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Technical specifications for sequencing batch reactor activated sludge process

序批式活性污泥法污水处理工程技术规范

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Technical specifications for sequencing batch reactor activated sludge process

1 Scope

This standard specifies the technical requirements for the process design, main process equipment, testing and control, construction and acceptance, operation and maintenance of the sewage treatment projects which use the sequencing batch reactor activated sludge method.

This standard is applicable to urban sewage and industrial wastewater treatment projects which use the sequencing batch reactor activated sludge process. It can be used as technical basis for environmental impact assessment, design, construction, environmental protection acceptance, facility operation management.

2 Normative references

The contents of this standard refer to the terms in the following documents. For undated references, the valid version applies to this standard.

GB 3096 Environmental quality standard for noise

GB 12348 Emission standard for industrial enterprises noise at boundary

GB 12801 General principles for the requirements of safety and health in production process

GB 18599 Standard for pollution control on the storage and disposal site for general industrial solid wastes

GB 18918 Discharge standard of pollutants for municipal wastewater treatment plant

GB 50014 Code for design of outdoor waste-water engineering

GB 50015 Code for design of building water supply and drainage

GB 50040 Code for design of dynamic machine foundation

GB 50053 Code for design of 10kV and under electric substation

GB 50187 Code for design of general plan of industrial enterprises

GB 50204 Code for acceptance of constructional quality of concrete structures

GB 50222 Code for fire prevention in design of interior decoration of buildings

GB 50231 General code for construction and acceptance of mechanical equipment installation engineering

GB 50254 Code for construction and acceptance of cow-voltage apparatus electric equipment installation engineering

GB 50268 Code for construction and acceptance of water and sewerage pipeline works

GB 50334 Quality acceptance code for municipal sewage treatment plant engineering

GB 50352 Code for design of civil buildings

GBJ 16 Code for fire protection of building design

GBJ 87 Specifications for the design of noise control system in industrial enterprises

GB 50141 Code for construction and acceptance of water and sewerage structures

GBZ 1 Hygienic standards for the design of industrial enterprises

GBZ 2 Occupational exposure limit for hazardous agents in the workplace

CJJ 60 Technical specification for operation, maintenance and safety of municipal wastewater treatment plants

HJ/T 91 Technical specifications requirements for monitoring of surface water and waste water

HJ/T 247 Specifications for environmental protection product. Vertical shaft mechanical surface aerator

HJ/T 251 Specifications for environmental protection product. Roots blower

HJ/T 252 Specifications for environmental protection product. Middle and fine bubble diffusers

HJ/T 260 Specifications for environmental protection product. Blast

submerged aerator

HJ/T 277 Specifications for environmental protection product - Rotary decanter

HJ/T 278 Specifications for environmental protection product - Single stage and high speed aeration centrifugal blower

HJ/T 279 Specifications for environmental protection product - Pusher submersible agitator

HJ/T 353 Technical guidelines of wastewater on-line monitoring equipment and installation (on trial)

HJ/T 354 Technical specifications for check and acceptance of wastewater on-line monitoring system (on trial)

HJ/T 355 Technical specifications for the operation and assessment of Wastewater on-line monitoring system (on trial)

Administrative measures for environmental protection acceptance of completion of construction projects (State Environmental Protection Administration, 2001)

3 Terms and definitions

The following terms and definitions apply to this standard.

3.1

Sequencing batch reactor activated sludge process

Refers to the activated sludge wastewater treatment method consisting of five basic processes of fill, aeration, settle, drawn, idle in the same reaction tank (reactor), abbreviated as SBR method. The main deformation processes include a cyclic activated sludge system/technology (CASS or CAST process), a demand aeration tank-intermittent aeration tank (DAT-IAT process), an alternating internal circulation activated sludge process (AICS process), etc.

3.2

Operating cycle

Refers to a cycle in which a reaction tank completes the fill, aeration, settle, drawn, idle work procedures in sequence. The time elapsed during an operating cycle is called the cycle time.

