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Design for Wuhan Green sewage treatment plant using SBR activated sludge process

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<p>The objective of the thesis project was to design a sewage treatment plant using Sequencing Batch Reactor(SBR) activated sludge process based on the requirements of Wuhan green sewage treatment plant. The main contents of the thesis are process comparison and selection,structure selection and plant layout arrangement.</p> <p>SBR process includes five phases,charging,aeration,sedimentation,discharge and standby process.SBR reactors treat the sewage from mechanical biological treatment facilities in batches.Then,oxygen pumped into the mixture of sewage and activated sludge to reduce the organic matter.After sedimentation, separate the mixture of mud and water.Remove the supernatant produced after the aeration precipitation and leave part of the activated sludge from the reactor as seed sludge.The purified water will be discharge to the river or sea if the quality meets the standard published by government</p>	
Keywords	SBR method, sewage treatment plant

Contents

1	Design task and data	1
1.2	The objectives and significance of design	1
1.2.1	Design objectives	1
1.2.2	Abbreviations and acronyms	1
1.2.3	Design significance	1
1.3	Design requirements	1
1.3.1	Principles to be followed in the operation of sewage treatment	2
1.4	Designing information	2
1.4.1	Defination and theory of BOD,N and P removal	2
1.4.2	Condition of water quality	4
1.4.3	Environmental condition	5
2	Design scheme	5
2.1	Process comparison and selection	5
2.1.1	Determination and the principles of the process flow	6
2.1.2	Sewage treatment process selection	6
2.1.3	Description and camparion of wastewater treatment process	8
2.2	Site selection	14
3	Selection of main structures	15
3.1	Bar screen	15
3.2	Grit chamber	16
3.2.1	Grit chamber selection	16
3.3	SBR pool	18

3.4	Concentrator	18
3.5	Mud storage tank	18
3.6	Dehydration	19
3.7	Sludge disinfection	19
4	Sewage treatment plant layout	19
4.1	Plane layout of wastewater plant	20
4.1.1	Plane arrangement principles	20
4.1.2	Plane arrangement	23
4.2	Elevation arrangement	25
4.2.1	Principles of elevation arrangement	26
5	Conclusion	27
	Reference	27
(1)	Internet journals	27
(2)	Internet documents	28
(3)	Books and documents	29
	Appendix	34

1.Design task and data

1.1 Design tasks

The population of the area where the water is treated is around 100,000. Average sewage discharge for each person is 0.1m³ per day.A design was created for a sewage treatment plant which would treat 10,000m³ of sewage water per day.It is a small size sewage treatment plant.As we all know,the water in China is in really bad condition and polluted.According to the data posted by Ministry of Water Resources of China,over 80% groundwater was polluted by the industry and agriculture.Therefore,a efficiency sewage water treatment process should be carried out to deal with the serious water issue.

1.2 Objectives

1.2.1 Design objectives

This thesis had two objectives.The first objective was to determine what sewage treatment methods would be used in the plant.The second objective was to design the treatment process for the plant.

1.2.2 Abbreviations and acronyms

A/O process	Anaerobic/Oxic
A2/O process	Anaerobic/Anoxic/Oxic
SBR method	Sequencing Batch Reactor Activated Sludge Process
AB method	Adsorption biodegradation
CLR	Continuous loop reactor
BOD	Biochemical oxygen demand
COD	Chemical oxygen demand
N	Nitrogen
P	Phosphorus
SS	Suspended solids

TSS Total suspended solids

1.2.3 Design significance

In nearly 200 years, the urban sewage treatment technology has been developed from the original natural treatment and simple primary treatment to advanced technologies and recycling. The treatment process has also developed from traditional activated sludge process to Anaerobic/Oxic process(A/O)、Anaerobic/Anoxic/Oxic(A2/O)、Adsorption biodegradation (AB) 、 and Sequencing Batch Reactor Activated Sludge Process (SBR) . With the development of China, different sewage treatment solutions are implemented in different situations. According to the <groundwater dynamic monthly report>published by the Ministry of water resources(MWR) of China,2013,there are over 80% groundwater is polluted by the discharge of agriculture and industry which made the water can not used in daily life or as drinking water. Most of the test water wells are distributing near the densely inhabited district. Therefore,a high efficiency technology need to be carried out to meet this problem.

1.3 Design requirements

The design requirements are given based on the combination of *Outdoor Drainage Design standard (GBJ14-87)*,*Shanghai Municipal Construction Committee,1987* and *Outdoor Sewage Plant Design Standard(GB50014-2006)*,*Shanghai Municipal Construction Committee,2006*.

The following paragraphs describe these requirements one by one.

(1) The sewage treatment plant design is the same as other engineering design .First of all, the effluent after treatment must meet the discharge requirements published by government. Choose the design process based on the economic and technical as well as the local specific condition.

(2) The design parameters used in the sewage treatment plant must be reliable. When designing, various natural conditions must be researched carefully, for example, the parameters of water quality and quantity and the data of similar engineering.

(3) Sewage treatment plant design must meet the economic requirements. After finishing the design of sewage treatment plant, the cost of general layout and facilities and the selection of chemical agents have to be reduced reasonably and the cost of operation and management have to be reasonable.

(4) The design of sewage treatment plant should be reasonable in terms of technology. Different types of water should undergo a corresponding treatment process. According to the principle of economic reasonability, it is necessary to make use of advanced technology, machinery and automatic control technology as much as possible, but safety and reliability have to be ensured.

(5) Sewage plant design must consider the conditions for safe operation, such as the appropriate set of diversion facilities beyond the pipeline and the safe storage of methane.

(6) With the available economic conditions, the plant layout, the appearance of the building, the environment should be beautiful and green.

1.3.1 Principles to be followed in the operation of sewage treatment works

To ensure the effectiveness of the sewage treatment and to at the same time, treat the municipal, industrial and agricultural wastewater properly. The utilization of water resources should be arranged in a land-saving and labor saving way. The further development of water treatment plant should be considered, advanced effective technology should be exploited and at the same time, make the design and layout economically reasonable.

