(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
5 February 2009 (05.02.2009)

PCT

(10) International Publication Number
WO 2009/017306 A2

(51) International Patent Classification:
C02F 3/30 (2006.01)

(21) International Application Number:
PCT/KR2008/003709

(22) International Filing Date: 26 June 2008 (26.06.2008)

(25) Filing Language: Korean

(26) Publication Language: English

(30) Priority Data:
10-2007-0062816 26 June 2007 (26.06.2007) KR

(71) Applicant and
(72) Inventor: **YOUN, Gil-Won** [KR/KR]; Suit302, 3Fl., Mi-jutown, 216-1, Pungnap-dong, Songpa-gu, Seoul 138-877 (KR).

(74) Agent: **KIM, Jong-Su**; 10Fl., Yeosam Bldg., 648-23, Yeoksam-dong, Gangnam-gu, Seoul 135-748 (KR).

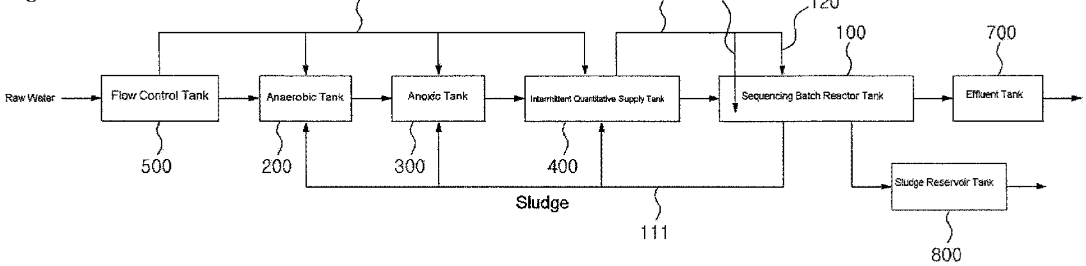
(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *without international search report and to be republished upon receipt of that report*

(54) **Title:** ADVANCED WATER RECLAMATION METHOD AND SYSTEM THEREOF

Figure 3



(57) **Abstract:** The present invention relates to an advanced water reclamation apparatus and method suitable for treatment of sewage and wastewater. The apparatus includes a flow control tank and a sequencing batch reactor tank isolated from the flow control tank and conducting aeration, settling and discharge processes to purify the influent water. The apparatus includes anaerobic, anoxic and intermittent quantitative supply tanks disposed between the flow control tank and the sequencing batch reactor tank; overflow pipes; a raw water supply unit including a raw water pump and a raw water transfer pipe; an influent water supply unit including an influent water pump and an influent water supply pipe; a sludge- returning unit including a sludge pump and a returning pipe; and a controller electrically connected to the pumps of the raw water supply unit, the influent water supply unit and the sludge-returning unit.

WO 2009/017306 A2

【DESCRIPTION】

【Invention Title】

ADVANCED WATER RECLAMATION METHOD AND SYSTEM THEREOF

【Technical Field】

The present invention relates to an apparatus and a method for highly processing sewage and wastewater, and, more particularly, to an advanced water reclamation apparatus and method suitable for thorough processing sewage and wastewater into reclamation water (intermediate water), and which is adapted to maximize the capability to remove nutrient salts such as organic contaminants, nitrogen (N) and phosphorus (P) contained in influent sewage and wastewater by improving the ability to cope with variations in flow rate, contamination concentration and temperature of the influent sewage and wastewater, thus maintaining the quality of treated water at a constant level, regardless of variations in the external environment.

【Background Art】

Generally, effluent treatment facilities employ an activated sludge process of biologically removing contaminants using microorganisms. Conventional activated sludge processes could obtain stable processing results in the treatment of organic contaminants but could not obtain the desired results the removal efficiency in regards to nutrient salts such as nitrogen (N) and phosphorous (P). Accordingly, a variety of advanced biological processes have been developed in order to improve the removal efficiency of nutrient salts as well as that of organic contaminant.

Among the variety of advanced biological processes, an A^2/O (Anaerobic/Anoxic/Aerobic) process and a sequencing batch reactor tank (SBR) process aim to improve the removal efficiency of nutrient salts such as organic contaminants, nitrogen (N) and phosphorous (P) by operating an anaerobic stage (tank), an anoxic stage (tank) and an aerobic stage (tank) as biological reactors. The A^2/O process is configured such that a biological reactor is partitioned off by partition walls into a plurality of biological reactors, which serve as an anaerobic tank, an anoxic tank and an aerobic tank, respectively. Meanwhile, the SBR process is configured such that one biological reactor is sequentially operated over time under different operating conditions, i.e., an anaerobic condition, an anoxic condition and an aerobic condition.

FIG. 1 is a process chart showing a conventional A^2/O type sewage treatment plant. As shown in the drawing, the A^2/O type sewage treatment plant comprises an anaerobic tank 20, an anoxic tank 30 and an aerobic tank 10 which are spatially isolated from each other by partition walls. The influent water, which is discharged from the aerobic tank 10, is introduced into a settling tank 40 in which extraneous substances contained in the influent water become settled out and then the influent water is discharged.

At this point, sludge generated in the settling tank 40 is again introduced into the anaerobic tank 20 and is subjected to a retreating process. Furthermore, in order to improve the removal efficiency of nitrogen, ammonium-nitrogen is converted into nitrate-nitrogen in the aerobic tank 10, and is then returned to the anoxic tank 30 using an internal return pump. The A^2/O type sewage treatment plant has disadvantages in that the biological reactors are spatially isolated from each other and that an additional settling tank is required.

FIG. 2 is a schematic view showing a conventional sequencing batch reactor tank (SBR) type sewage treatment plant. As shown in the drawing, the SBR type sewage treatment plant comprises one biological reactor 80. The biological reactor 80 is sequentially changed over time into an anaerobic condition, an anoxic condition and an aerobic condition. Accordingly, the sequencing batch reactor tank type sewage treatment plant has advantages in that it requires a smaller plant site area than that of the A^2/O type sewage treatment plant and it does not require any internal returning operation, thus obviating return pumps and return lines and simplifying the structure thereof.

Generally, the sewage treatment process using the sequencing batch reactor tank is configured such that a single biological reactor sequentially conducts an aeration process, a settling process and a discharge process over time and thus nitrification and denitrification reactions are repeatedly conducted in the single reactor. For example, the sewage treatment process is configured such that the nitrification occurs in the aeration process and the denitrification occurs in the settling process.

Since the SBR process is conducted such that one biological reactor is sequentially operated in an aerobic condition, anaerobic condition and an anoxic condition with the passage of time, the reactor must be maintained for a predetermined period of time in each of the process states in order create pure aerobic, anaerobic and anoxic conditions.

More specifically, in order to get desired water quality using the SBR process, the biological reactor must be maintained for the period of time required by each of the processes. Consequently, in order to maintain the period of time required by each of the processes, an amount of raw water, which is introduced into the biological reactor, must always be constant. However, because the amount of raw water, introduced from the outside, is actually not constant, the reaction time in each of the processes may become too short or long depending on an amount of influent raw water, thus making the production of desired water quality impossible.

In addition, such a problem may become more severe in the cases where there is variation in a contamination concentration of raw water itself or in the temperature of outside air. For example, when the contamination concentration of raw water is increased or the temperature of outside air is decreased, the period of time required for each of the processes is extended. In contrast, when the contamination concentration of raw water is decreased or the temperature of outside air is increased, the period of time required for each the processes is shortened. Accordingly, an amount of influent raw water, which is supplied to the biological reactor, must be controlled depending on such conditions, but conventional sewage treatment plants do not have the ability to control an amount of influent raw water.

In a conventional SBR process, when a flow rate or a load of raw water is temporarily increased, a period of time required for the nitrification reaction and the denitrification reaction is not sufficient, thus causing insufficient treatment of nitrogen. In this case, a dephosphorization must be conducted after a nitrification is conducted for a sufficient period of time. At this time, when the anoxic condition required for the denitrification reaction is immediately converted into the anaerobic condition and thus the denitrification is drastically decreased, an excessive intake rate of phosphorous under the subsequent aerobic condition is also drastically decreased, thus decreasing an elimination efficiency of phosphorous. In contrast, when a condition in which both of a flow rate and a load are decreased is maintained during a predetermined period of time, the supply of substrate is not sufficient and thus decomposition of microorganisms occur. As a result, the advanced process cannot be realized, the treatment of organic substances is also difficult, and eventually secondary contamination occurs. Consequently, there is no alternative but to renovate activity of microorganisms by again conducting a test operation of the sewage treatment plant.

As described above, in the conventional SBR process, because sewage and wastewater continuously flow into a biological reactor and there is no way to control the continuous inflow, the internal condition of the biological reactor changes into an aerobic condition, an anaerobic condition or an anoxic condition depending on inflow rate and water quality load of raw water and a temperature of outside air. For this reason, it is difficult to maintain pure aerobic, anaerobic and anoxic conditions required for the respective processes, by reason of responses being made to operations of the corresponding processes. Accordingly, although the conventional SBR process may be realizable in theory, the present technology does not allow the stable treatment of water to be achieved depending on inflow rate and water quality load of raw water and a temperature of outside air.

The present inventor has developed the present invention from field experience obtained over several years. The present invention provides an advanced biological water reclamation method and apparatus which is capable of drastically improving removal efficiency of organic contaminants and nutrient salts, by utilizing the advantages of the conventional sequencing batch reactor tank (SBR) process and a contact oxidation process while eliminating the disadvantages thereof.

【Disclosure】

【Technical Problem】

Accordingly, the present invention has been made keeping in mind the above problems occurring in the related art, and a primary object of the present invention is to provide an advanced water reclamation method and apparatus suitable for the treatment of sewage and wastewater, in which a conventional sequencing batch reactor (SBR) process and A^2/O process are combined into one, an anaerobic tank and anoxic tank are disposed between a flow control tank and a sequencing batch reactor tank to be spatially separated from each other so that a treatment of organic substances, which has not been satisfied by a single existing sequencing batch reactor tank, can be more reliably conducted, and denitrification and dephosphorization can be completely achieved using the anaerobic tank and the anoxic tank which are spatially separated from each other, thus improving a treatment efficiency of nutrient salts such as nitrogen (N) and phosphorous (P).

