Section 6

Aerobic Digestion

Aerobic digestion is a biological treatment process that uses long-term aeration to stabilize and reduce the total mass of organic waste by biologically destroying volatile solids. This process extends decomposition of solids and regrowth of organisms to a point in which available energy in active cells and storage of waste materials are sufficiently low to permit waste sludge to be considered stable. Waste sludge consists of suspended solids (SS) that have been removed during clarification and solids that are a result of the growth of the biological mass during the treatment process. The aerobic digestion process renders the solids less likely to generate odors during disposal and reduces bacteriological hazards. Properly designed, the aerobic digestion process should easily meet the U.S. Code of Regulations (40 CFR Part 503) for Class B biosolids.

Because of its similarities to the activated-sludge process, aerobic digestion is covered briefly here. For detailed process control and operations information, refer to Chapter 31, Aerobic Digestion.

DESCRIPTION OF PROCESS

During aerobic digestion, aerobic and facultative microorganisms use oxygen and obtain energy from the available biodegradable organic matter in the waste sludge. However, when the available food supply in the waste sludge is inadequate, the microorganisms begin to consume their own protoplasm to obtain energy for cell maintenance. Eventually, the cells undergo lysis, which releases degradable organic matter for use by other microorganisms. This phenomenon is called endogenous respiration.

The cellular material is oxidized aerobically to carbon dioxide, water, and ammonia. Approximately 75 to 80% of the cell material can be oxidized; the remaining amount is composed of nondegradable components. The ammonia from this oxidation is eventually oxidized to nitrate as digestion proceeds (Metcalf & Eddy, 1991).

Typically, aerobic digesters are used to treat waste activated sludge (WAS) from treatment systems that do not contain a primary settling process, or contain WAS only or trickling filter sludge or mixtures of WAS and trickling filter sludge. Many variations of the process exist, including conventional, high-purity oxygen, thermophilic, and cryophilic aerobic digestion. Conventional aerobic digestion is the most typically used and is the focus of this discussion. For details on process variations, see Chapter 31, Aerobic Digestion.

Conventional aerobic digestion aerates waste sludge for an extended period of time in unheated tanks, using air diffusers or surface aeration equipment. The waste sludge that has been removed from the main biological process is transferred to the digester units, where the oxygen for microbial metabolism is provided either by mechanical aerators or through a diffused aeration system. Each tank has a waste sludge feed line above the high water level, a solids draw-off line at the bottom of the tank, and a flexible, multilevel supernatant draw-off line to remove liquor from the upper half of the tank (California State University, 1991). Depending on geographical location and climatic conditions, these tanks might not have covers. Covers are used in colder climates to help maintain the temperature of the process. Covers should not be used if they reduce evaporative cooling too much and the liquid contents become too warm. When the liquid becomes too warm offensive odors may develop and the process effluent will have a poor quality (California State University, 1991). Following digestion, the remaining solids are separated from the liquid for dewatering or disposal.

Typically, an aerobic digester is operated by continuously feeding raw sludge with intermittent supernatant and digested sludge withdrawals. Supernatant is the clear liquid that forms above the settled solids in the digester. The digested solids are continuously aerated during filling and for the specified digestion period after the tank is full (Hammer, 1986).

In some operations the aeration system is shut down for 1 to 2 hours to allow the solids to settle and the supernatant to form. The supernatant is then decanted, allowing additional waste sludge to be added; thus, the solids concentration typically increases. For example, if solids wasted from the activated-sludge process are pumped to the aerobic digester at a concentration of 0.5 to 1.0% solids, the solids concentration in the digester may increase to 1.5 to 2.0%. If primary sludge is also delivered to the digester, the solids concentration in the digester may be in the 2 to 4% range or higher. The increase of solids concentration results from the decanting process. Decanting during digestion allows the solids to settle and the clear supernatant to be returned to the treatment process. This supernatant can cause additional biochemical oxygen demand (BOD), solids, and nitrogen loadings to the plant. Staff should be aware of the effect of returning the supernatant to prevent plant upset.