1.4 Designing information

1.4.1 Definition and theory of BOD and N and P removal

Biochemical oxygen demand(BOD)

BOD is usually used to indicate the the amount of dissolved oxygen needed by aerobic biological organisms to treat organic material present in a sewage water sample at a certain temperature over a specific time period. The BOD value is often used to express the degree of organic pollution of water, If the BOD value is high, it means that there are more pollutants in sewage. A low BOD indicates a low volume of organic materials, substances which are difficult to break down. In other words, the BOD value is higher, the amount of pollution in sewage is higher.

N removal

Nitrogen pollution is one of the most concerning environmental problems nowadays. Nitrogen is essential for the growth of all living organisms, but excessive amounts of nutrients released to the environment by human activities can break the ecological balance and pollute the water supply and influence human health.

Nitrogen exists in many forms; ammonia, nitrate(NO_3^-) and nitrite(NO_2^-) are the primary problems in the environment. Ammonia from decomposing organic materials in the soil is oxidized and then nitrate and nitrite are formed. Fertilizer, atmospheric deposition, storm water, animal deaths and fossil fuels are also the main reasons for nitrogen entering into the environment.

In surface waters, an excessive amount of nitrogen will cause the excessive growth of algae, usually called algal blooms. This phenomenon is also called eutrophication, which can kill or harm wildlife and aquatic habitats. The algae consume the dissolved oxygen in the water. The lack of oxygen in water causes hypoxia, which will kill the fish and other aquatic organisms. Algal blooms stay on the surface of the water and block the sunlight which is essential for aquatic plants to grow. Some algal blooms produce toxins and encourage bacterial

growths that can harm the health of people who are in contact with the polluted water, for example, swim in or drink the water or who eat tainted fish or shellfish. In drinking water, nitrogen can cause health risks for people, especially for infants and pregnant women. In agricultural areas, the nitrates are a serious concern because the groundwater well is the primary source of drinking water.

P removal

Phosphorus is another main nutrient that causes the increased eutrophication of water. Phosphorus is essential for the growth of organism, but an excessive amount of it will cause pollution.

Therefore, it is significant to remove the excessive amount of phosphorus released from municipal and industrial wastewater treatment plants to prevent eutrophication. Hence, it is significant to remove Nitrogen and Phosphorus in the whole water treatment process.

1.4.2 Condition of water quality

The influent quality of Wuhan Green sewage treatment plant is described below, the values are tested in a normal sunny day and provided by the tester from Wuhan Green water treatment plant laboratory:

BOD	180mg/l
COD	390mg/l
SS	180mg/l
NH ₃ -N	40mg/l
P	6mg/l

After the treatment the effluent will be discharged to Southern Lake; According to *Pollutant Discharge Standard for Urban Wastewater Treatment Plant (GB18918-2012)*, He Xinghai, 2012, the sewage treatment plant should implement the secondary level standard

The standard quality of effluent is based on the table 1, *standard GB 18918 – 2002*.

Discharge standard of pollutants for municipal wastewater treatment plant is as follows:

BOD	≤30mg/l
COD	≤100mg/l
SS	≤30mg/l
NH ₃ —N	≤25mg/l
P	≤3 mg/l

Number	Basic items need to be controlled	First level Standard A	First level Standard B	Secondary level standard	Third level standard
1	COD	50	60	100	120
2	BOD ₅	10	20	30	60
3	SS	10	20	30	50
4	Animal and plant oil	1	3	5	20
5	petroleum	1	3	5	15
6	Anionic surfactant	0.5	1	2	5
7	Total N	15	20	-	-
8	Ammonia nitrogen	5(8)	8(15)	25(30)	-
9	Total P(plant build before 31,12,2015)	1	1.5	3	5
	Total P(Plant build after 1,1,2016)	0.5	1	2	5
10	Dilution ratio	30	30	40	50
11	PH	6-9	6-9	6-9	6-9
12	Faecal coliforms(/L)	10 ³	10 ⁴	10 ⁴	-

Table 1. Maximum allowed discharge value of basic items which need to be controlled ,value are based on the standard GB 18918-2002.

1.4.3 Environment condition

Wuhan belongs to the north subtropical monsoon climate zone. Wuhan has abundant rainfall, sunshine, hot summers, the average temperature is 35°C and cold winters, the average temperature is 5°C. The annual average rainfall of Wuhan is about 1000mm and the annual average temperature is 10°C.

2.Design Scheme

The design scale of the urban sewage treatment plant is related to the inflow water quality and quantity. The water quality and quantity of the sewage can be calculated using the data provided by Wuhan Green sewage treatment plant. Based on the biodegradability and the principles of the urban sewage treatment, the suitable process will be decided.

2.1 Process comparison and selection of the sewage treatment plant

2.1.1 Determination of the principles of the process flow

The purpose of the urban sewage treatment is to make the discharge meet the standard or sewage reuse for the environment away from of pollution. The treated effluent can be reused for irrigation, urban land space or industrial production in order to save the water resources.

According to the *Urban sewage treatment and pollution control technology policy and Sewage treatment of new technology and design calculation examples*, Sun Liping, 2001. the following guidelines are used on the selection of urban sewage treatment process:

1. An urban sewage treatment process should be selected based on the scale of the treatment, water quality characteristics, the environmental functions of receiving water bodies and the local conditions and requirements, after a thorough comparison of the technical and economic indicators.

2. The main technical and economic indicators of the process selection include investment per unit treated sewage, investment per unit decreased polluting

substance, power consumption and cost per unit treated sewage, power consumption and cost per unit decreased polluting substance, floor area, operation performance, reliability, degree of management.

3.If the water quality composition is complex or special, a dynamic testing of the sewage treatment process should be carried out; if necessary, a pilot study should be conducted.

4.New and efficient technology should be adopted actively.New technology which is to be applied in China for the first time must undergo production tests to provide reliable design parameters so that it can be formally taken into use.

2.1.2 Sewage treatment process selection

The value of BOD/COD means the biodegradability of the sewage.A higher BOD/COD ratio means that the proportion of the pollutants contained in the waste water that can be biodegraded is larger;in other words,the biodegradability of the sewage is better.