In addition, another object of the present invention is to provide an advanced water reclamation method and apparatus which is capable of improving a treatment efficiency of organic substances and nutrient salts by providing an anaerobic tank and an anoxic tank, spatially separated from each other, between a flow control tank and a sequencing batch reactor tank, and which is capable of reliably treating raw water, regardless of a flow rate of raw water, water quality load and outside air temperature, by providing an intermittent quantitative supply tank between the anoxic tank and the sequencing batch reactor tank in order to solve problems occurring in the conventional process of continuously introducing raw water.

Furthermore, a still another object of the present invention is to provide an advanced water reclamation method and apparatus suitable for the treatment of sewage and wastewater, which includes a sequencing batch reactor tank having a non-powered driving function, in which the sequencing batch reactor tank is configured such that a part of the influent water supplied from a intermittent quantitative supply tank provided at an upstream end of the sequencing batch reactor tank is distributed and supplied to a water surface in the sequencing batch reactor tank, and the remaining part of the influent water is supplied to the bottom surface of the sequencing batch reactor tank, thus efficiently agitating influent water without requiring a supply of additional power.

Furthermore, another object of the present invention is to provide an advanced water reclamation method and apparatus suitable for the treatment of sewage and wastewater, which includes a sequencing batch reactor tank having an influent water stable contact chamber, in which a part of influent water supplied from an intermittent quantitative supply tank is supplied to the bottom surface of a sequencing batch reactor tank, the sequencing batch reactor tank being provided therein with an influent water stable contact chamber which is separated from the sequencing batch reactor tank by a partition wall and is filled with filtering material (medium), and raw water is supplied through the influent water stable contact chamber, thereby efficiently treating organic substances and nutrient salts having either a high or low concentration (a high flow load or low flow load) using biofilm attached to the medium, with the result that sewage and wastewater are reliably treated, regardless of a flow rate of raw water, water quality load and outside air temperature.

In addition, a further object of the present invention is to provide an advanced water reclamation method and apparatus suitable for the treatment of sewage and wastewater, which is configured such that continuous introduction and treatment are conducted in a case of high load and raw water is intermittently introduced in a predetermined amount and then treated to ensure stable and quality processing, in order to efficiently deal with variance in flow rate, and which is devised to maximize a treatment efficiency and to improve maintenability of equipment by switching operating cycles depending on variance in flow load.

【Technical Solution】

In order to accomplish the above objects, the present invention provides an advanced water reclamation apparatus suitable for treatment of sewage and wastewater including a flow control tank for reserving raw water introduced thereinto and discharging a required amount of raw water, and a sequencing batch reactor tank spatially isolated from the flow control tank and repeatedly conducting aeration, settling and discharge processes to purify nutrient salts, including organic substances, nitrogen (N) and phosphorous (P), contained in the introduced influent water and to discharge supernatant water, the apparatus including:

anaerobic, anoxic and intermittent quantitative supply tanks disposed between the flow control tank and the sequencing batch reactor tank to be spatially isolated therefrom; overflow pipes to allow the influent water to be flowed into the sequencing batch reactor tank through the flow control tank, the anaerobic tank, the anoxic tank and the intermittent quantitative supply tank; a raw water supply unit including a raw water pump and a raw water transfer pipe to distribute and supply the raw water reserved in the flow control tank to the anaerobic tank, the anoxic tank and the intermittent quantitative supply tank; an influent water supply unit including an influent water pump and an influent water supply pipe to supply the influent water reserved in the intermittent quantitative supply tank to the sequencing batch reactor tank; a sludge-returning unit including a sludge pump and a returning pipe to return sludge settled in the sequencing batch reactor tank to the anaerobic tank, the anoxic tank and the intermittent quantitative supply tank; and a controller electrically connected to the pumps of the raw water supply unit, the influent water supply unit and the sludge-returning unit, nilometers of the flow control tank, the anaerobic tank, the anoxic tank, the intermittent quantitative supply tank and the sequencing batch reactor tank, and a diffuser unit, a decanter and various control valves in the sequencing batch reactor tank, to control flows of raw water, influent water, sludge and treated water.

In the advanced water reclamation apparatus, the influent water supply unit may include an upper influent water supply unit for distributing and supplying a part of influent water reserved in the intermittent quantitative supply tank to a surface of water in the sequencing batch reactor tank, and a lower influent water supply unit for distributing and supplying another part of the influent water to a bottom of the sequencing batch reactor tank.

The upper influent water supply unit may include an upper supply pipe communicating with the influent pump disposed in the intermittent quantitative supply tank and having an end positioned over a water surface of the sequencing batch reactor tank, and an upper dispersion plate having a predetermined size for distributing and supplying influent water supplied through the upper supply pipe to a water surface of the sequencing batch reactor tank; and the lower influent water supply unit may include an influent water stable contact chamber vertically disposed in the sequencing batch reactor tank and having a lower end spaced apart from a bottom surface thereof by a predetermined distance and an upper end protruding from a water surface located at a maximum level, a lower supply pipe communicating with the influent water pump disposed in the intermittent quantitative supply tank and having an end positioned over a water surface in the influent water stable contact chamber, and a lower dispersion plate having a predetermined size for distributing and supplying influent water supplied through the lower supply pipe to a water surface of the influent water stable contact chamber.

In the advanced water reclamation apparatus, the overflow pipe associated with the intermittent quantitative supply tank may allow influent water overflowing from the intermittent quantitative supply tank to flow into the influent water stable contact chamber.

In the advanced water reclamation apparatus, the influent water stable contact chamber may be filled with contact filtration material (medium) for creating biofilm.

In another aspect, the present invention provides an advanced water reclamation apparatus suitable for treatment of sewage and wastewater including a sequencing batch reactor tank serving as a biological reactor tank which repeatedly conducts aeration, settling and discharge processes separated from each other in terms of time, so as to purify nutrient salts including organic substances, nitrogen (N) and phosphorous (P) contained in influent water and to discharge supernatant water, and including an intermittent quantitative supply tank wherein the sequencing batch reactor tank comprises an upper influent water supply unit for distributing and supplying a part of influent water to a water surface in the sequencing batch reactor tank, and a lower influent water supply unit for distributing and supplying another part of the influent water to a bottom surface of the sequencing batch reactor tank.

In an embodiment, the upper influent water supply unit may include an upper supply pipe communicating with the influent pump disposed in the intermittent quantitative supply tank and having an end positioned over a water surface of the sequencing batch reactor tank, and an upper dispersion plate having a predetermined size for distributing and supplying influent water supplied through the upper supply pipe to a water surface of the sequencing batch reactor tank; and the lower influent water supply unit may include an influent water stable contact chamber vertically disposed in the sequencing batch reactor tank and having a lower end spaced apart from a bottom surface thereof by a predetermined distance and an upper end protruding from a water surface located at a maximum level, a lower supply pipe communicating with the influent water pump disposed in the intermittent quantitative supply tank and having an end positioned over a water surface in the influent water stable contact chamber, and a lower dispersion plate having a predetermined size for distributing and supplying influent water supplied through the lower supply pipe to a water surface of the influent water stable contact chamber.

In the advanced water reclamation apparatus, the influent water stable contact chamber may be filled with contact filtration material (medium) for creating biofilm.

In the advanced water reclamation apparatus, the intermittent quantitative supply tank may include an overflow pipe to allow influent water overflowing from the intermittent quantitative supply tank to flow into the influent water stable contact chamber.

The apparatus may include a flow control tank, an anaerobic tank, a anoxic tank and the intermittent quantitative supply tank which are spatially isolated from the sequencing batch reactor tank, and the apparatus may include a sludge-returning unit including a sludge pump and a returning pipe to return sludge settled in the sequencing batch reactor tank to the anaerobic tank, the anoxic tank and the intermittent quantitative supply tank.

The apparatus may include overflow pipes provided on partition walls disposed between the flow control tank, the anaerobic tank, the anoxic tank and the intermittent quantitative supply tank so as to allow overflow water to naturally flow between the respective tanks.

The apparatus may include a raw water supply unit including a raw water pump and a raw water transfer pipe which are configured to distribute and supply raw water reserved in the flow control tank to the anaerobic tank, and the anoxic tank and the intermittent quantitative supply tank.

The apparatus may include a controller for controlling flow of influent water supplied through the upper influent water supply unit and the lower influent water supply unit.

In a further aspect, the present invention provides an advanced water reclamation method suitable for treatment of sewage and wastewater comprising separating a sequencing batch reactor tank in terms of time, repeatedly conducting aeration, settling and discharge processes to treat water and to discharge supernatant water, and intermittently supplying a predetermined amount of influent water through a intermittent quantitative supply tank provided on an end of the sequencing batch reactor tank, wherein a part of influent water reserved in the intermittent quantitative supply tank is distributed and supplied to a water surface in the sequencing batch reactor tank, and another part of the influent water reserved in the intermittent quantitative supply tank is distributed and supplied to a bottom surface of the sequencing batch reactor tank, thus agitating water in the sequencing batch reactor tank without requiring supply of additional power.

In an embodiment, in the aeration process, the part of the influent water reserved in the intermittent quantitative supply tank is distributed and supplied to a water surface in the sequencing batch reactor tank and the another part of the influent water reserved in the intermittent quantitative supply tank is distributed and supplied to a bottom surface of the sequencing batch reactor tank, thus agitating water in the sequencing batch reactor tank, and, in the settling and discharge processes, the influent water is distributed and supplied only to the bottom surface of the sequencing batch reactor tank and thus floating of sediment or eddying flow does not occur, thus allowing continuous introduction thereof.

In the advanced water reclamation method, when water in the intermittent quantitative supply tank is at a maximum level, water overflowing from the intermittent quantitative supply tank is distributed and supplied to the bottom surface of the sequencing batch reactor tank and thus floating of sediment or eddying flow does not occur, thus allowing continuous introduction thereof.

The advanced water reclamation method may include: preparing a flow control tank for reserving raw water disposed at an upstream end of the intermittent quantitative supply tank to reserve raw water therein and to discharge a predetermined amount of raw water, an anaerobic tank for receiving raw water from the flow control tank and for allowing dephosphorization therein, and an anoxic tank for receiving the dephosphorized influent water from the anaerobic tank and for allowing denitrification, all of which are spatially separated from each other; distributing and supplying raw water reserved in the flow control tank to the anaerobic tank, the anoxic tank and the intermittent quantitative supply tank; returning sludge settled in the sequencing batch reactor tank to the anaerobic tank, the anoxic tank and the intermittent quantitative supply tank; and causing water overflowing through overflow pipes of to the anaerobic tank, the anoxic tank and the intermittent quantitative supply tank to flow into the sequencing batch reactor tank.

