**Section 370.830 Anaerobic Sludge Digestion**

a) General

1) Multiple Units

 Multiple units or alternate methods of sludge processing shall be provided. Facilities for sludge storage and supernatant separation in an additional unit may be required, depending on raw sludge concentration and disposal methods for sludge and supernatant.

2) Depth

 If process design provides for supernatant withdrawal, the proportion of depth to diameter should be such as to allow for the formation of a reasonable depth of supernatant liquor. A minimum side water depth of 20 feet is recommended.

3) Design Maintenance Provisions

 To facilitate emptying, cleaning, and maintenance the following features are desirable:

A) Slope

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

B) Access Manholes

 At least 2 access manholes should be provided in the top of the tank in addition to the gas dome. There should be stairways to reach the access manholes. A separate side wall manhole shall be provided that is large enough to permit the use of mechanical equipment to remove grit and sand. The side wall access manhole should be low enough to facilitate heavy equipment handling and may be buried in the earthen bank insulation.

C) Safety

 Non-sparking tools, rubber-soled shoes, safety harness, gas detectors for inflammable and toxic gases, and at least two self-contained breathing units shall be provided for emergency use.

4) Toxic Materials

 If the anaerobic digestion process is proposed, the basis of design shall be supported by wastewater analyses to determine the presence of undesirable materials, such as high concentrations of sulfates and inhibitory concentrations of heavy metals.

b) Sludge Inlets and Outlets, Recirculation and High Level Overflows

1) Multiple sludge inlets and draw-offs and, where used, multiple recirculation suction and discharge points to facilitate flexible operation and effective mixing of the digester contents shall be provided unless adequate mixing facilities are provided within the digester.

2) One inlet should discharge above the liquid level and be located at approximately the center of the tank to assist in scum breakup. The second inlet should be opposite to the suction line at approximately the 2/3 diameter point across the digester.

3) Raw sludge inlet discharge points should be so located as to minimize short circuiting to the digested sludge or supernatant draw-offs.

4) Sludge withdrawal to disposal should be from the bottom of the tank. The bottom withdrawal pipe should be interconnected with the necessary valving to the recirculation pipe, to increase versatility in mixing the tank contents.

5) An unvalved vented overflow shall be provided to prevent damage to the digestion tank and cover in case of accidental overfilling. This emergency overflow shall be piped to a point and at a rate in the treatment process or sidestream treatment facilities so as to minimize the impact on process units.

c) Tank Capacity

1) Rational Design

 The total digestion tank capacity shall 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 or extent of mixing to be obtained, the degree of volatile solids reduction required, method of sludge disposal, and the size of the installation with appropriate allowances for gas, scum, supernatant and digested sludge storage. Secondary digesters of two-stage series digestion systems that are used for digested sludge storage and concentration shall not be credited in the calculations for volumes required for sludge digestion. Calculations should be submitted to justify the basis of design.

2) Empirical Design

 When such calculations are not submitted to justify the design based on the above factors, the minimum combined digestion tank capacity outlined below will be required. Such requirements assume that the raw sludge is derived from ordinary domestic wastewater, a digestion temperature is to be maintained in the range of 85~ to 95~ F (29~ to 35~ C), 40 to 50 percent volatile matter in the digested sludge, and that the digested sludge will be removed frequently from the process. (See also subsection (a)(1) above and Section 370.860(a)(1).)

A) Completely Mixed Systems

 For digestion systems providing for intimate and effective mixing of the digester contents, the system may be loaded up to 80 pounds of volatile solids per 1000 cubic feet of volume per day in the active digestion units.

B) Moderately Mixed Systems

 For digestion systems where mixing is accomplished only by circulating sludge through an external heat exchanger, the system may be loaded up to 40 pounds of volatile solids per 1000 cubic feet of volume per day in the active digestion units. This loading may be modified upward or downward depending upon the degree of mixing provided.

C) Digester Mixing

 Facilities for mixing the digester contents shall be provided where required for proper digestion by reason of loading rates or other features of the system. Where sludge recirculation pumps are used for mixing, they shall be provided in accordance with the applicable requirements of Section 370.850(a).

d) Gas Collection, Piping, and Appurtenances

1) General

 All portions of the gas system including the space above the tank liquor, storage facilities and piping shall be so designed that under all normal operating conditions, including sludge withdrawal, the gas will be maintained under pressure. All enclosed areas where any gas leakage might occur shall be adequately ventilated.

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 shut off valves shall be provided and protected from freezing. Water seal equipment shall not be installed. Safety equipment and gas compressors should be housed in a separate room with an exterior door.

3) Gas Piping and Condensate

 Gas piping shall have a minimum diameter of 4 inches, except that a smaller diameter pipe may be used at the gas production meter. Gas piping shall slope to condensation traps at low points. The use of float-controlled condensate traps is not permitted. Condensation traps shall be protected from freezing. Tightly fitted self-closing doors should be provided at connecting passageways and tunnels which connect digestion facilities to other facilities to minimize the spread of gas. Piping galleries shall be ventilated in accordance with subsection (d)(7).

4) Gas Utilization Equipment

 Gas burning boilers, engines, etc., shall be located in well ventilated rooms. Such rooms would not ordinarily be classified as a hazardous location if isolated from the digestion gallery or ventilated in accordance with subsection (d)(7). Gas lines to these units shall be provided with suitable flame traps.