Based on the description in *Environmental biotechnology (Page 10)*,T. Srinivas,*New Age International Publisher,2008*, BOD/COD ratios including explanations of how they affect the treatment process selection are description as following:

If $BOD/COD > 0.6$,the wastewater is fairly biodegradable and can be effectively treated biologically.

If $0.6 > BOD/COD > 0.3$,it is necessary to treat the sewage biologically

If $BOD/COD < 0.3$,biodegradation will not proceed,therefore,biological treatment is not possible.

If $BOD/COD=0$, there is a toxic substance in the sewage and biodegradation will not work.

In the design created during this thesis project, BOD and COD value are given as 180 and 390, so the biodegradability of the sewage is $BOD/COD=180/390=0.46 > 0.3$, so biochemical method can be used to deal with in this project .

China's urban sewage treatment technology development started later comparing with the foreign developed countries. Through 200 years, the technology has developed a lot in order to achieve different requirements of the effluent from the traditional activated sludge process to the oxidation ditch process. Even though, China's sewage treatment technology is still lagging behind many countries. While introducing foreign advanced technology, equipment and experience ,the combination of development of the country should carry out, especially the local actual situation, and explore the suitable urban sewage treatment system for our country.

The following content are giving according to *Urban Sustainable Development and Water Pollution Prevention and Control Measures*, ,Zhang Zhongxiang and Qian YiChina, Construction Industry Press,2008. Combined with the characteristics of China's national conditions, and gradually improve, the initial formation of the technical routes are mainly as follows:

1. Reuse of water as the purpose.
2. Nature biological purification and combined with artificial purification.
3. Modification of the traditional activated sludge treatment or the replacement of the artificial biological purification.
4. Based on the discharge and supplemented by the treatment.

Nowadays, environmental problems and water problems are the most serious problem in China. Therefore, how to use the water more reasonable will become the most concerned issue. The new nature biological purification and combined

with artificial purification technology now is most popular technology in China, they mainly refers to oxidation pond treatment and land treatment in large-scaled treatment plant, which has the advantages of low operation cost, less energy consumption and easy to manage. Some cities in China have also adopt adapt to local conditions.

Artificial purification is artificial to create conditions to make microorganism reproduction, improve the efficiency of microbial purification, including activated sludge and bio-film method, which is more common to use activated sludge method, it is the main technology used in domestic and foreign urban sewage treatment process. The traditional activated sludge process has abundance practical experience and technical data, reliable operation, good treatment effect, but there are more live and high cost characteristics, so after updating the process, there comes out oxidation ditch, SBR intermittent activated sludge process, A / O denitrification process, A2 / O simultaneous nitrogen and phosphorus removal process and other common process. Each of them have relatively different advantages. Combined with the specific conditions of our project, the sewage treatment plant also requires efficient nitrogen and phosphorus removal, which commonly used methods are SBR, AB, A2 / O method, oxidation ditch process.

2.1.3 Description and comparison of waste water treatment process

(1) The traditional activated sludge method

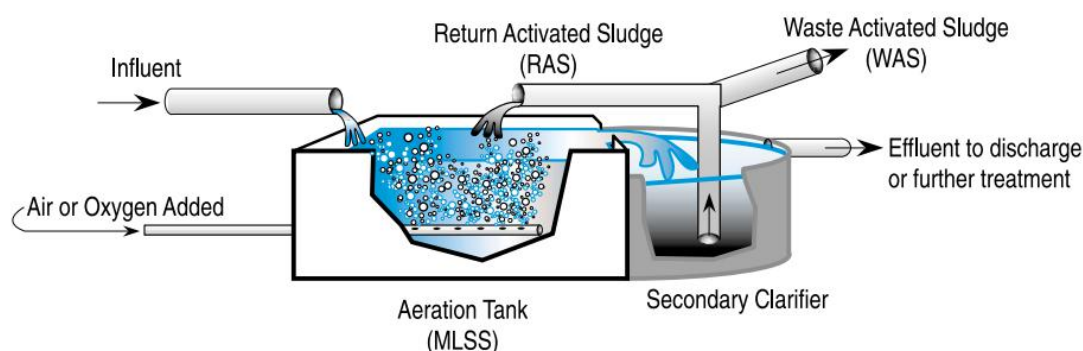
Working principle and advantages and disadvantages

The returned activated sludge from the secondary clarifier continuously flows into the aeration tank as the inoculated sludge, and the sewage from the secondary sedimentation tank is discharged into the aeration tank. In addition, the compressed air from the air compressor station enter through the trunk and branch pipe system and the laying of the aeration tank at the bottom of the air diffusion device, in the form of small bubbles into the sewage, the role of gas in addition to sewage oxygenation, but also to the aeration tank of sewage,

activated sludge in a state of intense agitation. Activated sludge and sewage mixed with each other and full contact, so that the normal reaction of activated sludge, the reaction is the result of sewage in the organic pollutants have been explained, removal, sewage can be purified.

The advantages are: good effect of sewage treatment, BOD removal rate can up to 90%. COD and SS removal rate are up to 90%; Abundant technical information and mature management experience; suitable for handling large amounts of sewage, reliable operation.

The shortcomings are: high operating costs, due to the waste left in the aeration tank, it increases the operating costs; high capital costs, large area. The working process is showing in the picture (picture 2) below .



