

Understanding Wastewater Operational Problems in Small Treatment Systems

**By Contributing Writer
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The operation of a small wastewater treatment plant is often more complex than the operation of a larger facility. Small treatment plants often do not have the flexibility or resources to respond to operational problems. However, the operator who understands operational problems can take some simple actions to control the process and produce good effluent. Understanding the biological processes and controlling the environmental conditions to promote good microbiological growth in the system is the most important role for the operator.

Wastewater treatment combines physical, chemical, and biological processes to produce a high quality effluent. In small systems, secondary treatment is primarily a biological process that provides specific environmental conditions to promote the growth of microorganisms that breakdown the pollutants. No matter the size of the treatment system or the technology used, the biological process involves microorganisms that remove the biochemical oxygen demand (BOD) and total suspended solids (TSS) in the wastewater. The growth of microorganisms depends upon basic conditions that include temperature, dissolved oxygen, nutrients, and pH. A change in environmental conditions will produce a change in the microorganisms that are present in the wastewater system that may adversely affect the operation of the system causing a decrease in the level of treatment. For these reasons, the operator must understand and correctly respond to changes in environmental conditions.

Temperature

A lower temperature will cause a decrease in microbial activity. At lower temperatures, the microorganisms are not as active. When the biological activity begins to decline, the level of treatment also decreases. More time must be provided to allow the microbes to decompose the BOD and TSS. This may require more recirculation of the wastewater during colder months, thereby increasing the aeration time or treatment time.

The nitrifying bacteria are especially sensitive to lower temperatures. When temperatures fall, the nitrifying bacteria become less active and may cause an increase in ammonia levels. In addition, colder water is denser, which causes the solids to settle more slowly. Colder temperatures in the winter months will require the operator to compensate by carrying a higher level of solids (which provides more microbial mass) to provide treatment and by allowing a longer detention time for settling in the clarifier.

Dissolved Oxygen

The level of dissolved oxygen is also an important indicator of the type of microorganisms that will predominate in the treatment system. Low dissolved oxygen concentrations tend to promote the growth of filamentous microorganisms that may produce a poor-quality effluent. In a suspended growth treatment process, aeration provides dissolved oxygen and mixing. These two processes must be kept in balance to produce plenty of oxygen for the microbial

population, keep the aeration tank contents well mixed, and promote the formation of good floc particles that will settle readily in the clarifier.

Over-aeration may cause “floc shear” in the aeration process, in which the floc particles become smaller due to over mixing. The smaller floc particles may not settle out properly in the clarifier and may create pin floc and turbidity in the effluent. The level of aeration must be adjusted to maintain good dissolved oxygen in the system while providing mixing that promotes good floc development.

Nutrients and pH

The microorganisms in wastewater must have nutrients, such as carbon, nitrogen, phosphorus, and sulfur. If conditions exist that change the ratio of these nutrients, the growth of filamentous bacteria may be promoted. For small wastewater systems, controlling the nutrients in the wastewater is extremely difficult. As a general rule of thumb, the available nitrogen in the forms of ammonia, nitrite, and nitrate should be above 1.0 mg/L in the effluent, and phosphate should be above 0.5 mg/L in the effluent. For a plant treating typical domestic wastes, the concentration of nutrients should be acceptable; however, small plants treating an industrial waste may need to adjust the nutrient concentration to promote the growth of good-settling bacteria.

Systems that treat wastes from fruit processing or fermenting may experience problems due to a low pH and a high carbohydrate waste. These conditions promote the growth of fungi that may cause the sludge to bulk and not settle in the clarifier.

The best control method is to control the pH of the wastes entering the plant. The control of pH may be accomplished by adding a caustic solution or raising the alkalinity of the waste. The operator must also remember that the process of nitrification tends to lower the pH in the aeration tank. Increasing denitrification in the aeration tank will help to increase the



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alkalinity and raise the pH. Controlling these processes may be a very complex job, and controlling the pH of the influent will provide the most economical control strategy.

