Dissolved Oxygen Technology

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Dissolved Oxygen (DO) is one of the most critical measurements in a wastewater treatment plant. Aerobic Bacteria require dissolved oxygen to live. Historically, plant operators around the United States have used handheld DO analyzers to periodically check aeration tank dissolved oxygen levels. Handheld DO instruments will only provide a snapshot of the DO in an aeration tank. They cannot detect when more air is required to handle a heavier biological oxygen demand (BOD) that has the potential to kill the aerobic bacteria, possibly causing the plant to violate NPDES permit. Handheld DO instruments cannot be used to control oxygen supply. For instance, at low BOD levels typically experienced during night time hours, the amount of dissolved oxygen required to maintain proper bacterial activity is less than that required during peak daytime hours. If a handheld instrument is used, the reduction of air supply must be initiated by an operator on site, if power savings are to be attained. Similarly during reduced loads caused by storm water inflows or colder temperatures, in the absence of automatic DO measurement, too much air can be used, thus wasting valuable energy and causing sludge bulking problems.

With rising power costs and the requirement that wastewater treatment plants meet more stringent NPDES permit requirements, handheld DO instruments coupled with human intervention, have proven to be an ineffective control mechanism for the operation of aeration basins. Proper control of aeration tank DO requires the use of continuous DO analyzers. These analyzers have been in use for over 40 years. Properly maintained on-line DO analyzers, used in conjunction with blowers using variable frequency drives, and plant integrated control systems (SCADA or PLC), can reduce plant power costs by up to 25%. Two dissolved oxygen technologies have been used in wastewater treatment facilities for over 40 years, unfortunately both have had many problems.

Galvanic technology consists of an anode and cathode made from different metals, both of which are immersed in an electrolyte solution and covered with an oxygen permeable membrane. When these dissimilar metals are immersed in the electrolyte, a spontaneous voltage occurs between the anode and cathode. As oxygen permeates the membrane, the cathode reduces the oxygen. This then creates a potential across the electrodes that is equal to the amount of dissolved oxygen in the system. The voltage is converted from a milliamp current and then converted in the instrument to an mg/l or ppm reading. Some galvanic systems do not use any membrane. These systems have had problems with low DO applications, as well as, with wastewater chemicals such as Ferrous Sulfate, Ferric Chloride and Aluminum Sulfate. Any chemical that produces an electrical charge can interfere with effective readings.

The second dissolved oxygen system that has been used is a Poloragraphic DO sensor. This system also uses an anode and cathode; however, it does not create a spontaneous voltage. Poloragraphic systems supply constant electrical voltage across the anode and cathode, as oxygen is reduced at the current supplied to the cathode is increased. The amount of electricity required to reduce the oxygen at the cathode is equivalent to the DO present in the system. These systems have had problems due to time intensive maintenance problems caused by the cleaning of the electrodes and the degree of stretch manually applied to membranes used with the older systems.

Both of the galvanic and poloragraphic systems have had many problems and have caused numerous complaints by plant operators and maintenance personnel. Both systems consume oxygen. In the process of consuming oxygen the anode is also consumed, eventually consuming itself and the electrolyte. Prior to total consumption of the anodes they can become coated and DO readings will trend towards zero causing faulty readings. Some systems allow for the cleaning of the anode and cathode. This is a tedious and time-consuming maintenance activity that is unloved by many operators.

Teflon membranes have been a problem; they are easily punctured by sharp objects or by being dropped. To combat this, many manufactures have gone to using thicker membranes. This however, causes the response time to become extremely slow. The membranes also can become coated with grease and dirt. As the membranes become coated, the DO reading again trends towards zero. Cleaning of these membranes is possible, however, it is very easy to puncture the membranes while cleaning them.

Finally, the electrolytes that have been used in conventional DO probes slowly dehydrate over time. As the electrolyte dehydrates, the system slowly trends towards zero. In systems with high sulfide content (H_2S) contamination of the electrolyte will occur. H_2S will eventually poison the electrolyte, as well as, the anode poisoning them and requiring the sensor to be replaced.

Today a new technology has been developed that does not require an anode, cathode or electrolyte. This system greatly reduces maintenance time and costs. The system is based on luminescent technology. A sensor is coated with a luminescent material; blue light from an LED strikes the sensor causing the luminescent material to become exited. As the exited material relaxes a red light is emitted. This light is measured by a photo detector. As oxygen molecules come into contact with the luminescent dye, its luminescence is quenched, and the amount of light given off by the sensor is reduced. The higher the oxygen content, the less luminescence is observed.

What does this technological breakthrough do for plant operations personnel? Elimination of the anode, cathode and electrolyte mean that there can be no poisoning of the sensors. This now provides a means of consistently measuring oxygen content in an aeration basing such that it will not be affected by the interferences that would cause traditional DO Sensor technologies to give erroneous readings. The life of the sensors is considerably longer than the life of traditional sensor technologies. There are no membranes, or electrolyte solutions that need replacement. In fact the only replacement part of the system is an inexpensive sensor cap. The cap is easily cleaned and is made of a plastic material that will not break and is not easily scratched. As this system is self-calibrating, no time consuming calibrations are required. Frequent cleanings are not required; as the system will produce accurate DO readings even with inorganic buildups on the sensor.

Unlike other Luminescent DO technologies the HachLDO™ does not require that the system be sent back to the factory for calibration and sensor replacement. This makes this sensor the new industry standard. The HachLDO™ system will provide consistent DO readings, and it is easy to use and maintain. This technology provides a quantum leap in DO measurement, and in conjunction with the Hach sc100™ controller; it represents the most efficient method of operating and controlling plant blowers and aeration systems available on the market today.

For more information contact Hach Company at 800-227-4224.