3.9

Reaction time

Refers to the time it takes for the aeration to stop during the fill and aeration processes in one operating cycle.

3.10

Biological selector

Refers to the pre-reaction zone that is provided at the front end of the reaction tank, to bring the return sludge into contact with and mix the undiluted sewage. The types of biological selectors are aerobic, anoxic and anaerobic.

3.11

Main reaction zone

Refers to the aerobic reaction zone downstream of the biological selector in the CASS or CAST reaction tank.

3.12

Pretreatment

Refers to the treatment measures set in front of the SBR reaction tank when the influent water's quality can meet the biochemical requirements of the SBR process, such as grilles, grit chambers, primary sinks, air floatation tanks, grease traps, fiber and hair traps, etc.

3.13

Preprocessing

Refers to the treatment process set in front of the SBR reaction tank according to the need to adjust the water quality when the influent water's quality cannot meet the biochemical requirements of the SBR process, such as hydrolysis acidification tank, coagulation sedimentation tank, neutralization tank, etc.

3.14

Standard state

It refers to a state where the atmospheric pressure is 101325 Pa and the temperature is 293.15 K.

Q_s - Design flowrate of rainwater, L/s.

5.1.1.3 The design flowrate of integrated domestic sewage is the product of the served population and the corresponding quota of integrated domestic sewage quota. The quota of integrated domestic sewage shall be determined according to the local water quota, combined with the level of the water supply & drainage facilities inside building and the popularity of the drainage system; it can be designed according to 80% ~ 90% of the local relevant water quota.

5.1.1.4 The total coefficient of change of integrated domestic sewage volume shall be determined according to the actual data of change of integrated domestic sewage volume. If there is no measurement data, it may be valued according to the relevant provisions of GB 50014, as shown in Table 1.

Table 1 -- Total coefficient of change of integrated domestic sewage

Average daily flowrate / (L/s)	5	15	40	70	100	200	500	≥1 000
Total coefficient of change	2.3	2.0	1.8	1.7	1.6	1.5	1.4	1.3

5.1.1.5 The design flowrate of industrial wastewater as discharged into the municipal pipeline network shall be determined according to the statistical survey data of wastewater discharge from industrial pollution source within the coverage of urban municipal drainage system.

5.1.1.6 The design flowrate of rainwater refers to the relevant provisions of GB 50014.

5.1.1.7 In areas with high groundwater level, it shall consider the amount of infiltration groundwater. The amount of infiltration groundwater should be determined based on actual measurement data.

5.1.2 Design flowrate of industrial wastewater

5.1.2.1 The design flowrate of industrial wastewater shall be designed according to the actual wastewater flowrate as measured by the total discharge port of the plant or industrial park. The test method shall comply with the provisions of HJ/T 91.

5.1.2.2 The change of flowrate of industrial wastewater shall be measured according to the characteristics of the process.

5.1.2.3 When it cannot obtain the actual measurement data, it may be determined by referring to the relevant provisions of the current national industrial water consumption, or otherwise determined according to the comparison of the current drainage data of the factory of same industry, the same scale, the same process.

5.1.2.4 When industrial wastewater and domestic sewage are combined for

requirements of the next-stage treatment unit.

6.1.2 It shall be ensured that the SBR reaction tank combines the characteristics of ideal impulsive flow in time and complete mixing in space.

6.1.3 It shall be ensured that the SBR reaction tank has a static sedimentation function and a good sludge-water separation effect.

6.1.4 It shall, according to the operating requirements of the SBR process, set the testing and control system, to realize the automation of operation management.

6.1.5 The SBR reaction tank shall be provided with a fixed accident drainage device, which may be located at the water level at the end of the decanting.

6.1.6 The drainage of SBR reaction tank shall be equipped with a decanter that prevents scum from flowing out of the facility.

6.1.7 For the reaction tank that restricts the aeration and fill, the fill method should use the submerged inflow.

6.1.8 For sewage treatment plants which have large changes in water quality and/or water volume, it should set the facilities for regulating water quality and/or water volume.

