ROYCE TECHNOLOGIES

APPLICATIONS BULLETIN

(Revised 1/20/06)
AB02.3

DISSOLVED OXYGEN CONTROL IN DENITRIFICATION BIOLOGICAL REACTORS

A recent tightening of regulations governing the discharge of nitrogen bearing wastes has increased an interest in wastewater treatment processes where sophisticated circular or oval raceways are used as biological reactors. Some existing plants are even converting traditional rectangular basins into biological reactors. These reactors synchronize the oxic, anoxic and anaerobic biochemical phases throughout their length to eliminate nitrogen and phosphorus from wastewater. The key to the success of these reactors is the ability to control dissolved oxygen levels at different locations around the reactor.

The general sequence of events are as follows, in this biochemical reaction process,:

The aerobic or oxic phase – air is injected into the process and the oxidation of carbonaceous and nitrogen compounds is achieved, resulting in the formation of nitrates through nitrification. The nitrifying bacteria also absorb phosphorus from the wastewater during this phase of the process.

The anoxic or denitrification phase – air injection is ceased and due to the absence of free oxygen, nitrate oxygen is used by the bacteria for respiration. This results in the formation of nitrogen, which escapes from the reactor as a gas.

The anaerobic phase – this phase begins when nitrate oxygen is depleted. The bacteria, due to a lack of oxygen, are stressed to the point of releasing some of their stored phosphorus. This part of the process also prepares the bacteria for the aerobic or oxic phase, which follows – allowing for the absorption of more phosphorus.

The monitoring and control of dissolved oxygen (DO) is critical to the success of this process. It is common for several DO instruments to be in use within each reactor, depending upon the design. But in the denitrification and anaerobic phases, it is not uncommon to require that a maximum of .1 to .2 PPM DO be maintained – the reliability of that reading is often the difference between a reactor going septic or not.

The Royce Models 9010 and 9040 DO Analyzers with Model 94 Sensors are uniquely qualified for this application for a number of reasons:

1. The Model 94 sensors are galvanic cells. This simply means that they use dissolved oxygen to read dissolved oxygen – or, at zero DO, the sensor is generating 0 milliVolts of current. Other polarographic type DO sensors require an electronic input from their parent instrument in order to read dissolved oxygen; the stability of this input effects the stability of the polarographic sensor in very low DO levels. Consequently, this type of sensor is very unreliable for the continuous monitoring of DO levels under 1 PPM.
2. Due to the extreme biological activity in these reactors, sensor membrane fouling is intensive. The Royce Model 9010 and 9040 instruments, with self-cleaning options for their Model 94 sensor, are uniquely capable of maintaining calibration over long periods of time without continuous manual maintenance. This includes sensors used in the anaerobic portion of the process where DO levels are kept extremely low, usually under .2 PPM.
3. The Model 9010 and each channel of the Model 9040 has two sets of control setpoints. Due to the critically low DO levels required in the anaerobic phase of the process, if these levels should drop to zero PPM dissolved oxygen, the active bacteria will die and nitrogen removal in the system will cease. This disruption of the process is critical and could be extremely costly to the entire plant process.

Conclusion

Wastewater treatment nitrification/denitrification biological reactors are becoming a necessary technology to meet the stringent environmental requirements of the 21st century. These processes require critical control over dissolved oxygen levels throughout the reactors. The operator with a hand held DO analyzer will not be an acceptable answer to the DO control of this process because it is a load based, rather than time based biological process. Highly reliable, sophisticated DO analyzers will be required to continually monitor and control these crucial processes. The Royce Models 9010 and 9040 DO analyzers, with the Model 94 sensor, are uniquely designed to fulfill these very critical requirements.

For a reprint of an article that appeared in the August 1992 issue of Water Engineering and Management magazine, written by a plant superintendent who manages biological reactors of the type noted above, call Royce Technologies at 1 800 347 3505.