OPERATIONAL PARAMETERS

The important factors in controlling the operation of aerobic digesters are similar to those for other aerobic biological processes, and include waste sludge characteristics, oxygen requirements, pH, temperature, mixing, and solids retention time (SRT). These parameters either affect or are used to monitor the operational performance of the process. Although controlling and monitoring of these parameters is important, the degree of control that can be exercised on each parameter varies. Monitoring helps control process performance and serves as a basis for future improvements.

WASTE SLUDGE CHARACTERISTICS. The characteristics of the waste sludge to be digested will be determined by the raw influent to the treatment system and by treatment processes that precede aerobic digestion. The waste sludge concentration is important to consider. Increasing the feed concentration by thickening will result in longer SRTs with subsequent increased levels of volatile solids destruction, and will reduce the frequency of supernatant decanting (WEF, 1992). Solids concentrations that are too high can cause the process to attempt to go autothermal and can reduce decanting effectiveness.

The organic strength of the waste sludge significantly affects the digestion process. Although organic loading rates vary, they typically range from 0.3 to 2.2 $kg/m^3 \cdot d$ (0.02 to 0.14 lb VSS/d/cu ft). Higher loading rates may result in higher oxygen demand and, in some cases, can exceed the oxygen-transfer capacity of the aeration system. This leads to anaerobic conditions and undesirable odors.

OXYGEN REQUIREMENTS. The most critical parameter in the aerobic digestion process is dissolved oxygen (DO). Maintaining adequate oxygen concentrations allows the biological process to take place and prevents objectionable odors. In aerobic digesters, DO concentrations typically range from 0.5 to 2.0 mg/L. Inadequate DO levels result in incomplete digestion and, more importantly, odor problems. Also, if air is used for mixing, the air must never be reduced below the mixing requirements regardless of the DO concentration.

The rate of oxygen use by the microorganisms depends on the rate of biological oxidation. The oxygen uptake rate (OUR) is expressed as milligrams of oxygen per gram of volatile suspended solids (VSS) per hour (mg O_2/g VSS·h). The OUR is used to determine the level of biological activity and the resulting solids destruction occurring in the digester. Typical OURs are shown in Figure 20.48.

pH. Two products of aerobic digestion that tend to lower the digester pH are carbon dioxide and hydrogen ions. A pH drop can occur when ammonia is oxidized to nitrate if the alkalinity of the wastewater is insufficient to buffer the solution. In situations where the buffering capacity of the sludge is insufficient, it may be necessary to chemically adjust the pH (Metcalf & Eddy, 1991). Carbon dioxide will dissolve in the liquid in an amount proportional to the partial pressure of carbon dioxide in the gas phase above the tank. For an open tank this is typically negligible. For a closed digester, however, the amount of carbon dioxide in the headspace below the cover may exceed 40% by volume, and the pH may subside to 6.0 under such conditions.

As with other biological systems, the aerobic digestion process performs better at either a neutral or slightly higher pH. The results suggest that either pH adjustment or increased alkalinity will improve performance and dewaterability. If pH adjustment is necessary, the proper chemical dosage can be determined by performing a bench-scale jar test and proportioning the chemical dosage from the jar test to the digester volume.

TEMPERATURE. The liquid temperature in an aerobic digester significantly affects the rate of volatile solids reduction that increases as temperature increases. As with all biological processes, the higher the temperature, the greater the efficiency. At temper-

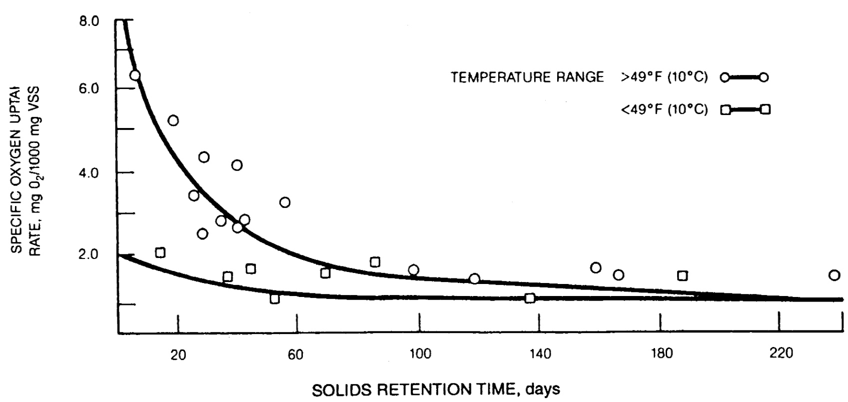

Figure 20.48 Influence of solids retention time and liquid temperatures on the oxygen uptake rates in aerobic digestion.

atures lower than 10 °C (50 °F) the process is less effective. In most aerobic digesters temperature is a function of ambient weather conditions and is not controlled.