6.1.9 The sewage treatment plant shall be provided with facilities for disinfecting the treated effluent.

6.1.10 The design of the influent pump room, grille, grit chamber, primary settlement tank, secondary settlement tank shall comply with the relevant provisions of GB 50014.

6.2 Pretreatment and preprocessing

6.2.1 The SBR sewage treatment project shall be provided with a grille for the influent. The pretreatment of the urban sewage shall also be provided with a grit chamber.

6.2.2 According to the requirements of water quality and SBR process type, determine whether the initial settlement tank is set in the SBR sewage treatment project. When setting the initial settlement tank, it may not provide ultra-fine grille.

6.2.3 When the influent water quality does not meet the conditions as specified in 5.2.3 or when it contains substances that affect biochemical treatment, it shall, according to the influent water quality, take appropriate pre-processing method.

6.3 Design of SBR process

6.3.5.1 When biological phosphorus removal of sewage cannot meet the requirements, it may use chemical phosphorus removal. The type of agent, dosage, dosing point shall be determined by testing or by reference to similar projects.

6.3.5.2 In case of chemical phosphorus removal, for the equipment and pipelines exposed to corrosive substances, it shall take anti-corrosion measures.

6.3.5.3 When the alkalinity for nitrification is insufficient, it shall provide the alkali addition system. The pH value at the nitrification stage shall be controlled at 8.0 ~ 8.4.

6.3.6 Sludge system

6.3.6.1 The design of sludge volume shall consider residual sludge and chemical dephosphorization sludge.

6.3.6.2 Calculation of residual sludge volume

Make calculation according to sludge yield coefficient, attenuation coefficient, non-biodegradable and inert suspended solid.

$$\Delta X = YQ(S_0 - S_e) - K_d V X_V + fQ(SS_0 - SS_e) \quad (12)$$

Where:

ΔX - The residual sludge amount, kg/d;

Y - The sludge yield coefficient, which is selected according to Table 3, Table 4, Table 5, Table 6, Table 7;

Q - Designed average daily sewage volume, m^3/d;

S_0 - 5-day biochemical oxygen demand of influent in the reaction tank, kg/m^3;

S_e - 5-day biochemical oxygen demand of effluent in the reaction tank, kg/m^3;

K_d - Attenuation coefficient, d^{-1};

V - The total volume of reaction tank, m^3;

X_V - The average mass concentration of mixed liquid volatile suspended solids (MLVSS) in the reaction tank, kg/m^3;

f - Sludge conversion rate of influent suspended solids (MLSS/SS), kg/kg, which should be determined according to the test data; or otherwise it may be taken as 0.5 ~ 0.7 in absence of test data;

d) The mixed liquid in the aerobic zone of the reaction tank returns back to the anoxic zone; the reflux ratio shall be determined according to the test, which shall not be less than 20%.

6.4.3 When CASS or CAST requires phosphorus removal and denitrification, the design of the reaction tank shall meet the following requirements:

a) The reaction tank is generally divided into three reaction zones, one is the anaerobic biological selector, the second zone is the anoxic zone, the third zone is the aerobic zone (as shown in Figure 4). The reaction tank may also be divided into two reaction zones. The zone 1 is anoxic (or anaerobic) biological selector; the zone 2 is an aerobic zone;

b) When the dissolved oxygen in the anoxic zone of the reaction tank is less than 0.5 mg/L, carry out the denitrification reaction is carried out, where the effective volume should account for 20% of the total effective volume of the reaction tank;

c) The dissolved oxygen in the anaerobic biological selector of the reaction tank is 0, the phosphorus-producing bacteria releases phosphorus, where the effective volume should account for 5% ~ 10% of the total effective volume of the reaction tank;

d) The mixed liquid in the aerobic zone of the reaction tank is refluxed to the anaerobic biological selector; the reflux ratio shall be determined according to the test, which should not be less than 20%.