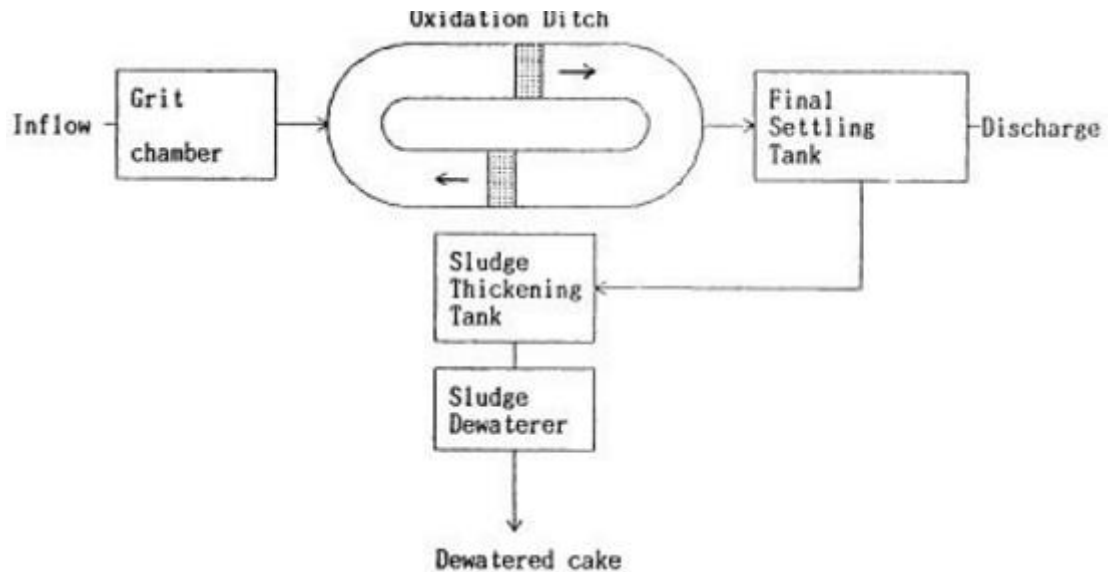
Pictue2: Traditional activated sludge process

(2) Oxidation ditch method

The working principle and its advantages and disadvantages

Oxidation ditch method is a process developed by traditional activated sludge treatment, it uses a continuous loop reactor as the bio-reactor. It is the core part of this method. The mixture of fluid continues to flow in the tank circularly to form anaerobic, anoxic, and aerobic stages. Oxidation ditch is a variant of the activated sludge method, the aeration tank was a closed ditch, so it is different in the hydraulic flow of the traditional activated sludge method.

The process is showing in picture 3.



Picture3:Oxidation ditch method

The advantages are:

Low energy consumption.

Work efficient in most kinds of weather..

Low operation cost.

Long hydraulic retention time.Less activated sludge waste is produced.High effluent quality.

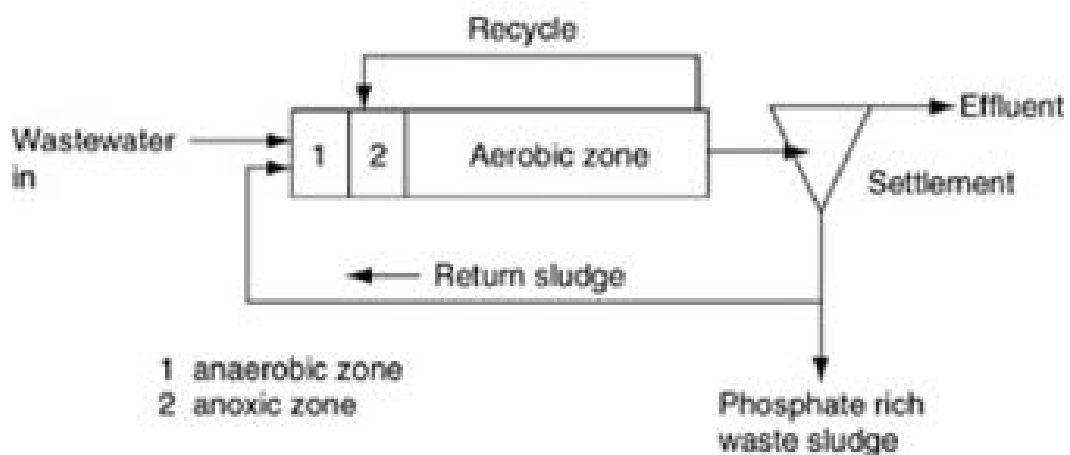
Its shortcomings:large area needed, easily to lead uneven flow, sludge expansion .

(3) A2 / O method

The working principle and its advantages and disadvantages

According to the substantive meaning,A2 / O process is anaerobic - anoxic - aerobic method.It Is a sewage treatment process which can simultaneous remove nitrogen and phosphorus .The original sewage and re-flux sludge contains phosphorous sent by sedimentation tank simultaneously enter into the anaerobic reactor. The role of anaerobic reactor is to release phosphorus, while part of the organic matter for ammonification. After that, sewage go into the

anaerobic reactor and enter into the anoxic reactor, the main function of this is denitrification. Nitrification through the inner loop aerobic reactor sent a large amount of circulating mixed solution, usually 2Q, the mixture from the anoxic reactor to aerobic reactor. The reactor is multifunctional, removing BOD, nitrifying and absorbing phosphorus, therefore to achieve the role of sewage treatment. The flow chart shows in picture 4.



Picture4:A2/O method

(4) Sequencing Batch Reactor (SBR) activated sludge method

SBR is a new technology for the treatment of domestic and industrial waste waters. The SBR process can treat all the waste water that can be treated by activated sludge process, which include anoxic/oxic systems, aerated lagoons, extended aeration processes, rotating biological contactors and oxidation ditches. The SBR is true batch reactor treatment mode, which does not allow waste water to enter the reactor during react. settle decant process.

SBR can be describe in five stages:

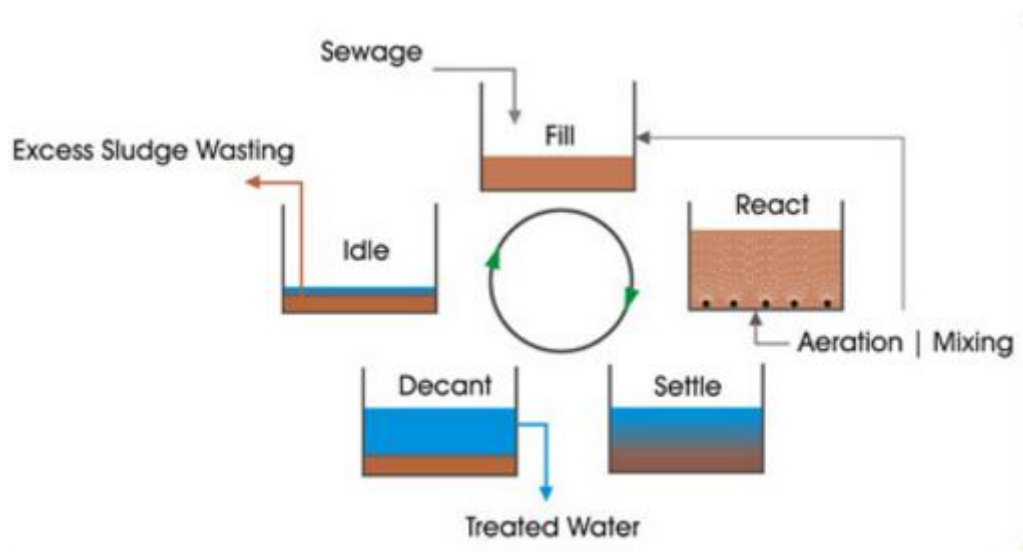
1. Inflow process: Inject the waste water, react after the tank is fulfilled.
2. Aeration reaction process: When the tank is filled fully with sewage, then start the aeration, which is the most important process, according to the purpose of sewage treatment.