MIXING. Mixing is essential in aerobic digesters. A well-mixed biomass ensures adequate contact between the organisms and their food supply and ensures uniform distribution of oxygen throughout the digester. The aeration system typically supplies the mixing. Adequate mixing is provided when the diffusers supply air at a rate of 0.3 to 0.6 L/m^3·s (20 to 35 cu ft/min/1000 cu ft). Supplemental mixing is required when the rate of aeration or oxygenation needed to meet the OUR is less than the rate needed to keep the organisms in suspension. Either mechanical mixer or mechanical aerator requirements may be used to supplement mixing needs.

SOLIDS RETENTION TIME. The SRT is a significant factor in the effective operation of aerobic digesters. It is defined as the total mass of biological solids in the reactor divided by the mass of solids removed from the process on a daily average.

$$\text{SRT} = \frac{\text{Total sludge mass, kg}}{\text{Solids removed per day, kg/d}} \tag{20.16}$$

Typically, increased SRT results in an increase in the degree of solids reduction. Figure 20.49 shows the relationship between SRT and solids reduction. This relationship can vary depending on the characteristics of the waste sludge being digested. Figure 20.50 illustrates the relationship between SRT and solids reduction for several waste sludge types.

Equation 20.16 helps predict digester performance after trends have been monitored at various SRT values. The overall SRT typically ranges from 10 to 40 days. Note that higher retention times reduce dewaterability of the digested solids; therefore, if dewaterability is an important consideration, SRT values should be kept on the low end of the range.

DESCRIPTION OF FACILITIES

TYPES OF REACTORS. Most aerobic digesters are constructed to allow the liquid level to fluctuate. Some aerobic digesters are designed with sloped floors so that digested solids are drawn off the bottom; others have a constant, weir overflow design.

Aerobic digesters are constructed of reinforced concrete and steel. In cold climates, steel tanks that are above the ground should be insulated. If the steel and concrete tanks are below the ground, they are well-insulated by the soil if the groundwater is drained from the exterior of the tank walls.

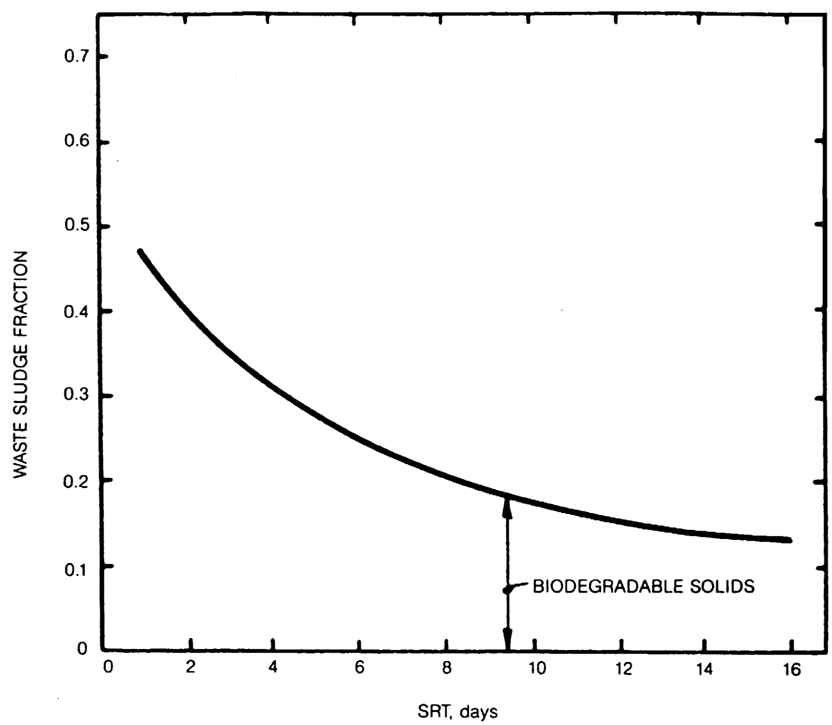

FIGURE 20.49 Effect of solids retention time on reduction of biodegradable solids by aerobic digestion.