6.4.4 The calculation and design of aeration system of the CASS or CAST process refer to 6.3.4 of this standard.

6.4.5 When the mixed liquid reflux system in the reaction tank is designed, it shall provide a reflux pump at the end of the reaction tank, to return the mixed liquid from the main reaction zone to the biological selector.

6.4.6 The number of reaction tanks in a system should not be less than 2.

7 Main process equipment

7.1 Drainage equipment

7.1.1 The drainage equipment of the reaction tank of SBR process should use a decanter, which includes a rotary decanter, a siphon decanter, a non-powered floating siphon decanter. The performance of the decanter shall comply with the provisions of the corresponding product standards. If a rotary decanter is used, it shall comply with the provisions of HJ/T 277.

7.1.2 The rake load of the decanter shall be 20 ~ 35 L/(m • s). The maximum

7.3.2 For anaerobic and anoxic, it should select a submersible pusher agitator. The performance of the agitator shall meet the requirements of HJ/T 279.

8 Testing and control

8.1 General provisions

8.1.1 The SBR sewage treatment project shall carry out process testing and control; and be configured with corresponding testing instruments and control systems.

8.1.2 The content of testing and control shall be determined according to the project scale, process flow, operation management requirements.

8.1.3 The automatic instrumentation and control system shall ensure the safety and reliability of the SBR sewage treatment project and facilitate operation management.

8.1.4 The computer control management system shall take into account the requirements of existing, newly-built and planned projects.

8.1.5 Electromechanical equipment involved in control and management shall be provided with testing devices for work and accident states.

8.2 Process testing

8.2.1 The fill pump room, grille, grit chamber shall be provided with the pH meter, level gauge, level-difference gauge, flow meter, thermometer, etc.

8.2.2 The SBR reaction tank should be provided with a thermometer, pH meter, dissolved oxygen (DO) meter, redox potentiometer, sludge concentration meter, level gauge, etc.

8.2.3 In order to ensure the safe operation of the sewage treatment plant (station), follow the requirements below to provide the monitoring instruments and alarm devices:

a) Fill pump room: It should be provided with the concentration monitoring instrument and alarm device of hydrogen sulfide (H_2S);

b) Sludge digestion tank: It should be provided with the concentration monitoring instrument and alarm device of methane (CH_4), hydrogen sulfide (H_2S);

c) Chlorination room: It should be provided with the concentration monitoring instrument and alarm device of chlorine (Cl_2).

9 Electrical

9.1 Power supply system

9.1.1 The electrical load of the process device shall be the secondary load.

9.1.2 The voltage level of high-and-low voltage electrical equipment shall be consistent with the voltage level of its power supply grid.

9.1.3 The instrumentation power supply of the central control room shall be equipped with an online uninterruptible power supply.

9.1.4 The grounding system should adopt a three-phase five-wire system.

9.2 Low-voltage power distribution

The layout of the power transformation & distribution equipment of the low-voltage power distribution room of the substation shall comply with the provisions of the national standard GB 50053.

9.3 Secondary line

9.3.1 The electrical equipment on the process line should be centrally monitored and managed in the central control room; and incorporated into the automatic control.

9.3.2 The control level of the electrical system shall be consistent with the process level. It should be incorporated into the computer control system, or it may be controlled by strong electricity.

10 Construction and acceptance

10.1 General requirements

10.1.1 The construction unit shall have the corresponding national engineering construction qualification. For the construction project, it should use the bidding to determine the construction unit and the supervision unit.

10.1.2 It shall follow engineering design drawings, technical documents, equipment specifications, etc., to organize the engineering construction. The engineering changes shall be implemented after obtaining the design change documents from the design unit.

10.1.3 Equipment materials, semi-finished products, components used in construction shall comply with the current national standards and design requirements. They shall obtain the certificate of conformity from the supplier.

provisions of GB 50352.

10.2.1.10 Construction of other buildings shall be carried out in accordance with the technical specifications for construction engineering measurement and construction.

