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A membrane bioreactor system for rural decentralized wastewater

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ABSTRACT

With the development of rural economy and continuous improvement of living standards, rural sewage pollution has gradually increased, and the pollution area has gradually increased. The invention aims at the rural decentralized domestic sewage, and develops a rural decentralized integrated membrane bioreactor system. The invention is a hybrid of a conventional biological treatment system and physical liquid–solid separation using membrane filtration in one system, which not only eliminates the need for secondary clarifiers, but also greatly improves the solid-liquid separation efficiency and the biochemical reaction rate. The invention combines a new type of ultrafiltration membrane technology and biological simulation technology. According to the quality and fluctuations of the water, using flate membrane, the membrane flux is increased by more than 30%, and the contact angle is reduced to less than 70 degrees, which optimizes the energy consumption of the equipment and reduces Remaining sludge. Recirculation is performed by air stripping to convert the air energy into the kinetic energy of the reflux liquid. The invention reduces the sludge return pump in the process, saves 30% energy consumption compared with the traditional process, and reduces the equipment failure rate.

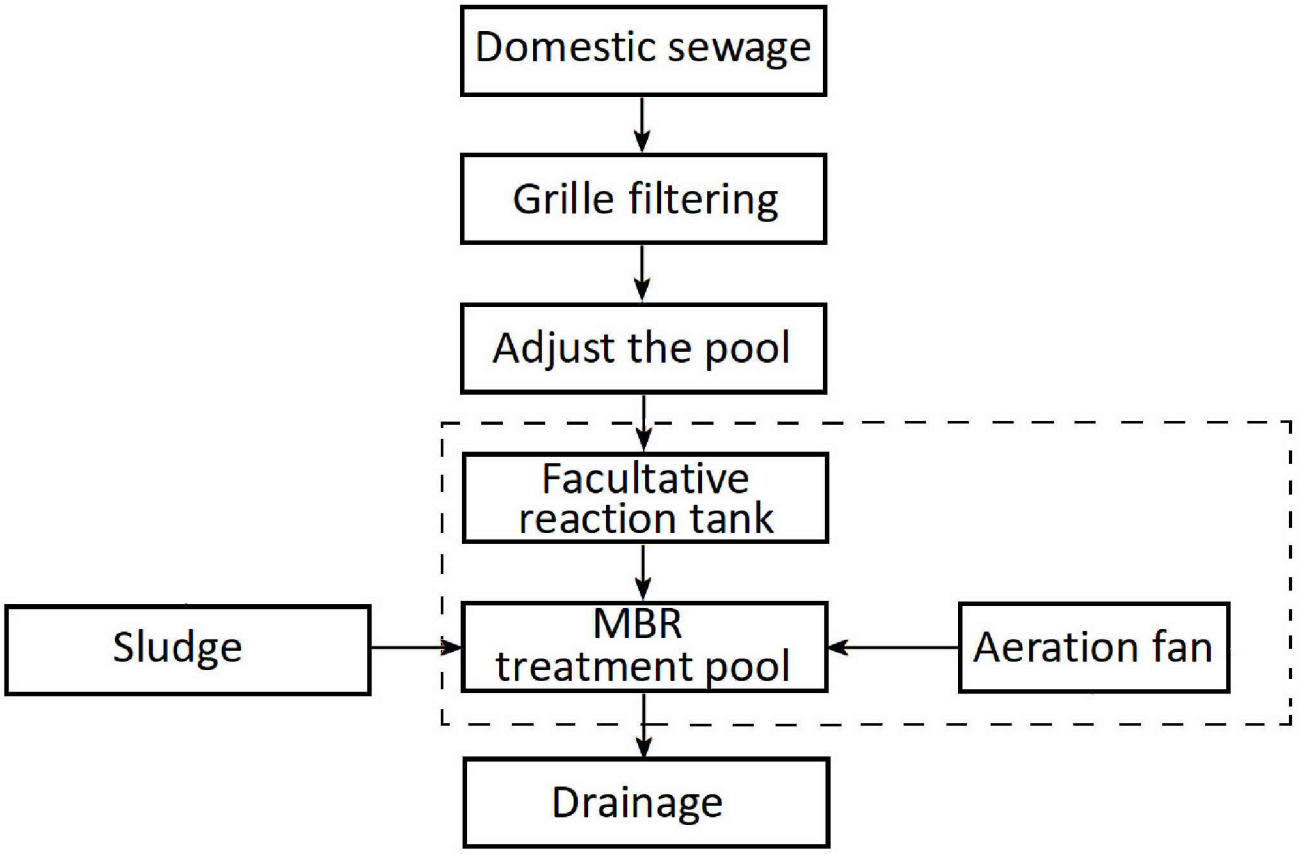

Figure 1

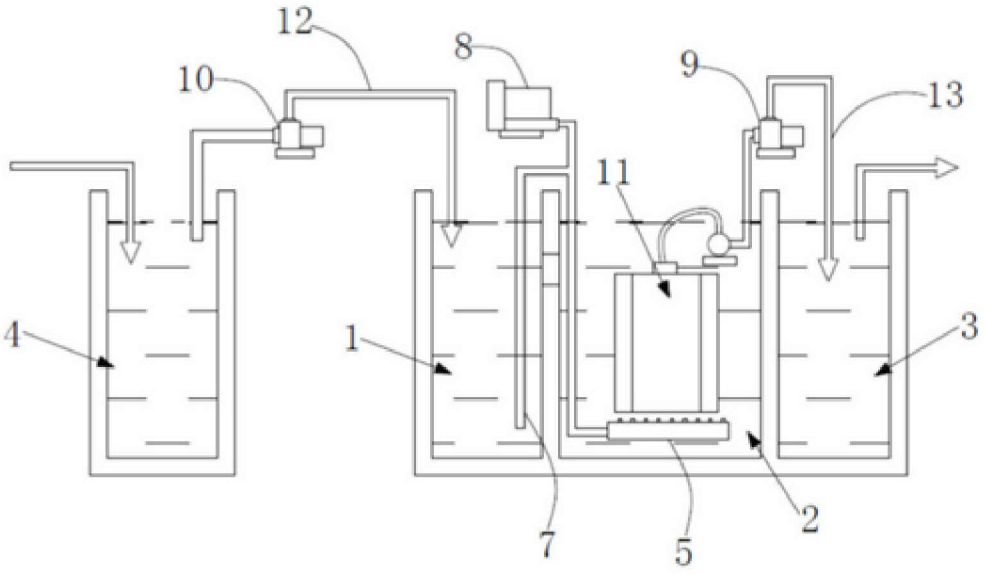

Figure 2

DESCRIPTION

TITLE

A membrane bioreactor system for rural decentralized wastewater treatment

FIELD OF THE INVENTION

This patent is in the field of sewage treatment in water treatment technology, and particularly relates to a membrane organism reactor.

BACKGROUND OF THE INVENTION