As described above, the advanced water reclamation method and apparatus according to the present invention can more completely achieve denitrification and dephosphorization, which could not be sufficiently achieved, by providing the anaerobic tank, the anoxic tank and the intermittent quantitative supply tank between the flow control tank and the sequencing batch reactor tank, and can intermittently introduce a predetermined amount of influent water into the sequencing batch reactor tank, regardless of variance in flow load of raw water, thus allowing stable operation of equipment depending on variance in flow load and also efficiently eliminating contaminated material such as organic substances, nitrogen and phosphorous.

In addition, the advanced water reclamation method and apparatus according to the present invention is configured such that a part of the influent water introduced into the sequencing batch reactor tank from the intermittent quantitative supply tank is distributed and supplied to a water surface in the sequencing batch reactor tank and a part of the influent water is distributed and supplied to a bottom surface of the sequencing batch reactor tank, thus efficiently agitating influent water in the sequencing batch reactor tank without supplying additional power.

【Advantageous Effects】

As described above, in the advanced water reclamation method and apparatus suitable for the treatment of sewage and wastewater, according to the present invention, a conventional sequencing batch reactor (SBR) process and A^2/O process are combined into one, an anaerobic tank and anoxic tank are disposed between a flow control tank and a sequencing batch reactor tank to be spatially separated from each other so that treatment of organic substances, which has not been satisfied by a single existing sequencing batch reactor tank, can be more stably conducted, and denitrification and dephosphorization can be completely achieved using the anaerobic tank and the anoxic tank which are spatially separated from each other, thus improving treatment efficiency of nutrient salts such as nitrogen (N) and phosphorous (P).

In addition, the present invention is capable of improving treatment efficiency of organic substances and nutrient salts by providing an anaerobic tank and an anoxic tank, spatially separated from each other, between a flow control tank and a sequencing batch reactor tank, and is capable of reliably treating raw water, regardless of flow rate of raw water, water quality load and outside air temperature, by providing an intermittent quantitative supply tank between the anoxic tank and the sequencing batch reactor tank in order to solve problems occurring in the conventional process of the continuous introduction of raw water.

Furthermore, the present invention can provide a sequencing batch reactor tank having a non-powered driving function, in which the sequencing batch reactor tank is configured such that a part of influent water supplied from an intermittent quantitative supply tank provided at an upstream end of the sequencing batch reactor tank is distributed and supplied to a water surface in the sequencing batch reactor tank, and the remaining part of the influent water is supplied to the bottom surface of the sequencing batch reactor tank, thus efficiently agitating influent water without requiring additional power to be supplied.

Furthermore, the present invention is configured such that a part of the influent water supplied from an intermittent quantitative supply tank is supplied to the bottom surface of a sequencing batch reactor tank, the sequencing batch reactor tank being provided therein with an influent water stable contact chamber which is separated from the sequencing batch reactor tank by a partition wall and is filled with a filtering material (medium), and raw water is supplied through the influent water stable contact chamber, thereby efficiently treating organic substances and nutrient salts having either a high or low concentration (a high flow load or low flow load) by using biofilm attached to the medium, with the result that sewage and wastewater are stably treated, regardless of a flow rate of raw water, water quality load and outside air temperature.

In addition, the present invention is configured such that continuous introduction and treatment are conducted in the case of high load and raw water is intermittently introduced in a predetermined amount and then treated to ensure stable and quality processing, in order to efficiently deal with variance in flow rate, and which is devised to maximize treatment efficiency and to improve maintenability of equipment by switching operating cycles depending on variance in flow load.

【Description of Drawings】

FIG. 1 is a process chart showing a conventional A^2/O type sewage treatment plant;

FIG. 2 is a schematic view showing a conventional sequencing batch reactor tank (SBR) type sewage treatment plant;

FIG. 3 is a schematic process chart showing the advanced water reclamation apparatus suitable for the treatment of sewage and wastewater, according to an embodiment of the present invention;

FIG. 4 is a schematic view showing a sequencing batch reactor tank having a non-powered agitation function, according to an embodiment of the present invention;

*48FIG. 5 is a schematic view showing the advanced water reclamation apparatus suitable for the treatment of sewage and wastewater, according to the present invention;

FIG. 6 is a schematic plan view of the advanced water reclamation apparatus suitable for the treatment of sewage and wastewater, according to the embodiment of the present invention;

FIGS. 7 and 8 are partial perspective views showing examples of dispersion plates according to the present invention;

FIGS. 9 and 10 are a perspective view and a cross-sectional view showing a non-powered rotary sprinkler according to the present invention;

FIG. 11 is a flow chart showing a water treatment process of the sequencing batch reactor tank according to the present invention; and

FIG. 12 is a time chart showing time periods required for the respective processes in operation mode of the sequencing batch reactor tank according to the present invention.

【Best Mode】

Hereinafter, an advanced water reclamation method and apparatus suitable for the treatment of sewage and wastewater, according to a preferred embodiment of the present invention will be described in detail with reference to the accompanying drawings.

FIG. 3 is a schematic process chart showing the advanced water reclamation apparatus suitable for the treatment of sewage and wastewater, according to an embodiment of the present invention, and FIG. 4 is a schematic view showing a sequencing batch reactor tank having a non-powered agitation function, according to an embodiment of the present invention.

Referring to the drawings, the advanced water reclamation apparatus suitable for the treatment of sewage and wastewater according to the present invention (referred to as 뱋 sewage treatment apparatus according to the present invention?hereinafter) comprises a flow control tank 500, an anaerobic tank 200, an anoxic tank 300, an intermittent quantitative supply tank 400, a sequencing batch reactor tank 100 and an effluent tank 700, in order of the natural flow (overflow) of raw water.

The flow control tank 500 receives and reserves influent raw water, and then distributes the influent raw water to the anaerobic tank 200, the anoxic tank 300 and the intermittent quantitative supply tank 400.

The anaerobic tank 200 communicates with the sequencing batch reactor tank 100 so as to receive sludge returned from the sequencing batch reactor tank to the anaerobic tank 200, and the influent raw water is dephosphorized in the anaerobic tank 200.

The anoxic tank 300 communicates with the anaerobic tank 200 and the sequencing batch reactor tank 100 so as to receive the returned sludge and the dephosphorized raw water, and the returned sludge and the dephosphorized raw water are then denitrified in the anoxic tank 300.

The intermittent quantitative supply tank 400 communicates with the flow control tank 500 and the anoxic tank 300 so as to intermittently supply a predetermined amount of the influent raw water to the sequencing batch reactor tank 100.

The sequencing batch reactor tank 100, which communicates with the intermittent quantitative supply tank 400, repeatedly conducts a series of aeration, settling and discharge processes to execute biological treatment of nutrient salts such as organic substances, nitrogen (N) and phosphorous (P) contained in the influent water, and at the same time the sequencing batch reactor tank 100 returns the sludge to the anaerobic tank 200, the anoxic tank 300 and the intermittent quantitative supply tank 400 and discharges the supernatant water through the effluent tank 700.

As described above, the sewage treatment apparatus according to the present invention is configured such that the anaerobic tank 200, the anoxic tank 300 and the intermittent quantitative supply tank 400, which are spatially separated from each other, are sequentially disposed between the flow control tank 500 and the sequencing batch reactor tank 100.

Overflow pipes are connected between the flow control tank 500, the anaerobic tank 200, the anoxic tank 300, the intermittent quantitative supply tank 400 and the sequencing batch reactor tank 100, respectively, so that the influent water overflowing from each of the tanks naturally flows into the subsequent tank. In this embodiment, the overflow pipes are constructed through through-holes formed in partition walls between the respective tanks.

A raw water distributing and supplying unit is further connected between the flow control tank 500 and the anaerobic tank 200, the anoxic tank 300 and the intermittent quantitative supply tank 400 so as to distribute and supply the raw water reserved in the flow control tank 500 to the respective tanks. The raw water distributing and supplying unit is composed of transfer pipes connected to the respective tanks and a pump installed on the flow control tank 500.

An influent water supplying unit is connected between the intermittent quantitative supply tank 400 and the sequencing batch reactor tank 100 so as to intermittently supply a predetermined amount of the influent water reserved in the intermittent quantitative supply tank 400 to the sequencing batch reactor tank 100. The influent water supplying unit is composed of an influent water supply pipe connected to the sequencing batch reactor tank 100 and an influent water pump installed in the intermittent quantitative supply tank 400.

A sludge-returning unit is connected between the sequencing batch reactor tank 100 and the anaerobic tank 200, the anoxic tank 300 and the intermittent quantitative supply tank 400 so as to return surplus sludge settled in the sequencing batch reactor tank 100 to the respective tanks. The sludge-returning unit is composed of a return pipe connected to the sequencing batch reactor tank 100 and a sludge pump installed in the sequencing batch reactor tank 100.

The sewage treatment apparatus according to the present invention includes the sequencing batch reactor tank which is adapted to repeatedly conduct a series of aeration, settling and discharge processes in a single biological reactor so as to purify nutrient salts such as organic substances, nitrogen (N) and phosphorous (P) contained in the influent water and to discharge the supernatant water.

Referring to FIG. 2 showing a conventional sequencing batch reactor tank 80, the conventional sequencing batch reactor tank 80 comprises one biological reactor tank 81, an influent water pipe 82 connected to the biological reactor tank 81, a supernatant water discharge unit 85 disposed in the biological reactor tank 81, an agitation unit 86 for agitating the influent water in the biological reactor tank 81, and an aeration unit 84. The conventional sequencing batch reactor tank 80 controls flows of influent water and supernatant water in such a way as to control the opening of the influent water pipe 82 and the activation of the supernatant water discharge unit 85, and also controls the aerobic, anaerobic and anoxic conditions in such a way as to control the agitation unit 86 and the aeration unit 84.

In the conventional sequencing batch reactor tank 80, the influent water is supplied below the surface of water in the biological reactor tank 81 through the influent water pipe 82, and is then agitated using a propeller type agitating blade rotated by a motor. The agitation unit 86 is intended to create turbulent flow in the reactor tank to increase the possibility of contact between contaminant and microorganisms, and is also intended to maintain a constant concentration of oxygen to optimize activity of the microorganisms.