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 the National Electric Code for Class 1, Group D, Division 2 locations. Refer to subsection (d)(7).

6) Waste Gas

A) Waste gas burners shall be readily accessible and should be located at least 50 feet 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. Waste gas burners shall be of sufficient height to prevent injury to personnel due to wind or downdraft conditions.

B) All waste gas burners shall be equipped with automatic ignition such as a 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.

C) Gas piping shall be sloped at a minimum of 2 percent up to the waste gas burner with a condensate trap provided in a location not subject to freezing.

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 370.410(g)(1-4) and (6).

8) Meter

 A gas meter with bypass shall be provided to meter total gas production for each active digestion unit. Total gas production for two-stage digestion systems operated in series may be measured by a single gas meter with proper interconnected gas piping. Where multiple primary digestion units are used with a single secondary digestion unit, a gas meter shall be provided for each primary digestion unit. The secondary digestion unit may be interconnected with the gas measurement unit of one of the primary units. Interconnected gas piping shall be properly valved with gastight gate valves to allow measurement of gas production from, or maintenance of, either digestion unit. Gas meters may be of the orifice plate, turbine or vortex type. Positive displacement meters are not recommended. The meter used must be specifically designed for contact with corrosive and dirty gases.

e) Digestion Tank Heating

1) Insulation

 Wherever possible digestion tanks should be constructed above ground-water level and shall be suitably insulated to minimize heat loss. Maximum utilization of earthen bank insulation should be used.

2) Heating Facilities

 Sludge may be heated by circulating the sludge through external heaters or by units located inside the digestion tank. Refer to subsection (e)(2)(B).

A) External Heating

 Piping shall be designed to provide for the preheating of feed sludge before introduction into the digesters. Provisions shall be made in the lay-out of the piping and valving to facilitate heater exchanger tube removal and cleaning of the lines. Heat exchanger sludge piping should be sized for peak heat transfer requirements. Heat exchangers should have a heating capacity of 130 percent of the calculated peak heating requirement to account for sludge tube fouling.

B) Other Heating Methods

i) The use of hot water heating coils affixed to the walls of the digester, or other types of internal heating equipment that require emptying the digester contents for repair, are not acceptable.

ii) Other systems and devices have been developed recently to provide both mixing and heating of anaerobic digester contents. These systems will be reviewed on their own merits. Operating data detailing their reliability, operation and maintenance characteristics will be required.

3) Heating Capacity

A) Sufficient heating capacity shall be provided to consistently maintain the design sludge temperature considering the insulation provided and ambient cold weather conditions. Where digestion tank gas is used for other purposes, an auxiliary fuel may be required.

B) The provision of standby heating capacity or the use of multiple units sized to provide the heating requirements shall be considered unless acceptable alternative means of handling raw sludge are provided.

4) Hot Water Internal Heating Controls

A) 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 removable heat jacket or coil in the digester can be held below a temperature at which caking will be accentuated. Manual control should also be provided by suitable bypass valves.

B) Boiler Controls

 The boiler should be provided with suitable automatic controls to maintain the boiler temperature at approximately 180~ F (82~ C) 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, excessive boiler water temperature or pressure.

C) Boiler Water Pumps

 Boiler water pumps shall be sealed and sized to meet the operating conditions of temperature, operating head and flow rate. Duplicate units shall be provided.

D) Thermometers

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

E) Water Supply

 The chemical quality of the water supply shall be suitable for use as boiler water. Refer to Section 370.550(b) for additional water supply considerations.

5) External Heater Operating Controls

 All controls necessary to insure effective and safe operation are required. Provision for duplicate units in critical elements should be considered.

f) Supernatant Withdrawal

 Where supernatant separation is to be used to concentrate sludge in the digester units and increase digester solids retention time, the design shall provide for ease of operation and positive control of supernatant quality.

1) Piping Size

 Supernatant piping should not be less than 6 inches in diameter.

2) Withdrawal Arrangements

A) Withdrawal Levels

 Piping should be arranged so that withdrawal can be made from 3 or more levels in the tank. An unvalved vented overflow shall be provided. The emergency overflow shall be piped to a point and at a rate in the treatment process or sidestream treatment facilities so as to minimize the impact on process units.

B) Withdrawal Selection

 On fixed cover tanks the supernatant withdrawal level should preferably be selected by means of interchangeable extensions at the discharge end of the piping.

C) Supernatant Selector

 A fixed screen supernatant selector or similar device may only be used in an unmixed secondary digestion unit. If such a supernatant selector is provided, provisions shall be made for at least one other draw-off level located in the supernatant zone of the tank, in addition to the unvalved emergency supernatant draw-off pipe. High pressure back-wash facilities shall be provided.

3) Sampling

 Provision shall be made for sampling at each supernatant draw-off level. Sampling pipes should be at least 1 1/2 inches in diameter and should terminate at a suitably sized sampling sink or basin.

4) Supernatant Disposal

 Supernatant return and disposal facilities shall be designed to prevent adverse hydraulic and organic effects on plant operations. If nutrient removal (e.g., phosphorus, ammonia) must be accomplished at a plant, then a separate supernatant side stream treatment system should be considered.

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