

CHAPTER 70 SLUDGE HANDLING AND DISPOSAL

71. DESIGN CONSIDERATIONS

71.1 Process Selection

— The selection of sludge handling and disposal methods should include the following considerations (See Chapter 40 also). In addition to Chapter 60, only items with a apply to drinking water sludge treatment:

- a. Energy requirements;
- b. Cost efficiency of sludge thickening and dewatering;
- c. Complexity of equipment;
- d. Staffing requirements;
- e. Sludge digestion or stabilization requirements, including the toxic effects of heavy metals and other substances on sludge stabilization and disposal;
- f. Treatment of side-stream flow such as digester and thickener supernatant;
- g. Sludge storage requirements;
- h. A backup method of sludge handling and disposal, and;
- i. Methods of ultimate sludge disposal.

72. SLUDGE THICKENERS

— As the first step of sludge handling, the need for sludge thickeners to reduce the volume of sludge should be considered. Particular attention should be given to the pumping and piping of the concentrated sludge and possible onset of anaerobic conditions in sewage sludge. Sewage sludge should be thickened to at least 5% solids prior to transmission to digesters.

73. ANAEROBIC SLUDGE DIGESTION

73.1 General

73.1.1 Multiple Units

— Multiple tanks are recommended. Where a single digestion tank is used, an alternate method of sludge processing or emergency storage to maintain continuity of service shall be provided.

73.1.2 Depth

- ___ For those units proposed to serve as supernatant separation tanks, the depth should be sufficient to allow for the formation of a reasonable depth of supernatant liquor. A minimum sidewater depth of 20 feet (6.1 m) is recommended.

73.1.3 Maintenance Provisions

- ___ To facilitate draining, cleaning, and maintenance, the following features are desirable:

73.1.3.1 Slope

- ___ The tank bottom should slope to drain toward the withdrawal pipe. For tanks equipped with a suction mechanism for withdrawal of sludge, a bottom slope not less than 1:12 is recommended. Where the sludge is to be removed by gravity alone, 1:4 slope is recommended.

73.1.3.2 Access Manholes

- ___ At least two 36 inch (91 cm) diameter access manholes should be provided in the top of the tank in addition to the gas dome. There should be stairways to the access manholes.

73.2 Sludge Inlets and Outlets

- ___ Multiple recirculation withdrawal and return points, to enhance flexible operation and effective mixing, should be provided, unless mixing facilities are incorporated within the digester. The returns, in order to assist in scum breakup, should discharge above the liquid level and be located near the center of the tank.
- ___ Raw sludge discharge to the digester should be through the sludge heater and recirculation return piping, or directly to the tank if internal mixing facilities are provided.
- ___ Sludge withdrawal to disposal should be from the bottom of the tank. This pipe should be interconnected with the recirculation piping to increase versatility in mixing the tank contents, if such piping is provided.
- ___ An unvalved vented emergency overflow shall be provided to prevent damage to the digestion tank and cover in case of accidental overfilling. This overflow shall be piped to an appropriate point and at an appropriate rate in the treatment process to minimize the impact on process units.

73.3 Tank Capacity

- ___ The total digestion tank capacity should be determined by rational calculations based upon such factors as volume of sludge added, its percent solids and character, the temperature to be maintained in the digesters, the degree of extent of mixing to be

obtained, and the degree of volatile solids reduction required. Calculations should be submitted to justify the basis of design.

- When such calculations are not based on the above factors, the minimum combined digestion tank capacity outlined below will be required. Such requirements assume that a raw sludge is derived from ordinary domestic wastewater, that a digestion temperature is to be maintained in the range of 90E to 100EF (32EC to 38EC), that 40% to 50% volatile matter will be maintained in the digested sludge, and that the digested sludge will be removed frequently from the system.

73.3.1 Completely-Mixed Systems

- Completely-mixed systems shall provide for intimate and effective mixing to prevent stratification and to assure homogeneity to digester content. The system may be loaded at a rate up to 80 pounds of volatile solids per 1,000 ft³ per day (1.28 kg/m³*d) in the active digestion units. When grit removal facilities are not provided, the reduction of digester volume due to grit accumulation should be considered. (Complete mixing can be accomplished only with substantial energy input.)

73.3.2 Moderately-Mixed Systems

- For digestion systems where mixing is accomplished only by circulating sludge through an external heat exchanger, the system may be loaded at a rate up to 40 pounds of volatile solids per 1,000 ft³ per day (0.64 kg/m³*d) in the active digestion units. This loading may be modified upward or downward depending upon the degree of mixing provided.