FIG. 4 shows the sequencing batch reactor tank 100 having a non-powered agitation function, which is applied to the sewage treatment apparatus according to the present invention. As shown in the drawing, the sequencing batch reactor tank 100 according to the present invention does not have an agitation unit rotated by a pump. In place of the agitation unit, the sequencing batch reactor tank includes a non-powered agitation unit which is adapted to agitate influent water without the supply of additional power in such a way that a part of the influent water is dispersed and supplied to the surface of water in the sequencing batch reactor tank 100 and the remaining part of the influent water is dispersed and supplied to the bottom of the sequencing batch reactor tank 100. As shown in the drawing, the non-powered agitation unit comprises an influent water pump (not shown) provided in the intermittent quantitative supply tank 400, an influent water supply pipe 405 for supplying influent water to the sequencing batch reactor tank 100, an upper influent water supply 120 for dispersing and supplying a part of the influent water, supplied through the influent water supply pipe 405, to the surface of water in the sequencing batch reactor tank 100, and a lower influent water supply 130 for dispersing and supplying a part of the influent water, supplied through the influent water supply pipe 405, to the bottom of water in the sequencing batch reactor tank 100.

First, the upper influent water supply 120 comprises an upper supply pipe 122 communicating with the influent water supply pipe 405 and disposed at its end over the surface of water in the sequencing batch reactor tank 100, and an upper dispersion plate 121 having a predetermined size for dispersing and supplying the influent water, supplied through the upper supply pipe 122, to the surface of water in the sequencing batch reactor tank 100. Preferably, the upper dispersion plate 121 includes a plurality of overflow notches 125 formed thereon.

The lower influent water supply 130, which is a cylindrical column or a square column vertically disposed in the sequencing batch reactor tank 100, comprises an influent water stable contact chamber 131, the upper end of which is spaced apart from the bottom of the sequencing batch reactor tank 100 and the lower end of which is disposed to protrude from the surface of water at the maximum level, a lower supply pipe 132 communicating with a three-way valve 133 mounted on the influent water supply pipe 405, and disposed at an end over the surface of water in the influent water stable contact chamber 131, and a lower dispersion plate 134 having a predetermined size for dispersing and supplying the influent water, supplied through the lower supply pipe 132, to the surface of water in the influent water stable contact chamber 131. Preferably, the lower dispersion plate 134 includes a plurality of overflow notches 135 formed thereon.

Consequently, the influent water, which is supplied over the surface of water through the upper influent water supply 120, is dispersed throughout a wide area of the surface of water. The influent water, which is dispersed onto the surface of water in the influent water stable contact chamber 131 through the lower influent water supply 130, flows toward the bottom along the enclosed influent water stable contact chamber 131 and thus becomes more stable. Then, the influent water comes into collision with the bottom surface of the sequencing batch reactor tank 100 and is then dispersed to the outside of the influent water stable contact chamber 131, thus forming an upward flow. A diffuser tube 141, which is disposed over the bottom of the sequencing batch reactor tank 100, functions to intensify the upward flow so as to promote the mixing with the downward flow and to cause a convection phenomenon, thus mixing the upward flow with the downward flow.

As seen from the above, the sequencing batch reactor tank according to the present invention has an excellent agitation effect even without using additional power. In addition, since the influent water, which is supplied through the influent water stable contact chamber 131, is widely dispersed throughout the bottom of the sequencing batch reactor tank 100, there is almost no eddying flow and flow velocity and there is no occurrence of local deflection of the influent water. Furthermore, since the influent water is supplied in wide and uniform manner, it has an advantageous affect on the activity of microorganisms.

Hereinafter, the preferred embodiment of the present invention is described in greater detail with reference to FIGS. 5 and 6. FIG. 5 is a schematic view showing the advanced water reclamation apparatus suitable for the treatment of sewage and wastewater, according to the present invention, and FIG. 6 is a schematic plan view of the advanced water reclamation apparatus suitable for the treatment of sewage and wastewater, according to the embodiment of the present invention.

As shown in the drawings, the advanced water reclamation apparatus suitable for treatment of sewage and wastewater, according to the present invention (referred to as 뗑 sewage treatment apparatus according to the present invention? hereinafter) comprises the sequencing batch reactor tank which is adapted to repeatedly conduct a series of aeration, anaerobic and anoxic processes so as to eliminate nutrient salts such as nitrogen and phosphorous and organic substances through nitrification, denitrification and excessive intake of phosphorous, and then to discharge supernatant water to the outside; the anaerobic tank 200 communicating with the sequencing batch reactor tank 100 to receive sludge returned from the sequencing batch reactor tank 100 and to allow the dephosphorization to occur therein; the anoxic tank 300 communicating with the sequencing batch reactor tank 100 and the anaerobic tank 200 to receive the returned sludge and the dephosphorized influent water therefrom and to allow the dephosphorization to occur therein; the intermittent quantitative supply tank 400 communicating with the anoxic tank 300 to intermittently supply a predetermined amount of the raw water to the sequencing batch reactor tank 100; the flow control tank 500 which receives and maintains a reserve of the raw water therein and distributes the raw water to the anaerobic tank 200, the anoxic tank 300 and the intermittent quantitative supply tank 400; the effluent tank 700 for sterilizing and discharging the supernatant water discharged from the sequencing batch reactor tank 100; and a sludge reservoir tank 800 communicating with the sequencing batch reactor tank 100 to collect and treat the returned sludge from the sequencing batch reactor tank 100.

In addition to these components, the sewage treatment apparatus according to the present invention further includes a controller 900 which controls an operation mode of the sequencing batch reactor tank 100 and controls the raw water, the influent water and the sludge in the respective tanks according to the operation mode. *In this regard, the terms 뱟aw water?is defined as polluted water which* is first introduced into the flow control tank, and the terms 삥nfluent water?is defined as polluted water which is treated in the respective tanks and is then introduced into the subsequent tanks. The controller 900 incorporates therein various operation modes that are programmed according to the variances of loads such as a flow rate, a contamination concentration of influent raw water and weather. Construction and effects of the controller 900 will be described in detail below.

First, sewage, polluted water and wastewater, such as livestock wastewater, industrial wastewater and waste leachate, are introduced into the flow control tank 500 through a raw water inflow pipe 501 formed in a side wall thereof. The flow control tank 500 includes a nilometer 502 for detecting a level of water reserved therein and a raw water pump 503.

The flow control tank 500 communicates with the anaerobic tank 200, the anoxic tank 300 and the intermittent quantitative supply tank 400 via a raw water transfer pipe 510 connected to the raw water pump 503, and the raw water transfer pipe 510 is provided with valves 511, 512 and 513, which are associated with the anaerobic tank 200, the anoxic tank 300 and the intermittent quantitative supply tank 400, respectively. The raw water reserved in the flow control tank 500 is intermittently supplied to the anaerobic tank 200, the anoxic tank 300 and the intermittent quantitative supply tank 400 in response to the signal from the nilometer 502 or the control action from the controller 900. As described above, since the raw water, which is introduced into the flow control tank 550, is distributed and supplied to the respective tanks, it is possible to respond to variances of flow rate of the raw water and to provide the anaerobic tank 200 and the anoxic tank 300 with substrate material required for the growth of microorganisms.

Connected between the flow control tank 500, the anaerobic tank 200, the anoxic tank 300, the intermittent quantitative supply tank 400 and the sequencing batch reactor tank 10 are overflow pipes 201, 301, 401 and 406 which permit influent water overflowing from the upstream tanks to naturally flow downstream. The overflow pipes 201, 301, 401 and 406 are adapted to operate without the supply of power at the time the flow overloads such that, when a water level of each of the respective tanks exceeds a predetermined level, the influent water naturally overflows into the subsequent tank.

The overflow pipe 406, which is connected between the intermittent quantitative supply tank 400 and the sequencing batch reactor 100, is disposed at an end thereof in the influent water stable contact chamber 131, which is described later, so that the influent water overflowing from the intermittent quantitative supply tank 400 is distributed and supplied to the bottom of the sequencing batch reactor tank 100. In this way, the influent water is introduced into the sequencing batch reactor tank 100 in the state of being stabilized in flow through the passage through the influent water stable contact chamber 131, so that the anoxic and anaerobic conditions of the sequencing batch reactor tank

100 can be maintained even in the case of overload of flow.

The anaerobic tank 200, which is intended to mix the sludge returned from the sequencing batch reactor tank 100 with the raw water introduced from the flow control tank 500 and to treat the mixture, communicates with the flow control tank 500 via the overflow pipe 201 installed on a side wall and the raw water transfer pipe 510 so as to receive the raw water, and receives sludge from the sequencing batch reactor tank 100 via a sludge-returning pipe, which is described later. The anaerobic tank 200 is further provided therein with an agitator 202 to agitate the returned sludge and the raw water introduced through the overflow pipe 201 and the transfer pipe 510. Accordingly, the anaerobic tank 200 agitates the sludge supplied from the sequencing batch reactor tank 100 and the raw water supplied from the flow control tank 500 to cause the dephosphorization.

The anoxic tank 300 communicates with the anaerobic tank 200 through the overflow pipe 301 installed on a side wall and includes an agitator 302 installed at a lower position therein. The anoxic tank 300 is provided thereunder with a sludge-retuning pipe 111, which is described later, so as to receive the sludge returned from the sequencing batch reactor tank 100. The anoxic tank 300 is supplied with an external carbon source (substrate) from the raw water introduced from the flow control tank 500.

Consequently, in the anoxic tank 300, the dephosphorized influent water overflowed from the anaerobic tank 200 and the sludge returned from the sequencing batch reactor tank 100 are agitated, thus causing the denitrification, and the denitrification is promoted with the aid of the external carbon source supplied from the outside.

The intermittent quantitative supply tank 400 communicates with the anoxic tank 300 via the overflow pipe 401 installed on a side wall thereof, and communicates at the bottom with the sequencing batch reactor tank 100 via the sludge-returning pipe 111, which is described later. The intermittent quantitative supply tank 400 directly receives the raw water from the flow control tank 500 through the transfer pipe 510.

Furthermore, the intermittent quantitative supply tank 400 includes a nilometer 402 for detecting a level of water therein, an influent water pump 403 and an agitator 404 therein. The influent water pump 403 is connected to the sequencing batch reactor tank 100 via the influent water supply pipe 405 to supply the influent water.

The intermittent quantitative supply tank 400 functions to agitate the influent water overflowed from the anoxic tank 300, the sludge returned from the sequencing batch reactor tank 100 and the raw water introduced from the flow control tank 500, thus homogenizing the water quality, and functions to supply a predetermined amount of the influent water in response to a control signal from the controller 900.

Since the sewage treatment apparatus according to the present invention includes the intermittent quantitative supply tank 400, which is provided at the front end of the sequencing batch reactor tank 100 to store and intermittently supply the influent water which is homogenized into a predetermined concentration, the sewage treatment apparatus is capable of actively controlling the influent water supplied to the sequencing batch reactor tank 100, regardless of variances of flow rate and contamination concentration of influent raw water and a temperature of outside air, and is capable of controlling flow of the influent water in response to a reaction mode of the sequencing batch reactor tank 100.