With the rapid improvement of urban sewage treatment rate, China has established a relatively complete technical system and management system for centralized sewage treatment, but there is still a large gap in rural decentralized domestic sewage treatment. Foreign research on decentralized rural sewage treatment has been carried out earlier. Currently, 20% to 30% of the population in Europe and the United States uses decentralized sewage treatment facilities, and 66% of the population in Japan uses purification tank technology. Decentralized processing technology has matured in these countries. However, China began to explore and practice decentralized wastewater treatment technology in the 1980s. The constructed wetland, stabilization pond, trickling filter, and Anaerobic-aerobic combination process has been studied and applied in rural areas of China. With the introduction of "Action Plan for Prevention and Control of Water Pollution" and "Three-year action plan for the

improvement of rural human settlements", people are paying more and more attention to the decentralized sewage treatment in rural areas. Carrying out the treatment of rural domestic sewage is to change the current situation of disorderly discharge of rural domestic sewage and improve the living conditions of farmers. It is an important task to improve the living environment in rural areas, and it is also the key to improving the water environment in river basins and regions.

At present, there are dozens of forms of decentralized rural sewage treatment technologies in China, such as constructed wetlands, aerobic biological contact oxidation processes, trickling filters, anaerobic biogas digester treatment technologies, small secondary sewage treatment devices, and membrane bioreactors. Constructed wetlands are artificial ecosystems modeled on natural wetlands, using the triple synergy of physical, chemical, and biological in the natural ecosystem to achieve the purification of sewage. In the aerobic biological contact oxidation treatment process, sewage flows through the filler with microorganisms attached. During the contact with the filler, the organic pollutants in the sewage are removed through the metabolism of the aerobic microorganisms to achieve sewage purification. The trickling filter is a biological treatment structure composed of crushed stone or plastic product filler. By imitating the principle of natural ecosystem, the synergy