At least two tanks are typically installed to allow flexibility for maintenance or repair. Increasing the aerobic digester size to produce an operating safety factor may create operational problems because of a loss of heat and increased energy requirements for mixing (WEF, 1992).

AIR AND OXYGEN SUPPLY EQUIPMENT. Either air or pure-oxygen-transfer equipment, such as conventional mechanical aerators, coarse-bubble diffusers, fine-bubble diffusers, or jet aerators, supply the oxygen needs for aerobic digestion. The best device not only should be capable of developing the required oxygenation and mixing, but should also provide flexibility (WEF, 1992).

Air diffusers typically are found near the bottom of the digester toward one side to induce a spiral or cross-roll mixing pattern. The most widely used air diffusers are the

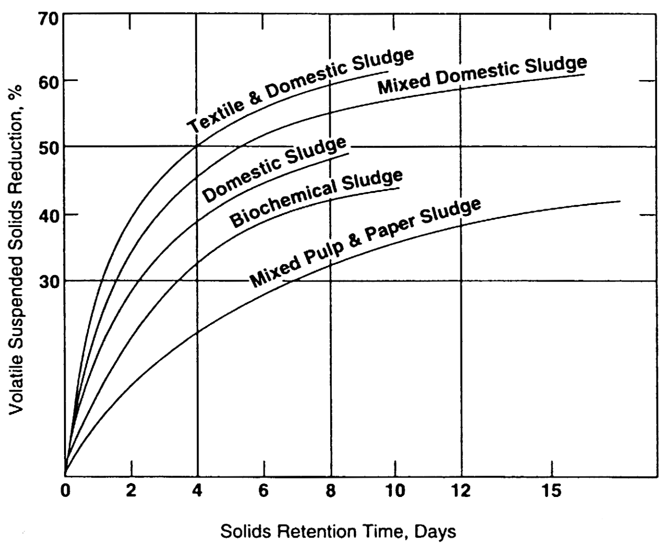

FIGURE 20.50 Relative solids destruction of several sludges by aerobic digestion.

small-bubble and large-bubble types. Blowers supply the air for mixing and aeration. Diffused-air systems tend to add heat to the digester, are not greatly affected by foaming conditions, and require the entire assembly to be removed for cleaning if it becomes clogged or plugged.

Both low- and high-velocity mechanical surface aerators, in either free-floating or fixed installations, are efficient in transferring oxygen (amount of oxygen fed by the aerator that has been absorbed by the biomass). Typically, mechanical surface aerators supply oxygen efficiently at approximately 0.5 kg/MJ (4 lb/kWh) have minimal maintenance requirements, are greatly affected by foaming conditions, and are greatly affected during cold weather by ice buildup.

Submerged mechanical aerators include a rotating submerged impeller mounted on a drive shaft extending vertically into the biological reactor. Compressed air is supplied beneath the impeller, where it is sheared into bubbles and pumped into the reactor (WEF, 1992). Typically, submerged mechanical aerators are unaffected by foaming and icing conditions, and tend to be more expensive than mechanical surface aerators.

Air requirements typically range from 0.5 to 0.6 L/m^3·s (30 to 40 cfm/1000 cu ft) for the treatment of secondary biological sludges, and from 0.75 to 1.1 L/ m^3·s (45 to 70 cfm/1000 cu ft) for the treatment of primary sludges.

PROCESS CONTROL

Aerobic digesters can be operated as either batch- or continuous-flow reactors.

BATCH OPERATION. Batch operation involves manually decanting digested solids. Originally, aerobic digestion was operated as a draw-and-fill process, a practice still being used at many facilities. Solids are pumped directly from the clarifiers to the aerobic digester. The time required for filling the digester depends on the tank volume available and the volume of waste sludge. When diffused-air aeration is used, the solids undergoing digestion are aerated continually during the filling operation.

When the solids are removed from the digester, aeration is discontinued and the stabilized solids are allowed to settle. The clarified supernatant is then decanted and returned to the treatment process. Another current mode of operation is batch feed and withdrawal without supernating, but with separate thickening with a belt thickener.

