**Section 370.920 Activated Sludge**

a) General

1) Applicability

A) Biodegradable Wastes

The activated sludge process, and its various modifications, may be used to treat wastewater which is amenable to biological treatment. Approval of new activated sludge plants shall be limited to those plants where the design average flow capacity exceeds 0.25 mgd.

B) Operation Control Requirements

 The activated sludge process requires close attention and competent operating supervision. Facilities and appurtenances for routine control and control tests shall be provided at all activated sludge plants. These requirements shall be considered when proposing this type of treatment.

C) Energy Requirements

 This process requires major energy usage to meet aeration demands. Energy costs and potential mandatory emergency public power reduction events, in relation to critical water quality conditions, must be carefully evaluated. Capability of energy usage phasedown while still maintaining process viability, both under normal and emergency energy availability conditions, must be included in the activated sludge design.

2) Specific Process Selection

 The activated sludge process and its several modifications may be employed to accomplish varied degrees of removal of suspended solids and reduction of 5-day BOD and nitrogenous oxygen demand. Choice of the process most applicable will be influenced by the proposed plant size, type of waste to be treated, treatability of waste, degree and consistency of treatment required and local factors. All designs shall provide for flexibility in operation. All plants shall be designed to operate in at least two modes.

3) Winter Protection

 Units shall be protected against freezing. Maximum utilization of earthen bank insulation shall be considered.

4) Process Efficiency

 The activated sludge process designed within the organic and hydraulic loading limits of these standards, treating normal domestic wastewaters unaffected by surge loadings, long term peak flows, or industrial wastes, may be expected to meet an effluent standard of 20 mg/l CBOD5 or BOD5 and 25 mg/l suspended solids when computed on a 30-day monthly average basis. Those installations which are anticipated to be subject to surge loadings, long term peak flows or industrial wastes shall have appropriate design modifications in order to assure consistent effluent quality.

b) Preliminary Treatment

 Effective removal of grit, debris, excessive oil and grease and screening of solids shall be accomplished prior to the activated sludge process. Where primary settling does not precede the activated sludge process, screening with ½ inch or smaller clear opening is recommended in order to prevent plugging of return sludge piping and pumps.

c) Primary Treatment Bypass

 When primary settling is used, provision shall also be made for discharging raw sewage directly to the aeration tanks following preliminary treatment.

d) Process Organic Loadings

 The aeration tank capacities and permissible loadings for the several adaptations of the processes shown in the table shall be used.

 Permissible Organic Loading

For The Activated Sludge Processes

For Normal Domestic Sewage\*

|  |  |  |
| --- | --- | --- |
| Process Mode | Plant Design Average Flow | Aeration Tank Organic Loading, lbs BOD5/day/1000 cu. ft. |
| Conventional, Complete Mix, Contact Stabilization,\*\* Step Aeration, Tapered Aeration | Less than 1 mgd | 35 |
| 1 mgd or greater | 50 |
| Extended Aeration Single Stage Nitrification |  | 15\*\*\* |

\* Where significant industrial wastes will be tributary to the process, design modification shall be made as required by subsection (a)(4), to assure compliance with effluent standards.

\*\* Total aeration capacity includes both contact and reaeration capacities.

\*\*\* Detention time at Design Average Flow for extended aeration shall be 24 hours. This requirement may govern tank capacity. Detention time for single stage activated sludge for nitrification is governed by Section 370.1210(c)(3)(B).

e) Aeration Tanks

1) Multiple Units

 Multiple tanks shall be provided. Tanks shall be designed so that each tank may be dewatered and operated independently.

2) Tank Geometry

The dimensions of each independent mixed liquor aeration tank or return sludge reaeration tank shall be such as to maintain effective mixing and utilization of air. Liquid depths should not be less than 10 feet. The shape of the tank, the location of the inlet and outlet and the installation of aeration equipment shall provide for positive control of short-circuiting through the tank.