73.4 Gas Collection, Piping, and Appurtenances

73.4.1 General

- The entire gas system shall be designed so that under all normal operating conditions, including sludge withdrawal, the gas will be maintained under positive pressure. All enclosed areas where any gas leakage might occur shall be adequately ventilated.

73.4.2 Safety Equipment

- All necessary safety facilities shall be included where gas is produced. Pressure and vacuum relief valves and flame traps, together with automatic safety shutoff valves, shall be provided. Water seal equipment shall not be installed. Gas safety equipment and gas compressors should be housed in a separate room with an exterior entrance.

73.4.3 Gas Piping and Condensate

- Gas piping shall be of adequate diameter and shall slope to condensate traps at low points. The use of float-controlled condensate traps is not permitted.

73.4.4 Gas Utilization Equipment

- ___ Gas-fired boilers for heating digesters shall be located in a separate room not connected to the digester gallery. Such separate rooms would not ordinarily be classified as a hazardous location. Gas lines to these units shall be provided with suitable flame traps.

73.4.5 Electrical Fixtures

- ___ Electrical fixtures and controls, in places enclosing anaerobic digestion appurtenances, where hazardous gases are normally contained in the tanks and piping, shall comply with Section 32.3.5. Digester galleries should be isolated from normal operating areas, in accordance with Section 73.4.7, to avoid an extension of the hazardous location.

73.4.6 Waste Gas

- ___ Waste gas burners shall be readily accessible and should be located at least 50 feet (15.2 m) away from any plant structure if placed at ground level, or may be located on the roof of the control building if sufficiently removed from the tank.
- ___ All waste gas burners shall be equipped with automatic ignition, such as pilot light or a device using a photoelectric cell sensor. Consideration should be given to the use of natural or propane gas to insure reliability of the pilot light.
- ___ In remote locations it may be permissible to discharge the gas to the atmosphere through a return-bend screened vent terminating at least 10 feet (3.0 m) above the ground surface, provided that the assembly incorporate a flame trap.

73.4.7 Ventilation

- ___ Any underground enclosures connecting with digestion tanks or containing sludge or gas piping or equipment shall be provided with forced ventilation in accordance with Section 32.7.2. The piping gallery for digesters should not be connected to other passages. Where used, tightly fitting, self-closing doors should be provided at connecting passageways and tunnels to minimize the spread of gas.

73.4.8 Meter

- ___ A gas meter with bypass should be provided to meter total gas production.

73.5 Digester Heating

73.5.1 Insulation

- ___ Wherever possible digestion tanks should be suitably insulated to minimize heat loss.

73.5.2 External Heating

- ___ Piping shall be designed to provide for the preheating of feed sludge before introduction to the digesters. Provisions shall be made in the layout of the piping and valving to facilitate cleaning of these lines. Heat exchanger sludge piping should be sized for heat transfer requirements.

73.5.3 Heating Capacity

- ___ Heating capacity sufficient to consistently maintain the design sludge temperature shall be provided. Where digester tank gas is used for sludge heating, an auxiliary fuel supply is required.

73.5.4 Hot Water Internal Heating Controls

73.5.4.1 Mixing Valves

- ___ A suitable automatic mixing valve shall be provided to temper the boiler water with return water so that the inlet water to the heat jacket can be held below a temperature at which caking will be accentuated.
- ___ Manual control should also be provided by suitable bypass valves.

73.5.4.2 Boiler Controls

- ___ The boiler should be provided with suitable automatic controls to maintain the boiler temperature at approximately 180EF (82EC), to minimize corrosion and to shut off the main gas supply in the event of pilot burner or electrical failure, low boiler water level, low gas pressure, or excessive boiler water temperature or pressure.

73.5.4.3 Thermometers

- ___ Thermometers shall be provided to show temperatures of the sludge, hot water feed, hot water return, and boiler water.

73.6 Supernatant Withdrawal

73.6.1 Piping Size

- ___ Supernatant piping should not be less than 6 inches (15.2 cm) in diameter.

73.6.2 Withdrawal Arrangements

73.6.2.1 Withdrawal Levels

- ___ Piping should be arranged so that withdrawal can be made from three or more levels in the digester. A positive unvalved vented overflow shall be provided.

73.6.2.2 Supernatant Selector

- If a supernatant selector is provided, provisions shall be made for at least one other drawoff level located in the supernatant zone of the tank in addition to the unvalved emergency supernatant drawoff pipe. High pressure backwash facilities shall be provided.