10.2.2 Equipment installation

10.2.2.1 Before equipment installation, it shall check the following documents:

a) Equipment installation instructions, electric diagrams, wiring diagrams;

b) Equipment's instruction manual, operation and maintenance manual;

c) Protection and paint standards;

d) Product's exit-factory certificate, performance test report, material certificate;

e) Equipment unpacking acceptance record.

10.2.2.2 The equipment foundation shall comply with the following provisions:

a) The equipment foundation shall be poured according to the design requirements and drawings. The concrete's designation, the elevation of the base surface shall comply with the requirements of specifications and technical documents;

b) The concrete foundation shall be flat and solid and have vibration-isolation measures;

c) The level and flatness of the embedded parts shall comply with the provisions of GB 50231;

d) The anchor bolts shall be pre-buried in accordance with the requirements of the original exit-factory manual; the position shall be accurate; the installation shall be stable.

10.2.2.3 The installed machinery shall strictly conform to the nominal allowable deviation of the external dimensions; it is not be allowed to exceed the tolerance.

10.2.2.4 It shall follow the requirements of the product's technical documents to carry out equipment installation and test run; do well in test-run records of equipment, intermediate handover inspection records, construction records, supervisory inspection records.

10.2.2.5 After the installation of electromechanical equipment, it shall meet the following requirements:

10.3.2 The project acceptance includes intermediate acceptance and completion acceptance. The intermediate acceptance shall be jointly carried out by the construction unit in conjunction with the building unit, the design unit, the quality supervision department. The building unit shall organize the construction, design, management, quality supervision, relevant units to carry out completion acceptance jointly.

10.3.3 After each construction procedure of the structure is completed, it shall carry out the intermediate acceptance. After the concealed work passes the intermediate acceptance, it can enter the next procedure.

10.3.4 Intermediate acceptance includes channel inspection, rebar inspection, main body acceptance, installation acceptance, linkage test. In the intermediate acceptance, it shall carry out inspection according to the specified quality standards and fill the intermediate acceptance records.

10.3.5 After the installation of the decanter is completed, it shall follow the requirements below to carry out the idle operation and fill test run:

a) Use a level meter to test the levelness of the decanter. Respectively, carry out idle run and fill test. The rake of the decanter shall be kept level;

b) Use the method of checking the construction record and the ruler inspection, to test the vertical deviation of the drainage branch and trunk of the decanter;

c) Use the method of checking the construction records and ruler inspection, to check the exhaust pipe, to ensure the opening of the upper end of the exhaust pipe of the decanter is 200 mm above the water surface. There shall be no blockage in the pipe;

d) Operate the decanter in the idling and water filling state. Respectively, check the firmness of the bolt of the drainage riser of the decanter. Maintain the stability of the drainage device of the decanter.

10.3.6 For the completion acceptance, it shall provide the following information:

a) As-built drawings and design change documents;

b) Certificate of conformity or test records of major materials and equipment;

c) Construction measurement records;

d) Test and inspection records of concrete, mortar, welding, water-tightness, air-tightness;

e) Construction records;

a) The test-run shall cover all structures in accordance with the whole process of design flowrate, to assess whether there is a problem with the elevation layout of each structure;

b) Test and calculate the process parameters of each structure;

c) Determine the amount of settled sand, moisture, ash content in the grit chamber;

d) Determine the SS value of the influent and effluent of the grit chamber;

e) Where there is the initial settlement tank, determine the sludge volume, moisture content, ash content of the settlement tank;

f) Determine the MLSS value of the activated sludge in the SBR reaction tank;

g) Determine the MLVSS/MLSS ratio of the activated sludge in the SBR reaction tank;

h) Determine the amount of residual sludge, moisture content, ash content;

i) The testing items of the quality of the influent and effluent of the SBR include: pH, SS, chroma, COD, BOD_5, ammonia nitrogen, total nitrogen, total phosphorus, total bacteria, coliform, petroleum, volatile phenol, mercury, cadmium, lead, arsenic, total chromium (or hexavalent chromium), cyanide;

j) Determination of toxic and harmful gases in sewage treatment plants (stations);

k) Count the influent and effluent volume, the power consumption, the power consumption of each item work of the whole plant;

l) Calculate the technical and economic indicators of the whole plant: the total amount of BOD_5 removal, the power consumption for BOD_5 removal (kW • h/kg), the operating cost of sewage treatment (Yuan/kg).