Meanwhile, the sequencing batch reactor tank 100 according to the present invention is one biological reactor tank, which is configured to separately operate under aerobic, anaerobic and anoxic conditions over time and to repeatedly conduct the aeration, settling and discharge processes as one cycle.

To this end, the sequencing batch reactor tank 100 comprises a sludge-returning unit 110 which is installed under the sequencing batch reactor tank 100 to return settled sludge to the anaerobic tank 200, the anoxic tank 300, the intermittent quantitative supply tank 400 and the sludge reservoir tank 800; the upper influent water supply 120 for distributing a part of the influent water supplied from the intermittent quantitative supply tank 400 to the surface of water in the sequencing batch reactor tank 100; the lower influent water supply 130 for introducing a part of the influent water supplied from the intermittent quantitative supply tank 400 to the bottom of the sequencing batch reactor tank 100 in a spray manner; a diffuser unit 140 installed at a lower position in the sequencing batch reactor tank 100 to supply oxygen into the influent water in the sequencing batch reactor tank 100; and a decanter 150 installed in the sequencing batch reactor tank 100 to separate only supernatant water after the settling of sludge and to discharge the supernatant water to the outside.

As described above, the upper influent water supply 120 comprises the upper supply pipe 122 communicating with the influent water supply pipe 405 and disposed at its end over the surface of water in the sequencing batch reactor tank 100, and the upper dispersion plate 121 having a predetermined size for dispersing and supplying the influent water, supplied through the upper supply pipe 122, to the surface of the water in the sequencing batch reactor tank 100. The lower influent water supply 130 comprises the influent water stable contact chamber 131 which is vertically installed in the sequencing batch reactor tank 100, the lower supply pipe 132 communicating with the influent water supply pipe 405 and disposed at an end over the surface of water in the influent water stable contact chamber 131, and the lower dispersion plate 134 having a predetermined size for dispersing and supplying the influent water, supplied through the lower supply pipe 132, to the surface of water in the influent water stable contact chamber 131. Preferably, each of the upper and lower dispersion plates 121 and 134 includes the plurality of overflow notches 125 or 135 formed thereon.

Furthermore, the sequencing batch reactor tank 100 includes a nilometer 101 installed at a side position thereof, and a DO-meter for measuring a concentration of dissolved oxygen or an ORP-meter for measuring an oxidation-reduction potential installed therein. Accordingly, the controller 900 controls the sequencing batch reactor tank 100 to operate in a proper mode in response to the measurements of the meters.

The sludge-returning unit 110 comprises a sludge pump 112 installed on the bottom of the sequencing batch reactor tank 100, and the sludge-returning pipe 111 connected to the sludge pump 112 to return the sludge to the anaerobic tank 200, the anoxic tank 300, the intermittent quantitative supply tank 400 and the sludge reservoir tank 800.

The sludge-returning pipe 111, which is connected to the sludge pump 112, diverges into the anaerobic tank 200, the anoxic tank 300, the intermittent quantitative supply tank 400 and the sludge reservoir tank 800, and the branch pipes diverging from the sludge-returning pipe 111 are provided with valves 112, 113 and 114, respectively, to allow the sludge to be directed to a target tank.

The upper influent water supply 120 and the lower influent water supply 130 constitute a non-powered agitation unit which is capable of agitating influent water in the sequencing batch reactor tank 100 without using an additional power source. More specifically, the influent water, which is distributed toward the water surface by the upper influent water supply 120, falls down in the state of being widely distributed throughout the water surface, and the influent water, which is distributed toward the surface of water in the influent water stable contact chamber 131 by the lower influent water supply 130, flows toward the bottom along the enclosed influent water stable contact chamber 131 and becomes calm, after which the influent water comes into collision with the bottom, thus creating upward flow. Consequently, the influent water flowing down from the water surface and the influent water flowing upward from the bottom are distributed over the entire area and are mixed with each other, thus realizing the agitation without eddying flow. In addition, the diffuser tube 141, which is installed over the bottom of the sequencing batch reactor tank 100, is activated to generate air bubbles and thus to cause the upward flow, thus more promoting the agitation.

The upper and lower dispersion plates 121 and 134, intended to distribute the influent water, supplied from the intermittent quantitative supply tank 400, to the water surface, are disposed such that the upper dispersion plate 121 is disposed at an upper position in the sequencing batch reactor tank 100 and is horizontally oriented, and the lower dispersion plate 134 is disposed at an upper position in the influent water stable contact chamber 131 to be horizontally oriented.

As shown in FIGS. 7 and 8 which are partial perspective views, the upper dispersion plate 121, which is formed into a flat rectangular box shape which opens at the top and has a predetermined surface area, includes a plurality of overflow notches 125 formed on both side vertical walls so as to disperse the influent water on the water surface in a wide and uniform manner. Each of the plurality of overflow notches 125 may be formed into various shapes such as an arched cut and an angled cut, and is not restricted to any specified shape.

As shown in FIG. 8, a guide tube 126 may be provided at the outside of each of the plurality of overflow notches 125. The guide tube 126 is a cylindrical tube, which opens at the upper and lower ends, and is shaped such that the lower end of the guide tube 126 extends beyond the bottom of the dispersion plate 121 and the upper end thereof is obliquely cut to expose the overflow notch 125. Consequently, the influent water overflowed through the overflow notch 125 is discharged through the guide tube 126 provided at the outside of the overflow notch 125, thus realizing more secure dispersion. Since the raw water is evenly distributed on the water surface of the sequencing batch reactor tank 100 in the above-described manner, the sewage treatment apparatus can obtain the same agitating ability as that obtained using an additional agitator activated under separate power, and can also achieve savings in the costs required for purchasing an agitator along with electricity costs.

Referring again to FIG. 5, the influent water stable contact chamber 131, which is disposed in the sequencing batch reactor tank 100, is intended to more methodically introduce the raw water, supplied from the intermittent quantitative supply tank 400, to a lower position in the sequencing batch reactor tank 100. The influent water stable contact chamber 131, which is formed into a cylindrical column or a square column which is vertically positioned, is configured such that the upper end thereof is positioned over the surface of water at the maximum level and the lower end thereof extends to a lower position in the sequencing batch reactor tank 100 with a gap having a predetermined height being defined between the bottom of the sequencing batch reactor tank 100 and the lower end. To this end, the influent water stable contact chamber 131 is suspended from the top of the sequencing batch reactor tank 100, or is provided at the lower end with a plurality of openings.

In this embodiment, the influent water stable contact chamber 131 is configured to have an area which is 20% of the total area of the sequencing batch reactor tank 100, and is constructed in such a way as to provide an internal space defined by four separate panels assembled into a square column shape. The lower end of the influent water stable contact chamber 131 is spaced apart from the bottom surface of the sequencing batch reactor tank 100 by a height ranging from 30cm to 50cm, and is opened so as to allow influent water to be distributed over the entire area therethrough. Although the area of the influent water stable contact chamber 131 is illustrated as the most preferable example, it should not be understood to be limited to this example but may be modified to have various areas.

As described above, the influent water stable contact chamber 131 is provided at an upper position with the lower dispersion plate 134 to thus constitute the lower influent water supply 130, and the overflow pipe 406 is provided between the intermittent quantitative supply tank 400 and the influent water stable contact chamber 131 so as to allow the influent water in the intermittent quantitative supply tank 400 to be introduced into the influent water stable contact chamber 131 in the case of overload of flow.

The influent water stable contact chamber 131 according to the present invention has a structure which enables supply and agitation of the influent water and contact oxidation. To this end, the influent water stable contact chamber 131 is filled with contact filtration material 136 for creating biofilm. Preferably, the influent water stable contact chamber 131 is filled with the contact filtration material 136 at a filling rate of about 50%. The contact filtration material may be charged in any of the fixed-bed and fluidized-bed types, and the contact filtration material 136 may be embodied as any kind of contact filtration material as long as it ensures reliable functionality and efficiency. In this regard, since the influent water stable contact chamber 131 is filled with the contact filtration material 136, the sewage treatment apparatus according to the present invention can conduct the sewage treatment in a very invariable manner and can efficiently deal with the variation in temperature during the winter season, regardless of whether the influent water has a low concentration or a high concentration. Furthermore, since the contact oxidation by the contact filtration material 136 is additionally provided, it is excellent in the ability to deal with concentration load and flow load of raw water, particularly low flow load of raw water.

The diffuser unit 140 comprises the diffuser tube 141 disposed on the bottom of the sequencing batch reactor tank 100, and a blower 143 communicating with the diffuser tube 141 via an air supply pipe 132 to supply air. Preferably, the diffuser tube 141 is evenly distributed over the entire area of the sequencing batch reactor tank 100 including the area of the lower end of the influent water stable contact chamber 131.

The decanter 150, which is intended to collect supernatant water in a section to a depth of about 40cm from the water surface and then discharge the collected supernatant water during the discharge process after the settling process of the sequencing batch reactor tank 100, includes a discharge pipe 151 which is connected to a side surface thereof and extends to the outside of the sequencing batch reactor tank 100 in order to discharge the collected supernatant water. A supernatant water-discharging pump 152 is mounted on the discharge pipe 151 to pump out the collected supernatant water.

The decanter 150 is connected to a drive pump 154 disposed over the sequencing batch reactor tank 100 via a wire 152 so that the decanter 150 can be moved depending on the water level of water in the sequencing batch reactor tank 100. Accordingly, the controller 900 controls the drive pump 154 in response to a signal from the nilometer 101 in the sequencing batch reactor tank 100, so as to pull or release the wire 152 and thus to always maintain the decanter 150 at a level suitable for the collection of supernatant water.

In this embodiment, although the decanter 150 has been described and illustrated as being configured such that the supernatant water which is introduced into the decanter 150 is discharged by the activation of the discharge pump 152, the decanter 150 may be alternatively configured, that is, the end of the discharge pipe 151 may be positioned at a level higher than the decanter 150 so as to enable the supernatant water to be naturally discharged using the potential energy occurring therebetween. In this case, the decanter 150 may include an automatic valve unit. As long as the decanter 150 can selectively collect supernatant water positioned near the water surface, the decanter 150 is not restricted to any particular structure, and any of existing decanters may be applied to the present invention.