73.6.3 Sampling

- Provisions should be made for sampling at each supernatant drawoff level. Sampling pipes should be at least 1.5 inches (3.81 cm) in diameter, and should terminate at a suitably-sized sampling sink or basin.

73.6.4 Alternate Supernatant Disposal

- Consideration should be given to supernatant conditioning, where appropriate, in relation to its effect on plant performance and effluent quality.

74. AEROBIC SLUDGE DIGESTION

74.1 Mixing and Air Requirements

- Aerobic sludge digestion tanks shall be designed for effective mixing by satisfactory aeration equipment. Sufficient air shall be provided to keep the solids in suspensions and maintain dissolved oxygen between 1 and 2 mg/l. A minimum mixing and oxygen requirement of 30 cfm/1,000 ft³ of tank volume (0.50 1/s*m³) shall be provided with the largest blower out of service. If diffusers are used, the nonclog type is recommended, and they should be designed to permit continuity of service. If mechanical aerators are utilized, a minimum of 1.0 hp/1,000 ft³ (26.3 W/m³) should be provided. Use of mechanical equipment is discouraged where freezing temperatures are normally expected.

74.2 Tanks

- The determination of tank capacities shall be based on rational calculations, including such factors as quantity of sludge produced, sludge characteristics, time of aeration, and sludge temperature. Multiple tanks are recommended. A single sludge digestion tank may be used in the case of small treatment plants or where adequate provision is made for sludge handling and where a single unit will not adversely affect normal plant operations.

74.2.1 Volatile Solids Loading

It is recommended that the volatile suspended solids loading not exceed 100 lb/1,000 ft³ of volume per day (1.60 kg/m³*d) in the digestion units. Lower loading rates may be necessary depending on temperature, type of sludge, and other factors.

74.2.2 Solids Retention Time

- ___ Required minimum solids retention time for stabilization of biological sludges vary depending on type of sludge. Normally, a minimum of 15 days retention should be provided for waste activated sludge and 20 days for combination of primary and waste activated sludge, or primary sludge alone. Where sludge temperature is lower than 50EF (10EC), additional detention time should be considered.

74.3 Supernatant Separation

- ___ Facilities shall be provided for separation and withdrawal of supernatant and for collection and removal of scum and grease.

75.□ SLUDGE PUMPS AND PIPING

75.1 SLUDGE PUMPS

75.1.1 Duplicate Units

- ___ Duplicate units shall be provided where failure of one unit would seriously hamper plant operation.

75.1.2 Type

- ___ Plunger pumps, screw feed pumps, recessed impeller type centrifugal pumps, progressive cavity pumps, or other types of pumps with demonstrated solids handling capability shall be provided for handling raw sludge. Where centrifugal pumps are used, a parallel plunger-type pump should be provided as an alternate to increase reliability of centrifugal pump. Provision for varying pump capacity is desirable.

75.1.3 Minimum Head

- ___ A minimum positive head of 24 inches (61 cm) shall be provided at the suction side of centrifugal-type pumps and is desirable for all types of sludge pumps. Maximum suction lifts should not exceed 10 feet (3.0 m) for plunger pumps.

75.1.4 Sampling Facilities

- ___ Unless sludge sampling facilities are otherwise provided, quick-closing sampling valves shall be installed at the sludge pumps. The size of valve and piping should be at least 1.5 inches (3.81 cm).
- ___□ Sampling facilities and flow metering should be provided on any discharge outfall line.

75.2 Sludge Piping

75.2.1 Size and Head

- Sludge withdrawal piping should have a minimum diameter of 8 inches (20.3 cm) for gravity withdrawal and 6 inches (15.2 cm) for pump suction and discharge lines. Where withdrawal is by gravity, the available head on the discharge pipe should be adequate to provide at least 2 fps (0.61 m/s) velocity.

75.2.2 Slope

- Gravity piping should be laid on uniform grade and alignment. The slope of gravity discharge piping should not be less than 3%. Provisions should be made for cleaning, draining, and flushing discharge lines.

75.2.3 Supports

- Special consideration should be given to the corrosion resistance and continuing stability of supporting systems located inside the digestion tank.

76. □ SLUDGE DEWATERING

76.1 Sludge Drying Beds

76.1.1 Area

- In general, the sizing of the drying bed may be estimated on the basis of 2.0 ft²/capita (0.19 m²/capita) when the drying bed is the primary method of dewatering, and 1.0 ft²/capita (0.09 m²/capita) if it is to be used as a backup dewatering unit. An increase of bed area by 25% is recommended for paved beds.