11 Operation and maintenance

11.1 General requirements

11.1.1 The operation, maintenance and safe production of the sewage treatment plant (station) shall be carried out in accordance with CJJ 60.

11.1.2 The operation management of the sewage treatment plant (station) shall ensure the continuous normal operation of the facility. The pollutant discharge can meet the national and local emission standards and the total amount control

requirements.

11.1.3 Before the operation of the sewage treatment plant (station), it shall formulate the process system diagram, facility operation and maintenance procedures, establish management systems such as equipment account, operation record, regular inspection, handover, safety inspection.

11.1.4 The process facilities and main equipment of the sewage treatment plant (station) shall be included into the account, to carry out maintenance, overhaul and inspection of all kinds of equipment, electrical, automation instruments and building (structures) regularly, to ensure stable and reliable operation of the facilities.

11.1.5 The operation and management personnel of the sewage treatment plant (station) shall be familiar with the processing technology and technical indicators of the factory as well as the operational requirements of the facilities and equipment. They can only go to post after technical training and production practice, passing the examination.

11.1.6 The operator shall perform system operation according to the operation procedures of post, regularly check the operation of the structures, equipment, electrical appliances, instruments.

11.1.7 Operators shall strictly perform their duties and responsibilities of the posts, conduct patrols and handovers. The operators of each post shall make relevant records in the production activities such as operation, inspection, handover, maintenance.

11.1.8 It shall regularly check the operational control indicators and the quality of the influent and effluent.

11.1.9 During the operation of sewage treatment plants (stations), it shall strictly implement frequent and regular safety inspection systems, to eliminate potential incidents and prevent accidents.

11.2 Operation

11.2.1 Adjustment of drainage ratio (or fill ratio)

When the set operating period is constant, when the actual influent flowrate changes, it may use the method of regulating the drainage ratio (or fill ratio) to ensure uniform water distribution in each reaction tank.

11.2.2 Regulation of operating cycle

When the amount of treated water changes greatly, it is necessary to regulate the operating cycle according to the daily treated water volume during the peak period, the daily treated water volume during the valley period, the daily average

11.3.1 The maintenance of the SBR reaction tank shall be the focus of the maintenance of whole plant.

11.3.2 The operator shall strictly implement the equipment operation procedures, make patrol inspection regularly on whether the equipment is operating normally, including temperature-rise, noise, vibration, voltage, current, etc. Any problems found shall be eliminated as soon as possible.

11.3.3 The rotating parts of each equipment shall maintain a good lubrication state. It shall add lubricant in time and remove dirt. If oil leakage or seepage is found, they shall be eliminated in time.

11.3.4 It shall regularly check the uniformity, flexibility of drainage, as well as the reliability of the automatic control of the decanter. Any problems found shall be eliminated in time.

11.3.5 At the beginning of the aeration of the blast aeration system, it shall empty the water accumulated in the drainage pipeline. It shall also frequently check the reliability of the automatic drainage valve.

11.3.6 The microporous aerator in the SBR reaction tank is easy to block. It shall check the blockage and damage of the aerator at regular intervals. Any damaged aerator shall be replaced in time, to keep the aeration system running well.

11.3.7 The water-free working time of the pusher submersible agitator shall not exceed 3 minutes.

11.3.8 During operation, it shall prevent vibrations due to damage or blockage of the impeller of the pusher submersible agitator, turbulence caused by surface air inhalation, uneven water flow, etc.

11.3.9 Regularly check and replace unqualified parts and consumables.

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