain the odor cap, which leads to higher capital and operating costs.

Floating circulators are ideal for creating an odor cap on top of the pond, because their intake hoses can be set for a shallow water depth, usually one to three feet, and because one machine will circulate to the edge of the pond in all directions. Consequently only one machine is usually needed per pond. Circulators maintain the oxygen in the odor cap through two mechanisms: (a) capture of photosynthetic oxygen during the daylight hours; and (b) surface re-aeration during the nighttime hours. Since the machine is not bringing up any BOD loading from deeper water, because there is no turbulence, usually there is no problem in maintaining oxygen in the odor cap 24 hours per day.

Regardless of what type of equipment is used to create and maintain an odor cap on an anaerobic pond, three practices are crucial to proper odor control in an anaerobic pond:

1. Inflow to the pond should be kept below the odor cap, so that the influent BOD does not use up the oxygen in the odor cap. If the odor control plan calls for a three-feet thick odor cap at the top of the pond, the inflow should be brought in horizontally at four feet deep or deeper. If an old pond is converted to sludge storage and the horizontal inflow pipe is not deep enough, than add a baffle or 45-degree elbow with a short pipe extension so that the inflow water does come in below the odor cap. And in ponds where the influent water enters vertically at the bottom of the pond, place a deflector, similar in shape to a card table, over the influent pipe to deflect incoming water into a horizontal pattern instead of allowing it to shoot up to the surface of the pond.
2. Similarly, the effluent should also be drawn off the pond from below the odor cap. This prevents the oxygenated water that comprises the odor cap from being drained off the pond. If an old pond is being converted to use for sludge storage and it has a skimming outlet pipe, devise an anti-skimming baffle, or 45-degree elbow and short pipe extension, to allow water leaving the pond to come from below the odor cap.
3. Finally, the influent to the pond, which contains the BOD for anaerobic digestion, cannot be hot water. Hot water will float across the top of the pond, and the BOD in it will use up the oxygen in the odor cap. For this reason, odor capping is difficult in some industrial treatment applications, such as beef processing, where the influent is hot wash-down water. Often these plants use hot water that is high in BOD. For those ponds, aerobic digestion of all influent is one solution, or the pond can be covered to achieve odor control.

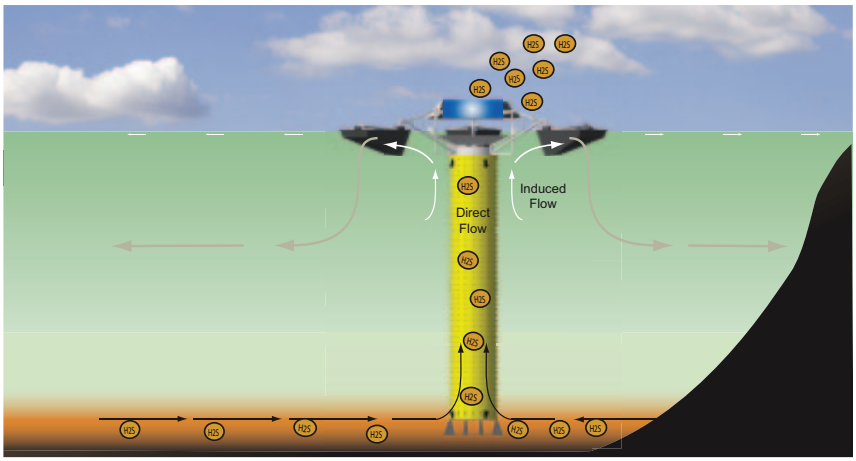

Figure 3: De-gassing a deep-water industrial pond. Deep dense water, along with hydrogen sulfide, is continuously drawn up to the surface of the pond and de-pressurized. Sulfides vent into the atmosphere at the distribution dish.

Deep industrial pond: Constant de-gassing in an anaerobic pond

Some industrial wastewater ponds can be quite deep, 30 to 50 feet, for example, and may contain mostly mineral and salt based wastewater, such as boiler blow-down water from a power plant. Mining ponds and oilfield wastewater ponds can also have this problem.

In these ponds, the sulfate comes in with the water and other minerals, as opposed to being released during digestion of organic material. In the anaerobic environment at the bottom of the pond, some sulfate is converted to sulfide, and trapped in the cold high-salt high-density water at the bottom of the pond. Then, when the pond turns over and goes into a full mixing mode, particularly in the fall and during some spring nights, huge amount of sulfides can be released into the air.

In these ponds, an effective odor control strategy is to place one or more circulators in the pond, depending on pond size, with the intake hose all the way to the bottom of the pond. The deep dense water with the dissolved hydrogen sulfide is continuously drawn up to surface of the pond, de-pressurized, and the sulfides vent into the atmosphere at the distribution dish. (See Figure 3.) Because water in ponds is found in thin horizontal layers, usually one machine set at the deepest part of the pond will remove sulfides across the bottom of the entire pond. The sulfide smell is usually noticeable right at the machine, but not at shore. Then, when the pond turns over from time to time, there is no odor event because no sulfides remain on the bottom water.

The same can happen in the spring - the top layer of water warms during the day but gets cold at night and plunges to the bottom, trading places with the stagnant water that contains lots of sulfides. This can occur every day for weeks or more, with the resulting smell drifting across an entire county.

CONCLUSION

Diagnosing odor problems in wastewater treatment plants can be intriguing and begins with a thorough investigation of the plant, its processes and purposes. What is the theory of the pond's design and how is it operating? How do the inflows and outflows work? Why and when are the odor problems occurring?

Just as each plant is unique, each solution is unique, but many pond odor problems, and solutions, will fall into one of the three categories mentioned above.

Whatever the situation, circulators can be a viable tool in both aerobic and anaerobic pond types. They can often be installed and operated at a fraction of the cost of other methods, yet operate compatibly with existing aeration systems. And in industrial applications in the U.S., the solar-powered machine qualifies for a 30-percent investment tax credit and accelerated depreciation. Treatment plant operators will discover it's worth their investigative time to consider circulators—and curtail resident complaints about odors forever.

About SolarBee™

SolarBee, Inc., a division of Medora Environmental, Inc., manufactures and installs solar-powered, long-distance water circulation equipment. Introduced in 2001, the floating, up-flow circulators can move up to 10,000 gallons per minute from depths of more than 100 feet with a solar-powered pump. SolarBee circulators help solve water-quality problems worldwide in freshwater lakes, wastewater lagoons, storm-water ponds, estuaries, potable and recycled water storage tanks and other reservoirs.

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