3) Freeboard

All aeration tanks shall have a freeboard of not less than 18 inches. Greater heights are desirable. Suitable water spray systems or other approved means of froth and foam control shall be provided if foaming is anticipated.

4) Inlet and Outlet Control

Inlets and outlets for each aeration tank unit shall be suitably equipped with valves, gates, stop plates, weirs, or other devices to permit balancing, proportioning, and measuring the flow to and from any unit and to maintain reasonably constant liquid level. The hydraulic elements of the system shall permit the design peak flow to be carried with any single aeration tank out of service.

5) Conduits

Channels and pipes carrying liquids with solids in suspension shall be designed to maintain self-cleansing velocities or shall be agitated to keep such solids in suspension at all design rates of flow. Adequate provisions should be made to drain segments of channels which are not being used due to alternate flow patterns.

f) Aeration Equipment

1) General

A) Aeration requirements depend upon mixing energy, BOD loading, degree of treatment, oxygen uptake rate, mixed liquor suspended solids concentration and sludge age. Aeration equipment shall be capable of maintaining a dissolved oxygen concentration of 2.0 mg/1 in the aeration tanks under all design loads. Energy transfer shall be sufficient to maintain the mixed liquor solids in suspension.

B) In the case of nitrification, the oxygen requirement for oxidizing ammonia must be added to the above requirement for carbonaceous BOD removal. The nitrogen oxygen demand (NOD) shall be taken as 4.6 times the diurnal peak ammonia (as nitrogen) content of the influent. In addition, the oxygen demands due to recycle flows such as sludge processing, return from excess flow first flush storage and other similar flows, must be taken into account due to the high concentrations of BOD and ammonia associated with such flows.

C) Careful consideration should be given to maximizing oxygen utilization per unit power input. Unless flow equalization is provided, the aeration system should be designed to match the diurnal organic load variation while economizing on power input.

2) Diffused Air Systems

A) Except as noted in subsection (f)(2)(B) below, normal aeration tank air requirements shall be based upon a design figure of 1,500 cu. ft. of air supplied/lb. of BOD5 applied to the aeration tanks. This design figure assumes that the equipment is capable of transferring 1.0 lb. of oxygen to the aeration tank contents/lb. of BOD5 applied to the aeration tank. For the extended aeration process, air requirements shall be based on a design figure of 2250 cu. ft. of air supplied per lb. of BOD5 applied to the aeration tanks to account for oxygen demand for endogenous respiration and ammonia (as nitrogen) for normal strength waste. Refer to Section 370.1210(c) for nitrification requirements.

B) Air requirements may be determined based upon transferring 1.0 lb. oxygen/lb. of applied oxygen demand, as determined by subsection (f)(1) above, using standard equations incorporating the factors listed below. When using this design technique, the field oxygen transfer efficiency of the equipment shall be included in the specifications, and the detailed design computations shall be contained in the basis of design:

i) Tank depth;

ii) Alpha factor of the waste;

iii) Beta factor of the waste;

iv) Documented aeration device transfer efficiency;

v) Minimum aeration tank dissolved oxygen concentrations;

vi) Critical wastewater temperature;

vii) Plant altitude.

C) In the absence of experimentally determined alpha and beta factors for the design described in subsection (f)(2)(B) above, wastewater transfer efficiency shall be assumed to be no more than 50% of clean water efficiency for plants treating primarily (90% or greater) domestic sewage. Treatment plants whose waste contains higher percentages of industrial wastes shall use a correspondingly lower percentage of clean water efficiency and shall submit calculations to justify such a percentage. The design wastewater oxygen transfer efficiency of the equipment shall be included in the specifications.

D) The specified capacity of blowers or air compressors, particularly centrifugal blowers, should take into account that the air intake temperature may reach 115° F or higher and the pressure may be less than normal. The specified capacity of the motor drive should also take into account that the intake air may be -20° F or less and may require oversizing of the motor or a means of reducing the rate of air delivery to prevent overheating or damage to the motor.