3. Sedimentation: Separate the mixture of mud and water, equivalent to a secondary sedimentation tank.

4. Discharge process: Remove the supernatant produced after the aeration precipitation, as the treated water and discharge, until reach the lowest water level in the reactor, leave part of the activated sludge from the reactor as seed sludge.

5. Standby process: After water discharge, the reactor is at a standstill state and waiting for a period.

Flow chart is shown in picture 5.



Picture5: SBR activated sludge process

Advantages:

Features: In most cases, no need to set the adjustment pool; Sludge value index value is low, easy to precipitate, under normal circumstances will not produce sludge expansion; by regulating the mode of operation, process the nitrogen and phosphorus removal reaction; higher automaticity; at that time, the effect is better than continuous; less investment; large area needed.

According to the comparison and description above, SBR method has the following advantages

1. Removal of organic matter is very efficient, and can proceed denitrification, phosphorus removal or both nitrogen and phosphorus removal. Also, treatment

facilities is very simple, easy to manage and operate. Now, it is recognized not only as the high efficient and simplified sewage treatment process, but also the preferred process for the world's small and medium-sized cities ' sewage treatment plant .

2.Comparing with tradition activated sludge treatment ,SBR process' anti-shock load capacity is much better, which is favorable for the small and medium-sized sewage treatment plant when water quality, water quantity have tremendous changes

3.SBR has unique ability to act as equalization tank, aeration tank and clarifier within single reactor.

4.Return activated sludge piping is eliminated.

5.In economic aspect.SBR method invest less than other methods. All the facilities can be bought from domestic ,don't need to import from abroad.The operation fee and maintenance fee is lower which is more suitable for small and medium-sized sewage plant.

According to the reasons mentioned above, SBR is developed rapidly domestic and abroad. The US Environmental Protection Agency (EPA) has made SBR as an alternative technology, financed by the federal government, therefore, SBR processes is being vigorously promoted. In Australia, there are nearly 600 sewage treatment plant built based on SBR process during recent 10 years. In China, SBR process has become the first choice of the process for small and medium-sized sewage treatment plants.Therefore, sequencing batch reactor activated sludge process (SBR) is decided to be used in the design.

2.2 Site selection

In the design of sewage treatment plant, the location of the treatment plant has great influence on the environmental sanitation, infrastructure investment and

operation management. Therefore, the site selection is a very important link. Therefore, the choice of site should be carried out in-depth, detailed technical comparison.

The general principles of site selection are:

1. Based on *Water Supply and Drainage Design Manual*, volume 5, Minimum sanitation distance between urban sewage treatment plant and surrounding planning residential and public building construction should be 300 meters.
2. Easy to deal with water reuse and safe discharge and according to *Integrated Wastewater Discharge Standard (GB8798-1996)*, protected areas are prohibited to build a new sewage outfall.
- 3,.Easy to facilitate centralized and disposal of sludge;
4. Have good engineering geological conditions;
- 6.Less demolition, less land, according to *environmental assessment requirements*, a certain degree of health protection distance;
7. The possibility of expansion;
8. The plant terrain should not be affected by floods, flood control standards should not be lower than the urban flood control standards, a good drainage conditions;
9. Convenient transportation and water and electricity conditions.

3. Selection of main structures

3.1 Bar screen

A grid is a set of parallel metal grids or screens that are normally installed at the entrance of a sewer, pumping, collection well to trap larger suspended solids or floats in order to reduce subsequent treatment load. The intermediate grille is located in front of the sewage pumping station, the fine grid is located behind the sewage pumping station. There are two ways to remove contaminants, namely, artificial slag removal and mechanical slag removal.

This design has a larger amount of sewage, in order to reduce labor intensity, the choice is mechanical slag removal. The parameters below is provided and suggested by Wuhan Green water treatment plant.

1. Thick grille design parameters:

Before the gate, depth $h = 0.8\text{m}$,

Over-gate flow rate $u = 0.9\text{m / s}$,

Grid gap width $e = 0.050\text{m}$,

Grid inclination $\alpha = 60^\circ$, use two coarse grid.

2. Fine grid design parameters

Before the gate ,depth $h = 0.8\text{m}$

Over-gate flow rate $u = 0.9\text{m / s}$,

Gate gap width $e = 0.01\text{m}$,

Grid inclination $\alpha = 60^\circ$, use two fine grille.

3.2 Grit chamber

3.2.1 Grit chamber selection

The function of the grit chamber is to remove the inorganic particles with large specific gravity. Grit chamber generally located before the pump inverted siphon, in order to reduce the inorganic particles abrade the pump and pipe; it can also be located before the primary settling tank to reduce sedimentation tank load and improve the sludge treatment structure of the treatment conditions and grit chamber. In the form of different flow direction ,the chambers can be divided into four categories: advection, vertical flow, aeration grit chamber and cyclone grit chamber

1. Advection grit chamber

Advantages: precipitation effective, impact resistance load, can adapt to temperature changes. Work stability, simple structure, easy construction, easy to manage.

Disadvantages: large area needed, uneven distribution of water, prone to short-term and bias flow, sludge spacing larger, in the pool, there is about 15% mixed with organic matter which make it more difficult for grit chamber to deal with the follow-up.