76.1.2 Percolation Type

- The lower course of gravel around the underdrains should be properly graded and should be 12 inches (30.5 cm) in depth, extending at least 6 inches (15.2 cm) above the top of the underdrains. It is desirable to place this in two or more layers. The top layer of at least three inches (7.6 cm) should consist of gravel 1/8 inch to 1/4 inch (3.18 to 6.35 mm) in size. Artificial media beds are also allowable.

76.1.2.1 Sand

- The top course should consist of 6 to 9 inches (15.2 to 22.9 cm) of clean coarse sand. The finished sand surface should be level.

76.1.2.2 Underdrains

- Underdrains should be pipe or drain tile at least 4 inches (10.2 cm) in diameter laid with open joints. Underdrains should be spaced not more than 20 feet (6.1 m) apart. The disposal of the underdrain filtrate is covered in Section 76.3.

76.1.3 Partially Paved Type

- The partially paved drying bed should be designed with consideration for space requirement to operate mechanical equipment for removing the dried sludge.

76.1.4 Walls

- Walls should be watertight and extend 15 to 18 inches (38 to 46 cm) above and at least 6 inches (15 cm) below the surface. Outer walls should be curbed to prevent soil from washing onto the beds.

76.1.5 Sludge Removal

- No fewer than two beds should be provided and they should be arranged to facilitate sludge removal. Concrete truck tracks should be provided for all percolation-type sludge beds.

76.1.6 Sludge Influent

- The sludge pipe to the drying beds should terminate at least 12 inches (30.5 cm) above the surface and be so arranged that it will drain. Concrete splash plates for percolation-type beds should be provided at sludge discharge points.

76.2 Mechanical Dewatering Facilities

- The number of mechanical dewatering facilities should be sufficient to dewater the sludge produced with one largest unit out of service. Unless other standby facilities are available, adequate storage facilities shall be provided. The storage capacity should be sufficient to handle at least three-month sludge production.

76.2.1 Auxiliary Facilities for Vacuum Filters

- A back-up vacuum pump and filtrate pump shall be installed for each vacuum filter. It is permissible to have an uninstalled back-up vacuum pump or filtrate pump for every three or fewer vacuum filters, provided that the installed unit can easily be removed and replaced. At least one filter media replacement unit shall be provided.

76.2.2 Ventilation

- Adequate facilities shall be provided for ventilation of dewatering area. For sewage sludges, the exhaust air should be properly conditioned to avoid odor nuisance.

76.2.3 Chemical Handling Enclosures

- ___ Lime-mixing facilities should be completely enclosed to prevent the escape of lime dust. Chemical handling equipment should be automated to eliminate the manual lifting requirement.
- ___ Polymer handling (for drinking water sludges) - see Sections 47.1.2, 47.1.3, and 47.1.8.

76.3 Drainage and Filtrate Disposal

- ___ Drainage from beds of filtrate from sludge dewatering units shall be returned to the sewage treatment or sludge handling process at appropriate points.

76.4 Other Dewatering Facilities

- ___ If it is proposed to dewater or dispose of sludge by other methods, a detailed description of the process and design data shall accompany the plans in accordance with Section 43.2.

77. MUNICIPAL SLUDGE DISPOSAL ON LAND

- ___ Sludge to be applied to land must meet the requirement of 40 CFR 257 and 40 CFR 503, including treatment to provide PSRP (Process to Significantly Reduce Pathogens). Plans that include land application of sludge must be forwarded to the OPC Non-Hazardous Waste Branch or EPD, as appropriate, for review.

78.□ SLUDGE LAGOONS

- ___ a. Section 44.4 shall apply to sludge lagoons.
- ___ b. Sludge lagoons should not be used for high pH sludge.
- ___ c. A sludge storage time of at least 10 years is recommended. Shorter times may be approved, but a plan for ultimate sludge disposal shall be presented in either case.
- ___ d. There shall be no discharge of sludge lagoon supernatant to the environment. All supernatant shall be discharged to the WWTP upstream of the major biological treatment process.
- ___ e. For sewage sludges, provisions must be made to prevent odors. Aeration is recommended.

79. OTHER SLUDGE DISPOSAL METHODS

- ___ When other sludge, disposal methods, such as incineration or landfill are considered, pertinent requirements from the Department shall be followed.