The effluent tank 700 includes an ultraviolet disinfection apparatus, and thus receives finally treated water which is disinfected by the ultraviolet disinfection apparatus. The effluent tank 700 discharges the treated water to the outside through an effluent pipe 701.

FIGS. 9 and 10 are a perspective view and a cross-sectional view showing a non-powered rotary sprinkler 600 which is a modification of the upper influent water supply 120 according to the present invention.

As shown in the drawings, the rotary sprinkler 600 comprises a rotating cylinder 610, a center shaft 620 vertically disposed at the center of the rotating cylinder 610, an influent water inflow pipe 630, a holder 640 for holding the upper end of the center shaft 620, and a plurality of holes 650 formed in the bottom and side surfaces of the rotating cylinder 610.

The rotating cylinder 610 comprises a cylindrical body 611 having a bottom surface and a predetermined size, and a plurality of rotating blades 612 disposed on the internal surface of the cylindrical body 611 and spaced apart from each other by predetermined intervals, in which each of the plurality of rotating blades 612 is bent to be inclined from the upper end to the lower end.

The center shaft 620, which is vertically disposed at the center of the rotating cylinder 610, includes a first bearing 621 disposed between the center shaft 620 and the rotating cylinder 610 to rotatably support the rotating cylinder 610, a support cap 623 disposed on the external bottom surface of the rotating cylinder 610 to fix the center shaft 620 and to support the rotating cylinder 610, and a second bearing 622 disposed between the rotating cylinder 610 and the support cap 623 to rotatably support the rotating cylinder 610.

The holder 640, which is provided on the upper end of the center shaft 620, enables the rotating cylinder 610 to be installed over the surface of water in the sequencing batch reactor tank 100.

The raw water inflow pipe 630 is positioned over the rotating cylinder 610 to be spaced apart therefrom, and the end of the raw water inflow pipe 630 is bent downwards from a position over the rotating cylinder 610 such that the end is positioned to be perpendicular to the front surface of the inclined rotating blade 610. The raw water inflow pipe 630 communicates with the intermittent quantitative supply tank 400.

The plurality of holes 650 is arranged along the diametrically opposite directions, and the number of the plurality of holes 650 is preferably set such that the amount of influent water introduced into the rotating cylinder 610 is balanced with the amount of water sprinkled through the holes to ensure smooth flow therethrough.

Consequently, as raw water introduced through the raw water inflow pipe 630 comes into collision with the front surfaces of the rotating blades 612, the rotating cylinder 610 is rotated by the impact pressure, and the introduced raw water in the rotating cylinder 610 is radially and widely distributed over the water surface through the plurality of holes 650 by the centrifugal force.

The non-powered rotary sprinkler 600, which is constructed in the above-described manner, is installed over the surface of water in the sequencing batch reactor tank 100 by the holder 640 supported on the sequencing batch reactor tank 100. Accordingly, the influent water introduced through the raw water inflow pipe 630 comes into collision with the front surface of the rotating blade 612 in the direction perpendicular to the front surface, thus rotating the rotating cylinder. The raw water in the rotating cylinder 610 is sprinkled over a wide area of the water surface of the sequencing batch reactor tank 100 through the plurality of holes 650 by the centrifugal force, and thus the raw water is quickly mixed with the influent water. In particular, since the non-powered rotary sprinkler 600 has excellent agitating capability even without using additional power, it is very advantageous to the activity of microorganisms in the sequencing batch reactor tank 100.

Hereinafter, an operation of the advanced water reclamation apparatus suitable for the treatment of sewage and wastewater, according to present invention is described.

Sewage, polluted water and wastewater, such as livestock wastewater, industrial wastewater and waste leachate, are introduced into the flow control tank 500 through a raw water inflow pipe 501, and are then reserved therein. When a level of the introduced water exceeds the maximum water level, the water overflows through the overflow pipes 201, 301, 401 and 406 installed on the respective partition walls, and is supplied into the sequencing batch reactor tank 100 through the anaerobic tank 200, anoxic tank 300 and the intermittent quantitative supply tank 400.

The raw water reserved in the flow control tank 500 is intermittently supplied into the anaerobic tank 200, the anoxic tank 300 or the intermittent quantitative supply tank 400 by the activation of one of the valves 511, 512 and 513 mounted on the influent water transfer 510 and the activation of the pump 503 in response to the control of the controller 900.

The controller 900 checks the reserved amount of the raw water in the flow control tank 500 by a detection signal from the nilometer 502 installed in the flow control tank 500, and determines the transfer amount of the raw water, thus controlling the amounts treated in the respective tanks at a constant level. In this embodiment, the controller 900 controls the valves such that about 40% of the total amount of water, which is supplied from the flow control tank 500 through the influent water inflow pipe 510, is supplied into the anaerobic tank 200 and about 30% thereof is supplied into each of the anoxic tank 300 and the intermittent quantitative supply tank 400. However, the ratio of supply amount may be varied depending on the conditions of the plant.

In the anaerobic tank 200, the raw water supplied from the flow control tank 500 and the sludge returned from the sequencing batch reactor tank 100 are agitated, thus promoting the dephosphorization. At this time, the raw water supplied from the flow control tank 500 serves as an external carbon source. The raw water, which has been dephosphorized in the anaerobic tank 200, flows into the anoxic tank 300 through the overflow pipe 301 installed on a side wall. In the anoxic tank 300, the influent water introduced from the anaerobic tank 200, the sludge returned from the sequencing batch reactor tank 100 and the raw water supplied from the flow control tank 500 are agitated, thus promoting the denitrification. At this time, the raw water supplied from the flow control tank 500 serves as an external carbon source, thus realizing more efficient treatment.

Subsequently, the raw water, which has been denitrified in the anoxic tank 300, flows into the intermittent quantitative supply tank 400 through the overflow pipe 401 installed on a side wall. In the intermittent quantitative supply tank 400, the influent water overflowed from the anoxic tank 300, the sludge returned from the sequencing batch reactor tank 100 and the raw water supplied from the flow control tank 500 are intermittently agitated, and are reserved therein for a predetermined period of time before being supplied to the sequencing batch reactor tank 100.

The raw water in the intermittent quantitative supply tank 400 is supplied into the sequencing batch reactor tank 100 by the pump 403 activated in response to the control of the controller 900. After the completion of the discharge process of the sequencing batch reactor tank 100, the influent water is supplied in an amount equal to the amount of the treated water discharged from the sequencing batch reactor tank 100.

In this regard, the amount of the influent water supplied from the intermittent quantitative supply tank 400 is set in response to the detection signal from the nilometer in the sequencing batch reactor tank 100. More specifically, when the level of water in the sequencing batch reactor tank 100 is lowered below a predetermined level due to a discharge process of the sequencing batch reactor tank 100, the pump 403 of the intermittent quantitative supply tank 400 is activated in response to the signal from the nilometer 402, thus supplying the influent water. When the level of water in the sequencing batch reactor tank 100 reaches to the predetermined level due to the supply of influent water from the intermittent quantitative supply tank 400, the pump 403 of the intermittent quantitative supply tank 400 is stopped in response to the signal from the nilometer 402. In this manner, the influent can be supplied into the sequencing batch reactor tank 100 in an amount suitable for the process.

The sequencing batch reactor tank 100 repeatedly performs a series of aeration, settling and discharge processes as one cycle, according to an operation mode set by the controller 900. During this operation, the influent water, which has been supplied into the sequencing batch reactor tank 100 from the intermittent quantitative supply tank 400, is subjected to anoxic, aerobic and anaerobic stages, and thus organic substances and nutrient salts are eliminated.

In the meantime, a conventional sequencing batch reactor tank has a limitation, in particular, as pertains to the control of phosphorous contained in sewage, polluted water and wastewater. The reason for this is because the shortening or extension of the anaerobic or anoxic condition makes efficient elimination of phosphorous impossible. In addition to the above, if raw water is continuously introduced in the case of an overload in amount of raw water, nitrogen and phosphorous components contained in sewage and wastewater introduced immediately after the discharge process are discharged together with treated water, thus deteriorating the quality of the treated water.

As described above, since the sewage and wastewater treatment apparatus according to the present invention includes the sequencing batch reactor tank 100 which is repeatedly operated in the anoxic, aerobic and anaerobic stages to eliminate nitrogen and phosphorous, and further includes the anaerobic tank 200 and the anoxic tank 300 which are spatially isolated from each other, nutrient salts such as nitrogen (N) and phosphorous (P), which could not be completely treated by a single sequencing batch reactor tank 100, can be more efficiently treated.

Referring to FIGS. 11 and 12, a water treatment process in the sequencing batch reactor tank 100 according to the present invention is now described. FIG. 11 is a flow chart showing a water treatment process of the sequencing batch reactor tank according to the present invention, and FIG. 12 is a time chart showing time periods required by the respective processes in operation modes of the sequencing batch reactor tank according to the present invention.

As shown in the drawings, the sequencing batch reactor tank 100 is repeatedly operated as one cycle of inflow and aeration, settling and discharge processes. The operation mode of the sequencing batch reactor tank 100 is divided into a high load mode, an intermediate load mode and a low load mode according to a load of introduced water. The separate operation modes are automatically changed over by the controller 900.

For example, the nilometers 402 and 502, which are installed in the intermittent quantitative supply tank 400 and the flow control tank 500, respectively, apply the corresponding level detection signals to the controller 900, and the controller 900, which has received the level information, controls the sludge pump 112, the blower 143, the raw water transfer pump 503, the influent water supply pump 403 and the like to switch the operation mode into an operation mode suitable for the water level.

Referring to FIG. 12, the controller 900 can select one of the high load operation mode, intermediate load operation mode and low load operation mode depending on a flow mode of sewage, polluted water and wastewater to be treated, and can operate the apparatus in the selected mode. Each of the operation modes is composed of three stages(aeration, settling and discharge processes) in one cycle, in which the high load operation mode requires three hours per single cycle and is thus conducted in an operation rate of 8 cycles/day, the intermediate load operation mode requires four hours per one cycle and is thus conducted in an operation rate of 6 cycles/day, and the low load operation mode requires 8 hours or 12 hours per one cycle and is thus conducted in an operation rate of 2 or 3 cycles/day. In an operation example below, the intermediate load operation mode, which requires four hours per single cycle, will be described as one example. The remaining operation modes other than the intermediate load operation mode are conducted in the same treatment processes with the exception of differences in the operating times of respective stages.

<Inflow and Aeration Process>

Typically, the inflow process is conducted in conjunction with the aeration process or as a part of the aeration process.