Hydraulic and Shock Loading

Small wastewater treatment plants often experience uneven hydraulic flows. The flow may be very low for several days or months, and then a sudden increase in flow occurs. These hydraulic surges may be due to industrial users or intermittent use of the system in recreational areas. Without provisions for flow equalization, an increased flow may wash solids out of the treatment plant. When this occurs, the incoming flow receives very little treatment before being discharged, and the loss of solids means a loss of the microorganisms that treat the waste.

The operator may take corrective actions during high-flow conditions that include increasing aeration or increasing the chemical feed rates

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maintenance procedures include dye testing, flushing lines, cleaning lines, root control, and using a camera to visually inspect sewer lines. Many small systems contract for these services that require specialized equipment.

In addition to uneven hydraulic loading, some small plants may experience a shock load that may contain a toxic substance or just have a very high BOD. This shock load can be very difficult for a small system to treat. In small systems, the flow is often too small to adequately dilute a shock load, causing the microorganisms in the treatment process to die off, producing poor-quality effluent.

A shock load can come from any source—a garage, a small commercial business, a restaurant, a homeowner’s garage, or even a small home business. A shock load can be created in the collection system when a sewer becomes clogged. In a clogged sewer line, solids build up in the line due to the low flow and become very septic. When the line is cleared and the sewage again flows toward the treatment plant, the accumulated solids may be quite septic and place a large dissolved oxygen load on the system.

The operator may not have many options, but if he or she is aware that a shock load is coming into the plant, diverting the flow (if possible) is the best solution. Increasing the rate of aeration or using chemicals, such as chlorine, to treat the waste, can mitigate the impact of a shock load. Chlorine, potassium permanganate, and hydrogen peroxide are all strong oxidants that can help to oxidize many waste chemicals. The operator should try to find out the source of the shock load to make the proper operational adjustments and before implementing any type of chemical treatment. Public education may be the best way to combat shock loads for small systems. Most systems will have some type of sewer-use requirements, and these requirements need to be continuously repeated to all users. Some systems periodically send out notices with their billing that identifies

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for disinfection. The specific types of corrective actions depend upon the type of treatment process and the cause of the hydraulic surge, but the operator should react to hydraulic surges and adjust the process to provide the best possible treatment.

The hydraulic surge in a wastewater plant may be caused by inflow and infiltration (I/I). I/I is caused by the flow of groundwater, stormwater, or illegal sewer connections that enter the collection system and mix with wastewater causing a large increase in the flow. Even small systems with a relatively new collection system may be subject to I/I, especially if improper construction methods were used during installation of the system. I/I problems are most severe after a rainfall event. The operator should have a routine inspection program of the collection system to find illegal sewer connections, manhole cracks, and breaks in sewer lines. Smoke testing can be another effective tool for small systems to find and eliminate I/I problems. Other sewer

substances that may not be disposed of through the wastewater system.

Small treatment plants may experience operational problems due to high organic loading. High organic loading may be due to the discharge of food processing wastes, or the treatment system may be overloaded due to the design of the system. High organic loading will require the operator to keep the wastes in the treatment process longer. Recirculation must be increased to provide a longer time for the organic wastes to be treated. Again, the use of oxidants, such as chlorine, may provide short-term help for an organically overloaded plant. However, the organic loading should be checked with the design parameters for the plant. If the actual organic loading is higher than the design loading, expanding the plant capacity is the only long-term solution.

Summary

The operator of a small plant must understand the importance of temperature, dissolved oxygen, nutrients, and pH in maintaining a

healthy population of microorganisms. [Table 1](#) summarizes the general operational problems associated with these conditions. When hydraulic or shock loads occur, the operator must be ready to respond quickly and provide the best treatment possible. An ongoing program of public education is an important tool to minimize the occurrence of shock loads and hydraulic surges.

Resources

More detailed troubleshooting guides for different treatment processes including trickling filters, rotating biological contactors, and lagoons are available from the National Small Flows Clearinghouse and the National Environmental Training Center, both of which may be found at the Web site www.nesc.edu or by calling (800) 624-8301. An extensive discussion of microbial troubleshooting may be found in the Manual on the Causes and Control of Activated Sludge Bulking by Jenkins, Richard, and Diagger, Lewis Publishers, Boca Raton, Florida, 2003.

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