of microorganisms, artificial fillers and biofilms is used to purify sewage. Anaerobic biogas digester treatment technology uses human and animal manure or crop straws to convert organic matter into methane and carbon dioxide by anaerobic and facultative microorganisms under the condition of hypoxia in the biogas digester. The small secondary sewage treatment device uses a combination of physical and biological methods for sewage treatment. Sewage first enters biological treatment such as anaerobic, facultative or aerobic after passing through the grille, primary sedimentation tank, and finally discharged through sedimentation. Membrane Bioreactor (MBR, Membrane Bioreactor) is an efficient and new sewage treatment technology formed by combining membrane separation technology and activated sludge system. There are various forms of decentralized sewage treatment technology in rural areas. Therefore, how to scientifically choose a sewage treatment process, and at the same time, based on the rural conditions, fully consider the construction and development of surrounding towns and industrial areas, formulate a suitable planning scheme deserves our attention. For more developed and land-stressed areas, the research and development of miniaturized integrated membrane bioreactor technology is particularly important.

Therefore, this patent has developed a set of rural decentralized integrated

membrane bioreactor system, including anaerobic tank, membrane bioreactor, clean-water reservoir, aeration blower, suction pump and splitter plates, and applied this system to China Regions such as Jiangsu and Zhejiang. The system not only has the technological advantages of the original membrane bioreactor, but also is convenient to use. It can carry out the evolutionary treatment of sewage from scattered households, and improves the flexibility of sewage treatment. Therefore, this system has an important role and promotional value for improving the quality of rural water environment in China.

SUMMARY

MBR technology is suspension culture biological treatment (activated sludge process) and the combination of membrane separation technology, membrane separation technique to replace the two pond, in the traditional activated sludge process, plays the biological treatment technology rely on microorganisms (mixture) separated from the culture medium, and microbes to insourcing stay in biochemical reaction pool, at the same time ensure that basically out of the water does not contain microbes and other suspended matter. The membrane bioreactor can effectively overcome the limitation related to the sludge settling performance and replace the secondary sedimentation tank. MBR can maintain a high biomass concentration, usually 8 ~ 10g/L for MLSS, up to 10 ~ 15g/L,

and 3 ~ 5g/L for MLSS in conventional activated sludge aeration tank. Therefore, the footprint of MBR process is only 1/2 ~ 1/3 of that of conventional treatment.

The sewage in the invention is led to the sewage treatment equipment through the sewage collection pipeline, and the sewage is first filtered through the grille and then sent to the regulating tank by the lifting pump, and then continuously sent to the integrated sewage purification equipment by the lifting pump.In integrated sewage purification equipment in the pool of oxygen and the biochemical degradation, and degradation of organic pollutants, the bottom aeration device, microbial needed oxygen provided by the equipment inside the blower, system through the mixture flow, use of denitrifying bacteria degradation of ammonia nitrogen, water entering the MBR membrane pool further degradation of filtering, spate separation, discharge standard after discharge.

DESCRIPTION OF DRAWING

Figure 1 is technical route description.

Figure 2 is the flow diagram of the MBR process.

Figure 3 is the schematics design of our invention.

DESCRIPTION OF PREFERRED EMBODIMENT

Principle

The Figure 1 illustrates a type of membrane bioreactor which consists of an anaerobic tank 1, a membrane bioreactor tank 2, a clearwater holding tank 3, an aerator 8, a suction pump 9,and and an isolation plate. The anaerobic tank 1 and the membrane bioreactor tank 2 are isolated by an isolation plate, and the membrane bioreactor tank 2 and the clearwater holding tank 3 are isolated by an isolation plate. The anaerobic tank 1 is provided with an anaerobic tank aeration pipe 7 and a water inlet pipe 12. An MBR membrane module 11 is arranged in the membrane bioreactor tank 2, and a membrane module aeration pipe 5 is arranged at the bottom of the MBR membrane module 11. A clearwater holding tank 3 is inserted with an outlet pipe 13. The anaerobic tank aeration pipe 7 and the membrane module aeration pipe 5 control aeration by an aerator 8, and the water outlet pipe 13 performs water outlet through a suction pump 9.

A sedimentation tank 4 is set on the other end of the water inlet pipe 12.

A feed pump 10 is set on the water inlet pipe 12.

An overflow port 6 is set near the top of the isolation plate between the anaerobic tank 1 and the membrane biological reaction tank 2.