2. Vertical flow grit chamber

Advantages: small area needed, convenient mud removal, easy operation and management.

Disadvantages: pool is big and deep, construction difficulties, higher cost, resistance to impact load and temperature adaptability is poor, the pool diameter is limited, too large diameter pool will lead to uneven water distribution.

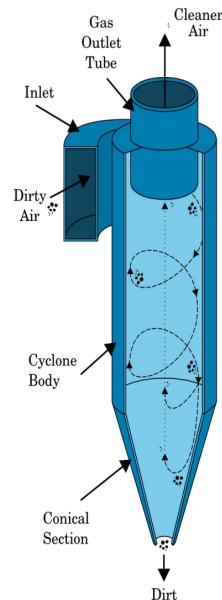
3. Aeration grit chamber

Advantages: Overcome the shortcomings of the advection grit chamber, so that sand and organic matter can be separate better. Sewage rotational flow velocity can be controlled by adjust the gas quantity, so that the sand removal rate is stable, the influence by quantity of flow changes is small. At the same time, it works as the role of per-aeration, the sand amount is large, and its containing less organic matter.

Disadvantages: due to the need for aeration, so anti-bubble device should be considered to set inside the pool, the other type is easy to produce biased flow or dead ends, and also with aeration device, the costs increase.

4. Cyclone grit chamber(vortex grit chamber)

Advantages: General design is round shape, in the pool center there is a speed adjustable rotary paddle plate, the water channel position in the circular pool tangential. It can adjust the rotational speed of rotating paddle plate and remove the fine sand which is hard to be removed by other grit chamber. It has the advantages of small area, low energy needed, high efficiency of grit removal.



Picture 6: cyclone grit chamber

Based on the comparison above three kinds of grit chamber, cyclone grit chamber is determined to use in the design.

3.3 SBR pool

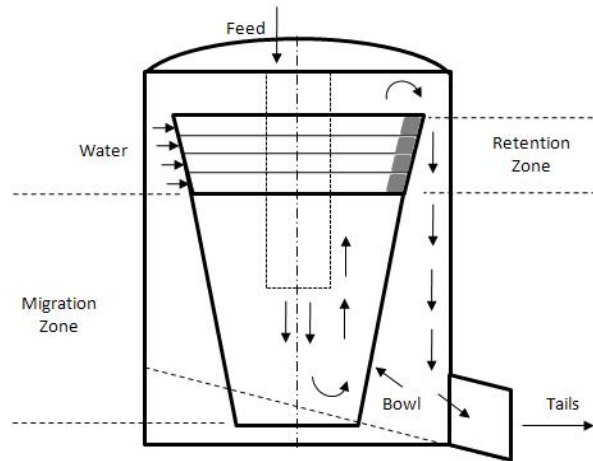
According to the comparison, the traditional SBR pool is used in the design.

3.4 Concentrator

Centrifugal Concentrator is determined to use in the design.

Centrifugal concentrators are filtration devices that operate under centrifugal force to separate solids from liquid phase, reducing the final volume. There are various kinds of concentrators to choose, therefore, percentage of retentate

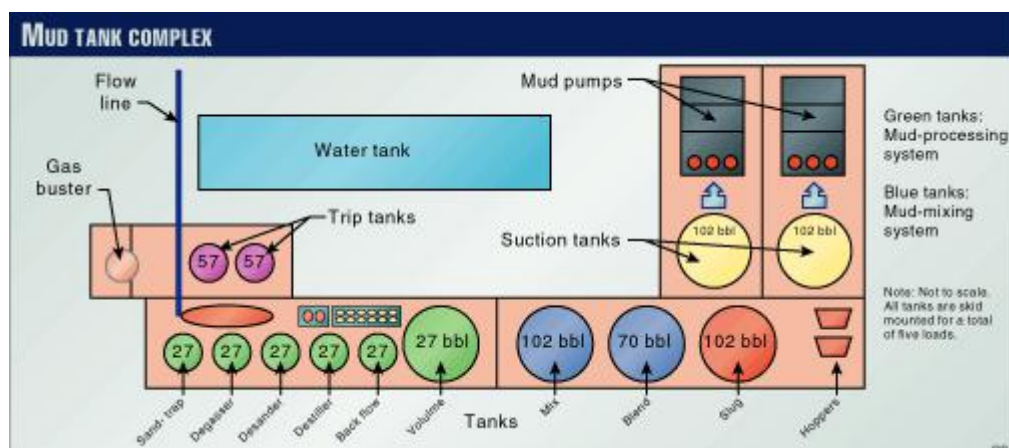
recovery, short spin times, reproducible performance, and the possibility of re-spinning are the main factor to considering.



Picture 7:centrifugal Concentrator

3.5 Mud storage tank

The mud tank can be built in various sizes and styles based on the design, it is easy to customize with the other facilities. Interior walls are made smoothly so that is easy to clean out and speedy adjustment. It is easy to see the amount of the mud in the tank.



Picture 8: mud tank complex

3.6 Dehydration

Centrifugal dewatering machine.

The centrifugal dewatering machine work according to centrifugal force and the compression power of a screw conveyor. It is totally automatic from start to finish, therefore it is easy to operate and manage. It excels in its ability to treat changes in sludge properties and operation stability, It is sealed, so that there is very little odor and it provided a good working environment and condition. The centrifugal dewatering machine is low power machine and it has the high efficiency. It can reduce the power consumption and easy to maintain .

3.7 Sludge disinfection

The sludge after treatment can be reused to build the roads and in agriculture. Before turning into use again, the sludge disinfection process should carry out because there are some pathogen organism remained in the sludge, usually they are bacteria, viruses and parasites. The sludge which contains the toxic content or the heavy metals can not be reused. They should send to landfill or incineration.

4. Sewage treatment plant layout

The structure and the facilities of process unit are set in the sewage treatment plant; the pipe, channel and other pipelines connect the treatment structure together; auxiliary buildings for example the offices and toilet; roads and green spaces. Therefore, there should be a reasonable plane planning for the variety of engineering facilities in sewage treatment plant.