The inflow process is essentially achieved by the inflow action of influent water into the sequencing batch reactor tank 100 from the intermittent quantitative supply tank 400. More specifically, after the completion of discharge process but before the initiation of aeration process or concurrently with the initiation of aeration process, the supply of influent water from the intermittent quantitative supply tank 400 is initiated, in which the influent water is supplied in an amount equal to the amount of treated water discharged from the sequencing batch reactor tank 100.

The controller 900 receives a signal from the nilometer 101 installed in the sequencing batch reactor tank 100, and activates the raw water supply pump 403 in the intermittent quantitative supply tank 400. By the activation of the supply pump 403, the influent water in the intermittent quantitative supply tank 400 is supplied into the sequencing batch reactor tank 100 through the influent water supply pipe 405. The controller 900 continues the supply of the influent water in response to the signal from the nilometer 101 until raw water reaches to the predetermined level in the sequencing batch reactor tank 100. In this regard, the supply of the influent water is preferably controlled so as to be completed within a period of about 1 hour after the initiation of the aeration process.

The controller 900 switches over the operation mode depending on a level of the influent water reserved in the intermittent quantitative supply tank 400. For example, when the intermittent quantitative supply tank 400 contains no influent water to be supplied, the nilometer 402 installed in the intermittent quantitative supply tank 400 detects the lack of influent water and sends the detection signal to the controller 900, and the controller 900 switches the operation mode into the low load operation mode. In contrast, when the intermittent quantitative supply tank 400 is fully filled with the influent water, the controller 900 switches the operation mode into the high load operation mode.

In this case, since the controller 900 controls the influent water to be separated and supplied to an upper level and a lower level of the sequencing batch reactor tank 100, and thus the influent water is distributed over the entire area of the sequencing batch reactor tank 100, there is no need for installation of an additional agitator and it is possible to obtain an excellent agitating efficiency, compared to a conventional agitator. Furthermore, since the influent water is distributed without supplying power, the apparatus can be semi-permanently used and it is possible to obtain advantages of both maintenance and cost savings.

However, the supply of influent water to the upper level of the sequencing batch reactor tank 100 using the upper influent water supply 120 is conducted only in the inflow and aeration process but is stopped in the subsequent settling and discharge processes to be described later. In contrast, the supply of influent water to the lower level of the sequencing batch reactor tank 100 using the lower influent water supply 130 can also continue in the settling and discharge processes. In particular, when the level of water in the intermittent quantitative supply tank 400 reaches to the maximum level, the influent water is supplied using the lower influent water supply 130, thus minimizing discharge of untreated contaminant.

In other words, since the influent water supplied through the lower influent water supply 130 is distributed and supplied to the lower level of the sequencing batch reactor tank 100 through the influent water stable contact chamber 131, the eddying flow or floating of sediment due to the inflow of influent water is minimized even in the settling and discharge processes. Accordingly, since the present invention can supply influent water in the settling and discharge processes as well as in the aeration process, the continuous treatment can be conducted even in the case of overload of flow.

In addition, since the influent water, introduced through the lower influent water supply 130, passes through the contact filtration material 136 charged in the influent water stable contact chamber 131 and flows into the sequencing batch reactor tank 100, even though influent water having a relatively high contamination concentration is introduced through the overflow pipe 406 in the case of an overload of flow, a stable treatment can be achieved.

The inflow process of influent water continues until the influent water reaches the standard level in the sequencing batch reactor tank 100. When the nilometer 101 detects that the influent water has reached the standard level, the nilometer 101 sends the signal to the controller 900, and the controller 900 instructs the activation of the influent water transfer pump 403 to be stopped, and instructs the inflow process of influent water to be completed, followed by the aeration process.

Upon initiation of the aeration, the controller 900 activates the blower 143 installed in the sequencing batch reactor tank 100, and the blower 143 supplies air to the diffuser tube 141, installed at a lower level of the sequencing batch reactor tank 100, through the air supply pipe 132, thus initiating the aeration process due to air generated through the diffuser tube 141. Because the decanter 150 is positioned on the water level and is in the standby state when the aeration process is initiated, the supply of supernatant water is not conducted.

The aeration process is operated such that a concentration of dissolved oxygen is maintained within a range of 1 ?3ppm. More specifically, when the controller 900 receives a signal detected by the DO-meter or the ORP-meter 102 which is installed in the sequencing batch reactor tank 100, the controller 900 controls the blower 143 to maintain the proper concentration of dissolved oxygen. Preferably, the aeration process is executed for about 2 hours in the intermediate load operation mode. In the aeration process, BOD oxidation and nitrification and excess intake of phosphorous by microorganisms occur.

<Settling Process>

In the intermediated load operation mode, the settling process is conducted about 2 ?3 hours after the initiation of the operation. The settling process is started after the completion of the aeration process, and the time required by the settling process may vary depending on a selected mode.

When switching the aeration process into the settling process, the controller 900 turns off the blower 143 and activates the three-way valve 133 mounted on the influent water supply 405 so as to interrupt the supply of influent water through the upper supply pipe 122, thus preventing the introduction of influent water onto the surface of water in the sequencing batch reactor tank 100. Meanwhile, since the introduction of influent water through the lower supply pipe 132 does not cause floating of sediment or eddying flow, this introduction may continue if required.

When the aeration process ceases, sludge in the sequencing batch reactor tank 100 settles down due to the force of gravity. The settled sludge forms a sludge layer of a certain thickness on the bottom of the sequencing batch reactor tank 100. At this point, the sequencing batch reactor tank 100 is converted to the anaerobic and anoxic conditions to eliminate nitrogen and phosphorous.

Because the settled sludge contains excessively uptook phosphorous, the excessive sludge is transferred to the sludge reservoir tank 800 after a predetermined elapse of time of the settling process. The transfer time may be controlled as necessary. After an elapse of a predetermined time, determined by the instructions of the controller 900, the valve mounted on transfer line 111 connected to the sludge reservoir tank 800 is closed, and then the sludge is split and returned to the anaerobic tank 200, the anoxic tank 300 and the intermittent quantitative supply tank 400 until the aeration starts again. The takeout of sludge continues until the settling process is completed, and the returning of the sludge continues until the discharge process is completed. The sludge, which is taken out, is introduced into the sludge reservoir tank 800, and is dehydrated therein to eliminate phosphorous. By this dehydration, 90% or more of phosphorous contained in the sludge can be eliminated.

In the settling process, the sequencing batch reactor tank 100 serves as a typical settling tank and anoxic tank. Since the settling occurs after completion of the aeration, there is no need for an additional settling tank. Furthermore, by the anoxic tank which functions to discharge nitrogen using denitrifying microorganisms, 85% or more of nitrogen can be eliminated.

As described above, the sludge in the sequencing batch reactor tank 100 is returned to the anaerobic tank 200, the anoxic tank 300 and the intermittent quantitative supply tank 400 in required amounts by activation of the sludge pump 112. In this embodiment, 35% of the total amount of sludge, which is returned from the sequencing batch reactor tank 100, is returned to anaerobic tank 200, 50% of the total amount is returned to the anoxic tank 300, and the remaining 15% of the total amount is returned to the intermittent quantitative supply tank 400. However, the ratio of the returning amounts may be properly adjusted depending on the plant conditions.

The returning of sludge to the anaerobic tank 200 is conducted in the anaerobic stage in the sequencing batch reactor tank 100, and phosphorous is eluted from the sludge returned to the anaerobic tank 200. At this point, as an energy source required for the elution, a carbon source of the raw water introduced into the anaerobic tank 200 from the flow control tank 500 is used.

The returning of sludge to the anoxic tank 300 is conducted in the sequencing batch reactor tank 100 at the beginning of the anoxic stage of the sludge, and nitrate-nitrogen in the sludge returned to the anoxic tank 300 is treated into nitrogen gas by denitrifying microorganisms and discharged. In this treatment procedure, the raw water supplied from the flow control tank 500 is used as the carbon source.

The settling process is conducted for about 1 ?2 hours, and the decanter 150 is operated to open the supernatant water collector, followed by the discharge process. Thereafter, the returning of sludge is conducted but the takeout of sludge is not conducted. This is intended to prevent the takeout of sludge, which is not sufficiently concentrated, in advance.

<Discharge Process>

In the intermediate load operation mode, the discharge process is conducted about 3 ?4 hours after the initiation of the operation. This process is initiated immediately after the settling process, and the discharge time may be variously set depending on a selected mode.

The returning of the settled sludge also continues even in the discharge process. At this point, in order to prevent floating of sediment, the raw water is introduced only to a lower level of the sequencing batch reactor tank 100 though the lower supply pipe 132 and the influent water stable contact chamber 131.

The discharge process is intended to discharge supernatant water, which is realized using the decanter 150. In this embodiment, although a single decanter 150 is described as being installed in the sequencing batch reactor tank 100 to collect supernatant water, two or more decanters 150 may also be installed depending on the magnitude of the equipment or a size of the decanter 151. In this embodiment, since the discharge of supernatant water is conducted after the aeration ceases and the sludge is settled, the collection of supernatant water does not occur in the aeration and settling processes.

Upon initiating of discharge process, the controller 900 instructs the drive pump 154 to operate in response to a signal from the nilometer in the sequencing batch reactor tank 100, thus moving the decanter 151 to the collection position for supernatant water depending on the water level. In other words, the wire 152 is wound or unwound by activation of the drive pump 154, and thus the decanter 150 connected to the wire 152 is vertically moved.

In this specification, the term 뱲ecanter?refers to a supernatant water collector, which is positioned at a level about 50cm below the water surface such that it is positioned below a layer composed of extraneous substances floating on the top of raw water, thus avoiding discharge of the extraneous substances.

When the position of the decanter 151 is determined and the aeration and discharge stages are completed, operations of collecting and discharging supernatant water are initiated. Accordingly, the supernatant water introduced into the decanter 151 can be discharged through the discharge pipe 151 connected to the decanter 150. The discharge process is conducted within a period of about 1 hour. Even though the discharge time be yet within the set period, when the supernatant water is discharged to fall below the limit level, the discharge operation may be ceased in response to a detection signal of the nilometer, thus avoiding discharge of sludge.

At the time of completion of the discharge stage, one cycle in the intermediate load operation mode is concluded. Thereafter, the sequencing batch reactor tank 100 is immediately switched into the aeration process, and the next cycle is again executed.

Meanwhile, the supernatant water, which is discharged through the discharge pipe 151, is discharged through the effluent tank 700. In the effluent tank 700, the treated water is sterilized using an ultraviolet disinfector and is then discharged to the outside.