In the process of use, the membrane bioreactor is installed in a container

and placed in the decentralized residence. The sewage is introduced into the sedimentation tank 4 through a pipeline for sedimentation, and then the precipitated sewage is sent to the anaerobic tank 1 for aeration through a water inlet pipe 12 by a feed pump 10, and then the aerated wastewater in the anaerobic tank 1 flows into the membrane bioreactor tank 2 through the overflow port 6, and the MBR membrane module 11 performs sewage purification treatment, and finally The treated sewage is pumped out by the suction pump 9 and sent to the clearwater holding tank 3 by the outlet pipe.

The anaerobic tank aeration pipe 7 is set to provide sufficient oxygen for the anaerobic tank 1 . The setting of the membrane module aeration pipe 5 can facilitate the scouring of the fouling on the MBR membrane module 11, so that the MBR membrane module 11 can maintain stable and effective sewage purification.

Procedure

The procedure of this invention is implemented as follows:

(1) The feed pump starts to feed water, and then the activated sludge, which is taken from the nearby sewage treatment plant, is added to the aerobic tank. The aeration period is 3 days, and the carbon source is added at the same time.

(2) Observe the growth of activated sludge. When the concentration of sludge in the aerobic tank reaches 2000-3000mg ·L-1, the water will flow out, and a certain amount of denitrifying bacteria will be added to the anoxic tank to improve the nitrification reaction capacity of the system;

(3) The equipment enters and exits the water, replenishes the bacteria at any time. When SV be maintained at about 30%, the installation operates normally.

Results and discussion

Table 1 Characterization of the wastewater before and after treatment.

sample		CODcr(mg·L^{-1})	NH^{4+}-N(mg·L^{-1})	TP(mg·L^{-1})	SS(mg·L^{-1})
1	Feed	813	57.9	11.3	120
	Effluent	21	0.512	0.820	16
	Removal efficiency%	97.4	99.1	92.7	86.7
2	Feed	243	60.1	10.4	108
	Effluent	20	0.616	0.792	11
	Removal efficiency%	91.8	99.0	92.4	89.8
3	Feed	481	136	21.7	142
	Effluent	21	5.840	0.784	10
	Removal efficiency%	95.6	95.7	96.4	93.0
4	Feed	142	42.4	6.54	67
	Effluent	5	0.484	0.416	6
	Removal efficiency%	96.5	98.9	93.6	91.0
5	Feed	465	91.2	16.7	85
	Effluent	10	0.892	0.908	12
	Removal efficiency%	97.8	99.0	94.6	85.9
6	Feed	129	52.6	5.23	63
	Effluent	24	3.030	0.780	10
	Removal efficiency%	81.4	94.2	85.1	84.1
Discharge standard(1B)		60	8(15)	1	20

Analysis

The process achieved good removal efficiency of 81.4%-97.8% of CODcr, 94.2%-99.1% of NH^{4+}-N, 85.1%-96.4% of TP, and 84.1%-93.0% of SS, which allowed the effluent quality to meet the 1B standard (GB 18918-2002) (e.g., COD, NH^{4+}-N, TP and SS no higher than 60, 8, 1, 20 $mg \cdot L^{-1}$, respectively)

The study examined the performances of the integrated MBR for rural wastewater reclamation. It was found that in the system 81.4%-97.8% of CODcr, 94.2%-99.1% of NH^{4+}-N, 85.1%-96.4% of TP, and 84.1%-93.0% of SS could be removed, and the treated water quality succeeded to meet the 1B standard of Discharge standard of pollutants for municipal wastewater treatment plant(GB 18918-2002). The MBR treatment process provides stable and high quality product water and has low emission amount of sludge. This integrated sewage purification installation has its distinct advantages of high treatment efficiency, ease of construction, and small footprint, thus saving land use and construction costs, which is extremely important for rural areas where limited footprint and financial issues exist. So this novel type of MBR is promising in the foreseeable future.