4.1 Plane layout of wastewater treatment plant

The layout of the sewage treatment plant should follow the requirements from *Outdoor Drainage Design Code (GB50014-2006)*, the production of processing structures and pump houses, air blower rooms, agent storage room , laboratory and offices and a variety of pipelines and other layouts. There are also all the

roads connection , outdoor lighting on the roads and structures and landscaped green areas in the plant area. According to the size of the treatment plant, generally use of topographic map which the scale is around 1:200-1:1000 to draw the total floor plan, commonly used scale is 1:500 ,this scale is according from *Sewage treatment plant and Plane layout and elevation layout*,Li Songqiang,2001.

4.1.1 Plane arrangement principles based on *Standard for structural design of water supply and sewerage engineering(GB50069-2002)* and *Outdoor Drainage Design Code (GB50014-2006)*,Section 6.

1.The area of the sewage plant should be based on the total size of the project control, and make arrangements for the construction phase, to determine a reasonable size for the recent scale, the amount of water within a year put into operation recently should reach 60% of the recent design.

2.The overall layout of the sewage plant should be based on the factory buildings and functions of structures and process requirements, combined with the site topography, climate and geological conditions, optimize the operating costs, ease of construction, maintenance and management and other factors determined by the technical and economic comparison.

3.The architectural modeling in sewage treatment plant modeling should be simple and beautiful building, materials saving, appropriate selection of material, and should make the building and structure groups and the effect of the surrounding environment coordinate with each other.

4.According to *Code for fire protection design of buildings (GB50016-2014)*,*production* and management buildings and living facilities should be arranged in a centralized manner, its location and orientation should be reasonable, and should maintain a certain distance with the processing structure.

5. Sewage and sludge treatment structures should be placed centralized respectively as much as possible. The spacing of the treatment structures shall be compact and reasonable, and shall meet the requirements of and shall meet the requirements of *Code for fire protection design of buildings (GB50016-2014)*, production for the construction of various structures, installation of facilities and inbuilt of various pipelines and the maintenance, repair and management requirements.

6. The sewage treatment plant process, vertical design should take full advantage of the terrain, correspond to the requirements of drainage unimpeded, reduce energy consumption, balance earthwork.

7. The location and design of fire control design in the pant and digestion tank, storage tank, sludge gas compressor room, sludge gas generator room, sludge gas burning device, sludge gas pipeline, sludge drying device, sludge incinerator and other hazards goods warehouses and others should be consistent with the current national fire safety requirements.

8. The sewage plant can be set according to need, in the appropriate places stacked materials, spare parts, fuel and waste materials and parking spaces.

9. The sewage plant should build the necessary access lead to the structures and ancillary buildings, according to *Code for Design of Outdoor Drainage (GB 50014-2006), 2016 Edition*, the design of the necessary channel should meet the following requirements:

- 1) The width of main roadway: 3.5 ~ 4.0m for single lane, 6.0 ~ 7.0m for double lane , and there should be a turning road.
- 2) The turning radius of the roadway should be 6.0 ~ 10.0m;
- 3) The width of the sidewalk should be 1.5 ~ 2.0m;
- 4) The inclination angle of the escalator leading to the elevated structure is generally 30 °, should not be more than 45 °;
- 5) Bridge width should not be less than 1.0m;

6) Roads, channels should be arranged based on the state's existing fire safety requirements, and should meet the requirements of the relevant local authorities.

10,.According to site conditions,a wall should be set up around the sewage treatment plant ,its height should not be less than 2.0m.

11.The size of the sewage treatment plant entrance gate should be able to access the transportation of the largest equipment or parts of the vehicle, and a separate transport of waste should be set to the side doors.

12.Between the treatment building ,there should be a homogeneous water distribution devices.A switchable connection pipe should be set between each treatment structure system .

13. Varies of sewers in the plant should be arranged comprehensively to avoid mutual interference. When the structure of pipeline is complex , tube gallery should be set up.The arrangement of water, mud transfer and gas transmission pipelines between the structures should meet that the length of the pipe is short, the loss is small, the flow is smooth, it is not easy to be blocked and easy to clear. The sewer pipe connection between the sewage treatment structures, when conditions are appropriate, open channel should be used.Pipe rack should be instrumentation cables, telecommunications cables, power cables, water pipes, sewage pipes, sludge pipes, recycled water pipes, compressed air pipes, and set the color code.There should be ventilation, lighting, radio, telephone, fire alarm and combustible gas alarm system, independent drainage system, hanging hole, pedestrian access and maintenance facilities, and all of them should comply with the relevant national fire protection requirements.

14.The sewage treatment plant should manage and arrange pipeline beyond the structure reasonably.

15.Emptying facilities should be set up next to the treatment building and discharged water should back flow and retreat.

16. Renewable water treatment system should be set up in the sewage treatment plant.

17. Water supply system, recycled water system in the plant is strictly prohibited connect with processing device directly.

18. The power supply system should be designed as second class load and an important sewage plant should be designed to be first class load. When the above requirements cannot be met, a backup power facility shall be provided.

19. The composition and area of the affiliated buildings of WWTPs shall be determined on the basis of the scale of the WWTP, the level of the process flow, the level of the computer monitoring system and the management system, in light of the actual local conditions and correspond with principle of conservation and accord with the relevant provisions.

20. The sewage treatment structures located in cold areas should concurrence with-thermal insulation and anti-freezing facilities.

21. According to the requirements of maintenance and management, distribution box, lighting, contact telephone, flushing water plug, bathroom, toilet and other facilities should be set up in the appropriate places in the plant.

22. Proper railings, anti-slide and other safety measures should be set next to the treatment building. Elevated structures should also be set up lightning protection facilities.

4.1.2 Plane arrangement

1. The technical process layout

Technical process layout is carried out based on the area and terrain provided by the design task, linear type design is determined to use here. This

arrangement has the advantages of short production pipelines, head loss is small, easy management, and is conducive for future expansion.

2. Construction plane layout

According to the function, the sewage treatment plant layout is divided into three areas:

1) Wastewater treatment area:

Composed of various sewage treatment facilities, arranged in a linear type. Including: the total sewage pumping station, grille, cyclone grit chamber, SBR pool, disinfection, metering tank, blower room.