For batch-feed digesters the typical operating steps are as follows:

1. Turn off the aeration equipment and allow the solids to settle. To avoid anaerobic conditions, limit the solids–liquid separation to several hours.
2. Decant as much supernatant as possible. For quality control, analyze a sample of the supernatant for pH and SS, and BOD concentrations.
3. Draw off the thickened, digested solids for second-stage digestion or for disposal. For quality control, monitor the drawn-off solids. The solids content will be significantly higher when primary sludges are digested.
4. If plant flexibility permits feed new waste sludge to the digester over a period of time.

It is suggested that the volume and concentration of the waste sludge added each day be somewhat uniform. At some digester installations, digested solids settling and drawoff are performed once per week, while waste sludge is added or fed daily. In this way, digester volume increases daily until the next decanting and drawoff period.

CONTINUOUS OPERATION. Continuous operation closely resembles the activated-sludge process. As in the fill-and-draw process, solids are pumped directly from the clarifiers to the aerobic digester. The digester operates at a fixed level, with the overflow sent to a solids–liquid separator. Thickened and stabilized solids are either recycled to the digestion tank or removed for further processing.

CONTINUOUS-FEED DIGESTERS. For continuous-feed digesters, the process can be improved by

- Adjusting the rate of settled return sludge to obtain the best balance between return sludge concentration and supernatant quality,
- Adjusting the settling chamber's inlet and outlet flow characteristics to reduce short-circuiting and unwanted turbulence that hinders solids concentration, and
- Modifying the weir and piping arrangements.

A lower solids concentration typically is obtained with continuous operation.

SOLID–LIQUID SEPARATION. Careful monitoring of the solid–liquid separation in the continuous- and batch-feed digesters increases the performance of an aerobic digester. The supernatant liquid should have low soluble BOD and total suspended solids (TSS) concentrations for both batch and continuous-flow operations. Table 20.19 lists characteristics of supernatant from the aerobic digestion process.

PROCESS PERFORMANCE

The performance of an aerobic digester system is measured by its efficiency while stabilizing and converting raw and partially oxidized waste sludge to a product that is suitable for subsequent processing or disposal. Performance includes the degree of solids reduction, OUR, and reduction in pathogenic organisms.

TABLE 20.19 Characteristics of supernatant from aerobic digestion systems.

Parameter[a]	Range	Typical value
pH	5.9–7.7	7.0
BOD_5, mg/L	9.0–1 700	500
Filtered BOD_5, mg/L	4.0–183	50
COD, mg/L	288.0–8 140	2 600
Suspended solids, mg/L	46.0–11 500	3 400
Kjeldahl nitrogen, mg/L	10.0–400	170
NO_3–N, mg/L	—	30
Total phosphorus, mg/L	19.0–241	100
Soluble phosphorus, mg/L	2.5–64	25

[a] BOD_5 = five-day biochemical oxygen demand; COD = chemical oxygen demand; and NO_3–N = nitrate-nitrogen.

SOLIDS REDUCTION. If an aerobic digester is operated at optimal temperature and SRT, it provides solids reduction similar to that of an anaerobic digestion system. The fraction of volatile solids contained in the feed sludge varies with the process used and the wastewater being treated. As the temperature is reduced, the SRT is increased. At temperatures lower than 10 °C (50 °F) little reduction of biodegradable solids can be expected. Figure 20.51 shows the general relationship between temperature, SRT, and solids reduction.

PATHOGEN REDUCTION. During aerobic digestion, the degree of pathogen reduction is similar to that achieved by biological reduction in that it increases as the temperature and SRT increase. Reductions of one order of magnitude are achieved at temperatures and SRT values of 35 °C (95 °F) and 15 days, or 25 °C (77 °F) and 30 days. Pathogen reduction is similar to solids reduction in that little pathogen reduction can be expected at temperatures less than 10 °C (50 °F), while significant reduction may be achieved at temperatures greater than 20 °C (68 °F) (WEF, 1995).