Table 2 below shows the main parameters of this MBR

Table 2 The main parameters of the installation:

Serial number	item	factor	remark
	Integrated sewage purification installation	Capacity:5-200ton·d^{-1}； Full- automatic PCL control, water pump and water level linkage control; Intelligent alarm; No personnel required.	
1	Integrated sewage tank	The box material can be divided into carbon steel and glass steel; Carbon steel needs to be anticorrosive paint: epoxy coal asphalt paint.	
2	MBR membrane module	Flat sheet membrane, membrane pore size: 0.1μm; Membrane material: polyvinylidene fluoride (PVDF); water production: 400 -600L·p^{-1}·d^{-1}.	
3	Centrifugal pump	Self-priming centrifugal pump is selected according to the water production.	
4	Vortex air pump	The high-pressure vortex air pump is selected according to the required aeration of the membrane module.	
5	Level controller	Controlling the water level of the membrane pool and the water level of the clearwater holding tank	
6	Electronic control system	Full- automatic PCL control; Telemonitoring.	

WHAT WE CLAIM IS:

1. A membrane bioreactor system for rural decentralized wastewater treatment, characterized in that: the equipment has the characteristics of miniaturization and integration, suitable for decentralized treatment of rural sewage, and the quality of the effluent water is high, which can be reused.

2. According to system of claim 1, wherein integrate new ultrafiltration membrane technology and biological simulation technology; according to the quality and fluctuations of the water, the use of flat membranes has improved the membrane flux by more than 30%, and the contact angle has been reduced to below 70 degrees, optimizing the energy consumption of the equipment and the remaining pollution; very little mud.

3. According to system of claim 1, wherein backflow can be carried out by air stripping, which converts air energy into reflux liquid kinetic energy, which reduces the sludge return pump in the process; this technology saves 30% energy consumption compared with traditional processes, and reduces equipment failure rate.