E) The blowers shall be provided in multiple units, so arranged and in such capacities as to meet the maximum total air demand with the single largest unit out of service. The design shall also provide for varying the volume of air delivered in proportion to the load demand of the plant.

F) The air diffusion piping shall be capable of delivering 200 percent of the design air requirements. Air piping systems should be designed such that the friction head loss from the blower outlet (or silencer outlet where used) to the diffuser inlet does not exceed 0.5 psi at 100 percent of design air requirements at average operating conditions for temperature and pressure.

G) The spacing of diffusers should be in accordance with the oxygenation requirements through the length of the channel or tank, and should be designed to facilitate adjustments of their spacing without major revision to air header piping. Diffusers in any single assembly shall have substantially uniform pressure loss.

H) Individual assembly units of diffusers shall be equipped with control valves, preferably with indicator markings for throttling and for complete shut off. The arrangement of diffusers shall also permit their removal for inspection, maintenance and replacement without dewatering the tank and without shutting off the air supply in the tank, unless the dewatered aeration basins are no more than 25% of the total aeration basin capacity. Total aeration basin capacity shall include the basins in both stages of a two-stage activated sludge process.

I) Air filters shall be provided in numbers, arrangement, and capacities to furnish at all times an air supply sufficiently free from dust to prevent clogging of the diffuser system used.

3) Mechanical Aeration Systems

A) Oxygen requirements shall be determined in accordance with subsections (f)(2)(B) and (f)(2)(C) above.

B) The mechanism and drive unit shall be designed for the expected conditions in the aeration tank in terms of the power performance. Certified testing shall verify mechanical aerator performance. The design field oxygen transfer efficiency of the equipment shall be included in the specifications, and the detailed design computations shall be contained in the basis of design.

C) The mechanical aerators shall be provided in multiple units, so arranged and in such capacities as to maintain all biological solids in suspension, meet maximum oxygen demand and maintain process performance with the largest unit out of service. Provision shall be made for varying the amount of oxygen transferred in proportion to the load demand on the plant.

D) Due to high heat loss, the mechanism as well as subsequent treatment units shall be protected from freezing.

E) Motors, gear housing, bearings and grease fittings shall be easily accessible and protected from inundation and spray as necessary for proper functioning of the unit.

g) Return Sludge Equipment

1) Return Sludge Rate

 The rate of sludge return, expressed as a percentage of design average flow of sewage, shall be variable between limits of 15 and 100 percent.

2) Return Sludge Pumps

A) If motor driven return sludge pumps are used, the maximum return sludge capacity shall be obtained with the largest pump out of service. The rate of sludge return shall be varied by such means as variable speed motors or drives, multiple constant speed pumps, or telescoping valves. A positive head should be provided on pump suctions. Pumps shall be capable of passing spheres of at least 3 inches in diameter. Pump suction and discharge openings shall be at least 4 inches in diameter.

B) If air lift pumps are used for returning sludge from each settling tank, no standby unit shall be required provided that the design of the air lifts is such as to facilitate their rapid and easy cleaning. Air lifts should be at least 3 inches in diameter and provided with adjustable air valving to permit flow control in accordance with subsection (g)(1) above.

3) Return Sludge Piping

 Suction and discharge piping should be at least 4 inches in diameter and should be designed to maintain a velocity of not less than 2 feet per second when return sludge facilities are operating at normal return sludge rates. Suitable devices for observing, measuring, sampling and controlling return activated sludge flow from each settling tank shall be provided.

4) Waste Sludge Control

 Waste sludge control facilities should have a maximum capacity of not less than 25 percent of the average rate of sewage flow and function satisfactorily at rates of 0.5 percent of average sewage flow. Means for observing, measuring, sampling and controlling waste activated sludge flow shall be provided. Waste sludge may be discharged to the primary settling tank, concentrator or thickening tank, sludge digestion tank, vacuum filters, or any practical combination of these units. Refer to Sections 370.820 and 370.710(b)(1)(A).

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