REACTOR LOADING. When starting an aerobic digester it is important to not overload the digester. Feed sludge should be added to the digester on a regular schedule and the aeration system equipment should be operated continuously. An aeration

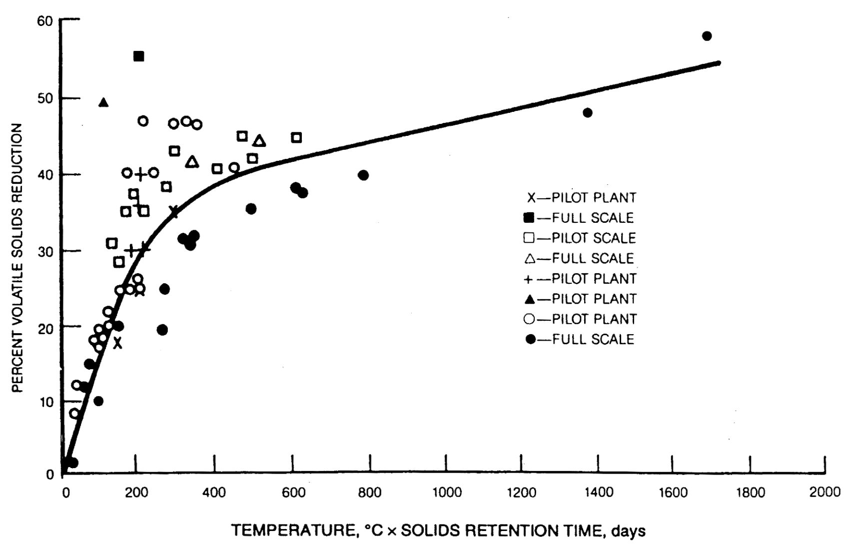

FIGURE 20.51 Volatile solids reduction as a function of digester liquid temperature and digester solids retention time.

system with adequate capacity ensures DO concentrations of 1 mg/L or more. Overaeration or overloading of the digester may cause foaming problems. If the initial volume of sludge does not provide sufficient liquid volume to operate the aeration system effectively, additional sludge or plant influent may be fed to obtain the needed volume. The daily sludge feed can then be added on a regular schedule, preferably during as long a period as possible.

Occasionally, the VSS concentration and OUR should be determined. Sludge can be wasted after the OUR drops below the target rate of 2 mg/g VSS (as regulated in the U. S. Code of Regulations [40 CFR Part 503] rules). The volatile solids percentage reduction depends on the feed type, age, temperature, and retention time.

The startup of an aerobic digester that processes primary sludge takes a substantially longer time and more oxygen than for digestion of WAS. The degree of aerobic digestion depends on the concentration of solids in the digester and on the rate of solids feed. For routine monitoring, the total VSS may be used in place of TSS. As organic loading increases, the required SRT and total oxygen requirements increase and have a direct effect on process efficiency. For a complete-mix, continuous-flow digester, the volumetric loading rate and detention are used to indirectly reflect solids destruction.

Regular loading, rather than periodic slug doses or large inputs, improves most biological process efficiencies. Regular feeding reduces both volume and aeration equipment requirements; however, batch-type operations often are used in aerobic digesters.

Poor supernatant may result with continuous-feed conditions unless decanting occurs in a tank completely separated from the biological reactor turbulence, or aeration is terminated to allow decanting. Turbulence in the decanting chamber impairs supernatant quality and imposes an excessive solids-recycle load at the head of the treatment plant. Batch-type operations avoid the decanting problems by temporarily stopping aeration and permitting supernatant withdrawal under more quiescent conditions.

TROUBLESHOOTING

Typical performance of an aerobic digester includes the following:

1. DO concentration of at least 1 mg/L as long as minimum mixing in the digester is maintained.
2. An SRT of 10 to 15 days for WAS and 15 to 20 days for primary sludge and WAS.

3. A VSS reduction ranging from 40 to 50%. If temperatures are low (<15 °C [<59 °F]), reductions may fall to 35 or 40% unless very long detention times are provided.
4. Digester pH greater than 6.5.

If any of these parameters show unusual values, the following discussions of air diffuser clogging, low DO concentrations, nuisance odors, excessive foaming, solids deposition, low pH, and freezing and Table 20.20 can serve as troubleshooting guides.