2) Sludge treatment area:

Located in the down wind direction of the main wind direction, composed of sludge treatment structure, present as a linear layout. Including: sludge concentration, the sludge dewatering, storage tank and other facilities.

3) Living area:

The area is a area combined with office, dormitory, cafeteria, boiler room, bath room and other buildings, located in the upwind direction of the wind.

3. Sewage plant piping arrangement

Sewage plant pipeline arrangement mainly has the following pipeline layout:

1) Sewage plant process piping

After sewage upgrading through the main pumping station after, in accordance with the treatment process after the treatment ,release to the water body.

2) Sludge process piping

Sludge is mainly residual sludge, according to the process shipped out from the factory after treatment.

3) Drainage pipelines

Drainage system, including the structure of supernatant and overflow pipeline, the structure of the vent pipe, the building of the drainage pipe, plant rainwater pipe. For rainwater pipelines, if the water quality can meet the discharge standard and can be discharged directly. But the sewage in the supernatant and overflow pipelines of the structures and the drainage pipes of the structures and the drains of the buildings have really high pollutant concentration and the water quality can not reach the discharge standard , they can not be discharged directly. Therefore, collect them and access to the pump pool to continue processing.

4) Air pipeline

Benefits for the air pipelines:

energy saving ;

easy,fast and safe installation;

high mechanical stress

5) Fire hydrant arrangement

From outside the factory access to water consuming points the building,outdoor fire hydrant should installed at intervals of 120.0 m according to the *Code for Fire protection design of buildings,GB50016-2014*.

4.Roads in plant layout

1) The main road layout

The road from outside and the roads of buildings in the plant are connected and to be the main road.Considering about the size of the cars and vans,road's width is 6.0m, located 1.5m on both sides of the sidewalk, and plant trees and virescence.

2) Roadway layout

The main structure buildings arranged roadway, road width with 4.0m and present as annular layout.

3) Walk-side layout

For the buildings without goods and equipment transport, connect the walkways with main road or roadway .

5.Green layout

Plant a lot of trees and make some small garden in some area of the plant.

4.2 Elevation arrangement

In order to enable the sewage flow smoothly between the treatment structures and in order to ensure the normal operation of the plant,the elevation layout is needed to determine the structure and connecting pipe elevation.

To reduce the operating costs and ease of maintenance and management, it is appropriate to consider the flow of sewage between treatment structures by gravity flow; sludge is also better to use gravity flow, should minimize the number of pumping if it necessary to enhance.In order to ensure the smooth flow of sludge, the head loss between the treated structures should be calculated accurately and also the reserve head should be reserved when consider about the expansion in the future.The major tasks for elevation arrangement is:

- 1.To determine the standard elevation of treatment of structures and pumping station;
2. Determine the size and elevation of the connecting pipelines between the treatment structures;
- 3.Through the calculation to determine the standard elevation of the water surface which can make the sewage along the treatment process flow between the structures in order to ensure the proper operation of sewage treatment plant.

4.2.1 Principles of elevation arrangement

The principles are based on the standard provided by *code for design of outdoor drainage (GB 50014-2006) ,2016 Edition and Sewage treatment plant and Plane layout and elevation layout,Li Songqiang,2001.*

- 1.To ensure the smooth flow of sewage between the various structures.
- 2.Careful calculation of pipeline losses along the way, local losses, the structure of the treatment, measurement equipment and contact pipe head loss; consider the maximum flow, rain flow and accident flow increase, and leave some leeway; When a structure ceases to operate, the remaining structures in parallel with it and the associated connection canals can pass the full flow.
- 3.When consider the long-term development, the amount of water reserved head should increase.
- 4.Choose a process with a longest distance and largest head loss to do hydraulic calculation.
- 5.According to *Sewage treatment plant and Plane layout and elevation layout,Li Songqiang,2001*, when calculation of head loss, generally should use the recent maximum flow as structures and pipe design flow; calculation of long-term flow of pipes and equipment involved, the flow should be designed to long-term maximum flow, and add reasonable amount of standby head for future expansion.
- 6.When setting the end of the pumping station, hydraulic calculation usually use the highest water level of the sewage after treatment as a starting point, against the sewage treatment process upwards and calculation back, in order to prevent the treatment of sewage cannot flow out by gravity. The two pumping stations need less head, lower operating costs. But at the same time, should also consider the excavation depth should not be too large to avoid excessive construction investment and increase the construction difficulties.
- 7.When designing the elevation layout, it should also pay attention to the sewage process and sludge process to minimize the amount of sludge which are needed to be retreated.

8. Coordinate the relationship between the elevation arrangement and the plane layout, to reduce the land occupation and good for sewage and sludge transportation, and to reduce the project investment and operation cost.

5. Conclusion

SBR activated sludge process is a new technology, developed within 40 years. Nowadays, it is more widely used in all over the world especially for the small and medium sized plant. When comparing to other treatment methods, it is still immature. In the design, only the basic content and the outline of the process is present. With the help of the waste water treatment engineers' expertise, the design of SBR process will achieve a more ideal result.

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Appendix

Original table of table 1:

GB18918-2002

表1 基本控制项目最高允许排放浓度(日均值)

单位 mg/L

序号	基本控制项目		一级标准		二级标准	三级标准
			A 标准	B 标准		
1	化学需氧量 (COD)		50	60	100	120 ^D
2	生化需氧量 (BOD ₅)		10	20	30	60 ^D
3	悬浮物 (SS)		10	20	30	50
4	动植物油		1	3	5	20
5	石油类		1	3	5	15
6	阴离子表面活性剂		0.5	1	2	5
7	总氮 (以 N 计)		15	20	-	-
8	氨氮 (以 N 计) ^②		5 (8)	8 (15)	25 (30)	-
9	总磷 (以 P 计)	2005 年 12 月 31 日前建设的	1	1.5	3	5
		2006 年 1 月 1 日起建设的	0.5	1	3	5
10	色度 (稀释倍数)		30	30	40	50
11	pH		6-9			
12	粪大肠菌群数 (个/L)		10 ⁴	10 ⁴	10 ⁴	-