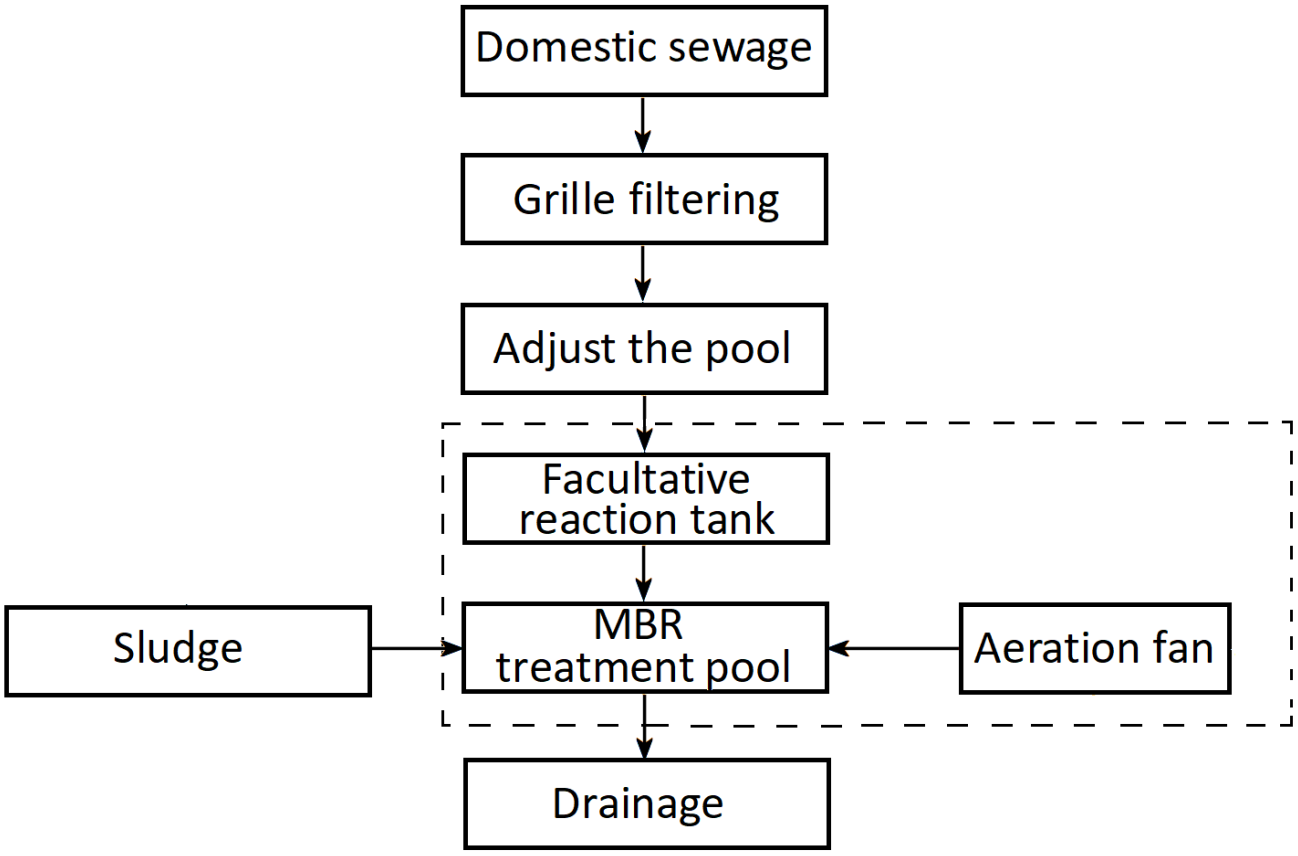

Figure 1

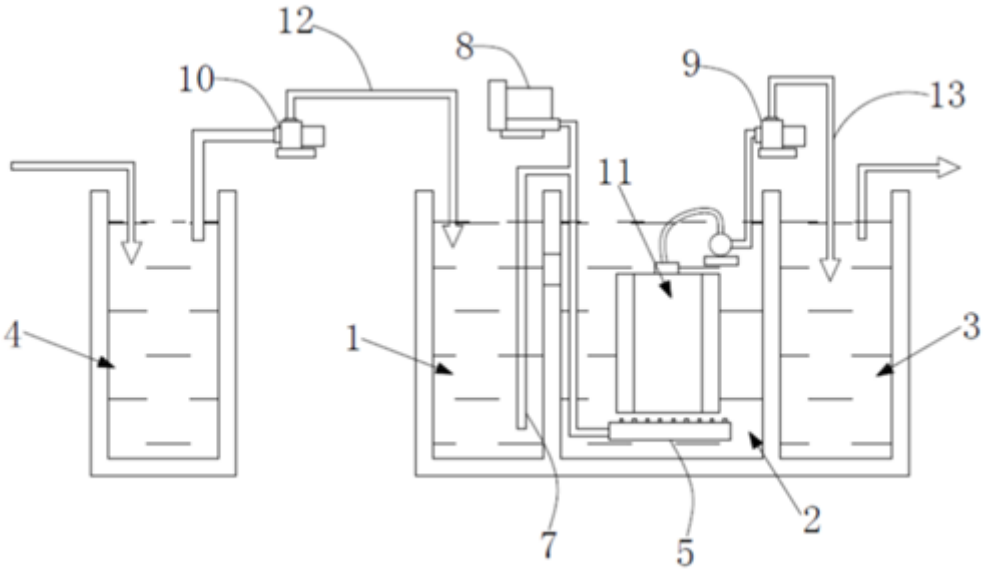

Figure 2

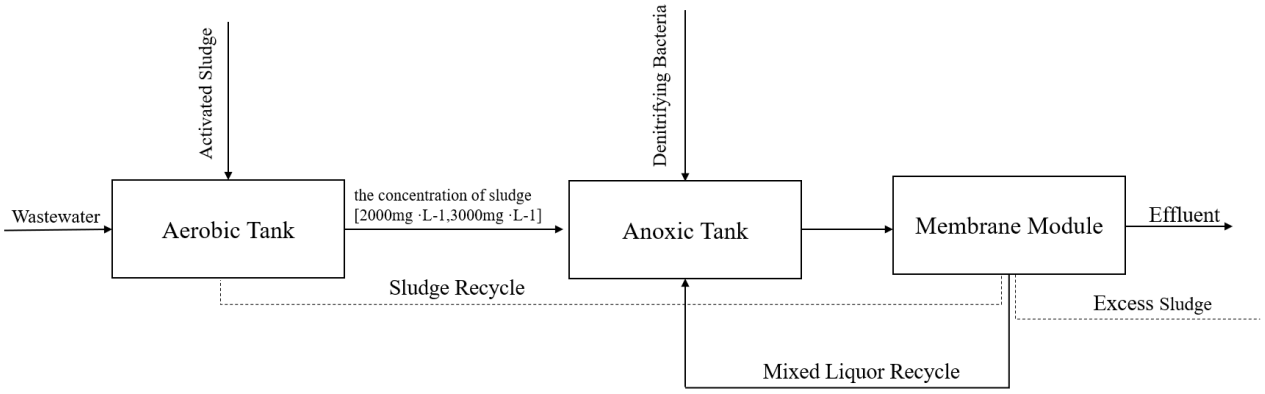

Figure 3