CLOGGING OF AIR DIFFUSERS. A buildup of rags or grit on the diffusers causes diffuser clogging when the aeration system is shut off to concentrate the digested solids before supernatant decanting and solids withdrawal. Over time rags and grit in the digester may lodge on and inside the diffuser mechanisms. When aeration is resumed, the particulates clog the diffusers and eventually will reduce air discharge, causing an increase in the blower discharge pressure. Diffusers that are susceptible to this problem should be avoided.

Effective maintenance prevents or cures clogging. While elimination of diffuser clogging is difficult, equipment modification can reduce its frequency and severity.

LOW DISSOLVED OXYGEN CONCENTRATIONS. An inefficient aeration system or excessive organic loading to the digester can cause a low DO concentration. Blower, mechanical aerator, or aeration diffuser deterioration results in a loss of aeration efficiency. Routinely check and monitor the air delivery rate and pipeline pressures for potential problems. Record the position of all air valves. Investigate suspected clogging, leaks, and excess pressure. Occasionally check the power delivered to mechanical aeration shafts to determine their condition. Mechanical aerator efficiency decreases if the liquid level exceeds specified upper and lower operational limits. Consult the manufacturer's engineering data and operations and maintenance (O&M) manuals for recommended liquid level limits.

Increased organic loading can cause problems whenever the rate of oxygen required for the aerobic digestion reaction is greater than the rate at which oxygen can be transferred into the sludge liquid by the aeration system. Typically, this problem can be solved by reducing the organic loading rate and increasing the SRT. This is done by decreasing the influent waste sludge mass, the total volume added, and the amount of solids withdrawn from the digester.

Excessive solids concentrations in the digester can also cause low DO concentra-

TABLE 20.20 Troubleshooting guide for aerobic digestion (U.S. EPA, 1978).

Indicators/ observations	Probable cause	Check or monitor	Solutions
Excessive foaming	Organic overload	Organic load	Reduce feed rate
			Increase solids in digester by decanting and recycling rate
	Excessive aeration	Dissolved oxygen	Reduce aeration rate
Low dissolved oxygen	Clogging	Decant digester, withdraw sludge, and inspect diffusers	Clean diffuser or replace with coarse-bubble diffusers or sock-type devices
	Improper liquid level	Check equipment specifications	Establish proper liquid level
	Blower malfunction	Air delivery rate, pipeline pressure, valving	Repair pipe leaks; set valves in proper position; repair blower
	Organic overload	Check organic load	Reduce feed rate
Sludge has objectionable odor	Inadequate solid retention time	Solids retention time	Reduce feed rate
	Inadequate aeration	Dissolved oxygen should exceed 1 mg/L	Increase aeration or reduce feed rate
Ice formation on mechanical aerators	Extended freezing weather	Check digester surface for ice block formation	Break and remove ice before it causes damage
pH in digester has dropped to undesirable level (less than 6.0–6.5)	Nitrification is occurring and wastewater alkalinity is low	pH of supernatant	Add sodium bicarbonate to feed sludge or lime or sodium hydroxide to digester
	In covered digester, carbon dioxide is accumulating in air and is dissolved into sludge		Vent and scrub carbon dioxide

tions. When SS concentrations reach or exceed 3.5 to 4%, oxygen-transfer efficiencies are reduced. This reduction may cause operational problems because of low DO concentrations, depending on the capacity of the aeration system.

NUISANCE ODORS. Inadequate DO is the primary cause of odors. To correct odor problems, first increase the DO concentration by additional aeration (0.5 mg/L is a minimum DO requirement). Second, reduce the organic loading. If both of these fail, the addition of chemicals such as potassium permanganate or hydrogen peroxide to help oxidize the odor-causing compounds in the digester may be needed. This is considered an expensive and temporary solution to the problem. Bench-scale jar tests can be used to determine the amount of chemicals needed in the digester.

EXCESSIVE FOAMING. Foaming can be caused by factors ranging from simple organic overloading to complex filamentous bacterial growth. To reduce foaming, decrease organic loading, install foam-breaking water sprays, reduce excess aeration rates, and use defoaming chemicals. To avoid dilution of the digester contents operate water sprays sparingly.

Curing filamentous bacterial growth is a difficult task that should be handled at the biological reactors. Addition of oxidants such as chlorine and hydrogen peroxide has been used both with and without beneficial results. Shocking the system with several hours of anaerobic conditions has also been tried. In most cases, limited sprays and defoaming agents control the foam until natural forces can cause a shift to a nonfilamentous type of bacteria.

SOLIDS DEPOSITION. Deposition may occur when gritty materials enter the digester and when the aeration and mixing devices do not create enough turbulence to resuspend the solids following a supernatant decanting sequence. Solids deposition can be prevented by improving operation of the grit chamber, if one exists, or by using more powerful aeration and mixing equipment. Adding fillets to tank bottoms helps reduce solids buildup.

LOW pH. In covered digesters, nitrification or accumulated carbon dioxide may cause low pH. Monitoring records of the alkalinity and nitrates in the digester supernatant or of the carbon dioxide in the air space will indicate whether the addition of lime or sodium hydroxide to the digester or venting of carbon dioxide is appropriate. Soda ash and sodium bicarbonate are also effective with less chance for overdosing.

FREEZING. Extended subfreezing weather may lead to ice formation on the digester's liquid surface and on the mechanical aeration equipment. To prevent malfunction and possible breakdown during cold temperatures, examine open digesters for ice formation. Break the ice and remove it before it damages digester appurtenances by wind action or expansion forces. Use warm air to thaw mechanical aerators affected by ice formation. In extremely cold climates it may be necessary to construct temporary covers to prevent freezing.

DATA COLLECTION AND LABORATORY CONTROL

Consistent data collection and process control through laboratory analyses are essential. Analyses for TSS, VSS and DO concentrations, and OUR of the raw and digested solids provide the minimum data for efficient operation of the aerobic digester. However, additional analyses would be warranted if operational problems arise.

MAINTENANCE MANAGEMENT PROGRAM. A planned maintenance program for the aerobic digester is similar to the maintenance program for the activated-sludge process. Key elements, including identification of maintenance tasks, scheduling, staffing, and a record system, should be plotted on trend charts to show trends in process changes over time.

MAINTENANCE TASKS. The key components that require regular attention include

- Aeration or oxygen supply system,
- Mixing and pumping equipment, and
- Instrumentation and control equipment.

Aeration and Oxygen Supply. The principal requirement for the aeration or oxygen supply system is the inspection and service of the diffuser and blower equipment. Schedule diffuser mechanism inspections at least once per year. Blowers should be maintained in accordance with manufacturer's recommendations.

Mixing and Pumping Equipment. Annually, inspect the mixing and pumping equipment for worn blades and impellers. Replace faulty components and record critical parts for inventory. Service the seals, packing, and points of lubrication as frequently as recommended by the manufacturer.

Instrumentation and Control. Use a trained service representative to maintain the instrumentation and control components. Consider using the training courses available from equipment suppliers. Contract maintenance may also be available.

RECORDS. The importance of maintaining adequate O&M records cannot be overemphasized. The purpose of recording data is to track operational information that will identify and duplicate optimum operating conditions.

Records of the volume and concentration of waste sludge fed to the digester and volume and concentration of digested solids removed from the digester should be kept. Additional information needs to include DO concentration and pH. Keep a monthly report form. In plants where the aeration system capacity is marginally adequate in providing desirable DO concentration in the digester, record DO concentration data on a trend chart. If chemicals are added to the digester for pH or odor control, record the type and amount of chemicals added. If mechanical aerators are used, record power usage. In the case of diffused-air systems, air flow records may be of interest. If airflow meters are not available, records of power consumption may be useful. Experimenting with the aeration system often leads to significant savings in power costs.

REFERENCES

California State University (1991) *Operation of Wastewater Treatment Plants*. Vol. II, Sacramento, Calif.

Hammer, M.J. (1986) *Water and Wastewater Technology.* John Wiley & Sons, New York.

Metcalf & Eddy, Inc. (1991) *Wastewater Engineering: Treatment, Disposal,* Reuse. McGraw-Hill, Inc., New York.

Water Environment Federation (1992) *Design of Municipal Wastewater Treatment Plants*. Manual of Practice No. 8, Alexandria, Va.

Water Environment Federation (1995) *Wastewater Residuals Stabilization*. Manual of Practice No. FD-9, Alexandria, Va.