Although the preferred embodiment of the present invention has been described in detail, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the invention. Accordingly, the modifications, additions and substitutions should be understood to fall within the scope of the present as disclosed in the accompanying claims.

【CLAIMS】

【Claim 1】

An advanced water reclamation apparatus suitable for treatment of sewage and wastewater including a flow control tank for reserving raw water introduced thereinto and discharging a required amount of raw water, and a sequencing batch reactor tank spatially isolated from the flow control tank and repeatedly conducting aeration, settling and discharge processes to purify nutrient salts, including organic substances, nitrogen (N) and phosphorous (P), contained in the introduced influent water and to discharge supernatant water, the apparatus comprising:

anaerobic, anoxic and intermittent quantitative supply tanks disposed between the flow control tank and the sequencing batch reactor tank to be spatially isolated therefrom;

overflow pipes to allow the influent water to be flowed into the sequencing batch reactor tank through the flow control tank, the anaerobic tank, the anoxic tank and the intermittent quantitative supply tank;

a raw water supply unit including a raw water pump and a raw water transfer pipe to distribute and supply the raw water reserved in the flow control tank to the anaerobic tank, the anoxic tank and the intermittent quantitative supply tank;

an influent water supply unit including an influent water pump and an influent water supply pipe to supply the influent water reserved in the intermittent quantitative supply tank to the sequencing batch reactor tank;

*176a sludge-returning unit including a sludge pump and a returning pipe to return sludge settled in the sequencing batch reactor tank to the anaerobic tank, the anoxic tank and the intermittent quantitative supply tank; and

a controller electrically connected to the pumps of the raw water supply unit, the influent water supply unit and the sludge-returning unit, nilometers of the flow control tank, the anaerobic tank, the anoxic tank, the intermittent quantitative supply tank and the sequencing batch reactor tank, and a diffuser unit, a decanter and various control valves in the sequencing batch reactor tank, to control flows of raw water, influent water, sludge and treated water.

【Claim 2】

The advanced water reclamation apparatus according to claim 1, wherein the influent water supply unit comprises an upper influent water supply unit for distributing and supplying a part of influent water reserved in the intermittent quantitative supply tank to a surface of water in the sequencing batch reactor tank, and a lower influent water supply unit for distributing and supplying another part of the influent water to a bottom of the sequencing batch reactor tank;

the upper influent water supply unit comprises an upper supply pipe communicating with the influent pump disposed in the intermittent quantitative supply tank and having an end positioned over a water surface of the sequencing batch reactor tank, and an upper dispersion plate having a predetermined size for distributing and supplying influent water supplied through the upper supply pipe to a water surface of the sequencing batch reactor tank; and

the lower influent water supply unit comprises an influent water stable contact chamber vertically disposed in the sequencing batch reactor tank and having a lower end spaced apart from a bottom surface thereof by a predetermined distance and an upper end protruding from a water surface located at a maximum level, a lower supply pipe communicating with the influent water pump disposed in the intermittent quantitative supply tank and having an end positioned over a water surface in the influent water stable contact chamber, and a lower dispersion plate having a predetermined size for distributing and supplying influent water supplied through the lower supply pipe to a water surface of the influent water stable contact chamber.

【Claim 3】

The advanced water reclamation apparatus according to claim 1 or 2, wherein the overflow pipe associated with the intermittent quantitative supply tank allows influent water overflowing from the intermittent quantitative supply tank to flow into the influent water stable contact chamber.

【Claim 4】

The advanced water reclamation apparatus according to claim 1 or 2, wherein the overflow pipe associated with the intermittent quantitative supply tank allows influent water overflowing from the intermittent quantitative supply tank to flow into the influent water stable contact chamber.

【Claim 5】

The advanced water reclamation apparatus according to claim 2, wherein the upper influent water supply unit is a non-powered rotary sprinkler, comprising:

a rotating cylinder including a cylindrical body having a predetermined size and a bottom surface, and a plurality of rotating blades disposed on an internal surface of the cylindrical body which are radially arranged;

a center shaft vertically disposed at a center of the rotating cylinder for rotatably supporting the rotating cylinder;

a raw water inflow pipe disposed over the rotating cylinder to be spaced apart therefrom and communicating with the influent water pump disposed in the intermittent quantitative supply tank, so as to introduce influent water in a direction perpendicular to a front surface of each of the plurality of rotating blades under a predetermined water pressure;

a holder for holding an upper end of the center shaft to maintain the rotating cylinder over a water surface in the sequencing batch reactor tank; and

a plurality of holes formed in a bottom surface and a side surface of the rotating cylinder to allow influent water in the rotating cylinder to be sprinkled on a water surface in the sequencing batch reactor tank due to a centrifugal force.

【Claim 6】

An advanced water reclamation apparatus suitable for treatment of sewage and wastewater including a sequencing batch reactor tank serving as a biological reactor tank which repeatedly conducts aeration, settling and discharge processes separated from each other in terms of time, so as to purify nutrient salts including organic substances, nitrogen (N) and phosphorous (P) contained in influent water and to discharge supernatant water, and including an intermittent quantitative supply tank wherein

the sequencing batch reactor tank comprises an upper influent water supply unit for distributing and supplying a part of influent water to a water surface in the sequencing batch reactor tank, and a lower influent water supply unit for distributing and supplying another part of the influent water to a bottom surface of the sequencing batch reactor tank;

the upper influent water supply unit comprises an upper supply pipe communicating with the influent pump disposed in the intermittent quantitative supply tank and having an end positioned over a water surface of the sequencing batch reactor tank, and an upper dispersion plate having a predetermined size for distributing and supplying influent water supplied through the upper supply pipe to a water surface of the sequencing batch reactor tank; and

the lower influent water supply unit comprises an influent water stable contact chamber vertically disposed in the sequencing batch reactor tank and having a lower end spaced apart from a bottom surface thereof by a predetermined distance and an upper end protruding from a water surface located at a maximum level, a lower supply pipe communicating with the influent water pump disposed in the intermittent quantitative supply tank and having an end positioned over a water surface in the influent water stable contact chamber, and a lower dispersion plate having a predetermined size for distributing and supplying influent water supplied through the lower supply pipe to a water surface of the influent water stable contact chamber.

【Claim 7】

The advanced water reclamation apparatus according to claim 6, wherein the influent water stable contact chamber is filled with contact filtration material (medium) for creating biofilm.

【Claim 8】

The advanced water reclamation apparatus according to claim 6 or 7, wherein the intermittent quantitative supply tank includes an overflow pipe to allow influent water overflowing from the intermittent quantitative supply tank to flow into the influent water stable contact chamber.

【Claim 9】

The advanced water reclamation apparatus according to claim 6 or 7, wherein the apparatus comprises a flow control tank, an anaerobic tank, a anoxic tank and the intermittent quantitative supply tank which are spatially isolated from the sequencing batch reactor tank, and wherein the apparatus comprises a sludge-returning unit including a sludge pump and a returning pipe to return sludge settled in the sequencing batch reactor tank to the anaerobic tank, the anoxic tank and the intermittent quantitative supply tank.

【Claim 10】

The advanced water reclamation apparatus according to claim 9, wherein the apparatus comprises overflow pipes provided on partition walls disposed between the flow control tank, the anaerobic tank, the anoxic tank and the intermittent quantitative supply tank so as to allow overflow water to naturally flow between the respective tanks.

【Claim 11】

The advanced water reclamation apparatus according to claim 9, wherein the apparatus comprises a raw water supply unit including a raw water pump and a raw water transfer pipe which are configured to distribute and supply raw water reserved in the flow control tank to the anaerobic tank, and the anoxic tank and the intermittent quantitative supply tank.

【Claim 12】

The advanced water reclamation apparatus according to claim 9, wherein the apparatus comprises a controller for controlling flow of influent water supplied through the upper influent water supply unit and the lower influent water supply unit.

【Claim 13】

The advanced water reclamation apparatus according to claim 6, wherein the upper influent water supply unit is a non-powered rotary sprinkler, comprising:

a rotating cylinder including a cylindrical body having a predetermined size and a bottom surface, and a plurality of rotating blades disposed on an internal surface of the cylindrical body to be radially arranged;

a center shaft vertically disposed at a center of the rotating cylinder for rotatably supporting the rotating cylinder;

a raw water inflow pipe disposed over the rotating cylinder to be spaced apart therefrom and communicating with the influent water pump disposed in the intermittent quantitative supply tank, so as to introduce influent water in a direction perpendicular to a front surface of each of the plurality of rotating blades at a predetermined water pressure;

a holder for holding an upper end of the center shaft to maintain the rotating cylinder over a water surface in the sequencing batch reactor tank; and

a plurality of holes formed in a bottom surface and a side surface of the rotating cylinder to allow influent water in the rotating cylinder to be sprinkled on a water surface in the sequencing batch reactor tank due to a centrifugal force.

【Claim 14】

An advanced water reclamation method suitable for treatment of sewage and wastewater comprising separating a sequencing batch reactor tank in terms of time, repeatedly conducting aeration, settling and discharge processes to treat water and to discharge supernatant water, and intermittently supplying a predetermined amount of influent water through a intermittent quantitative supply tank provided on an end of the sequencing batch reactor tank, wherein

a part of influent water reserved in the intermittent quantitative supply tank is distributed and supplied to a water surface in the sequencing batch reactor tank, and another part of the influent water reserved in the intermittent quantitative supply tank is distributed and supplied to a bottom surface of the sequencing batch reactor tank, thus agitating water in the sequencing batch reactor tank without requiring supply of additional power.

【Claim 15】

The advanced water reclamation method according to claim 14, wherein, in the aeration process, the part of the influent water reserved in the intermittent quantitative supply tank is distributed and supplied to a water surface in the sequencing batch reactor tank and the another part of the influent water reserved in the intermittent quantitative supply tank is distributed and supplied to a bottom surface of the sequencing batch reactor tank, thus agitating water in the sequencing batch reactor tank, and, in the settling and discharge processes, the influent water is distributed and supplied only to the bottom surface of the sequencing batch reactor tank and thus floating of sediment or eddying flow does not occur, thus allowing continuous introduction thereof.

【Claim 16】

The advanced water reclamation method according to claim 14 or 15, wherein, when water in the intermittent quantitative supply tank is at a maximum level, water overflowing from the intermittent quantitative supply tank is distributed and supplied to the bottom surface of the sequencing batch reactor tank and thus floating of sediment or eddying flow does not occur, thus allowing continuous introduction thereof.

【Claim 17】

The advanced water reclamation method according to claim 14 or 15, wherein the method comprises:

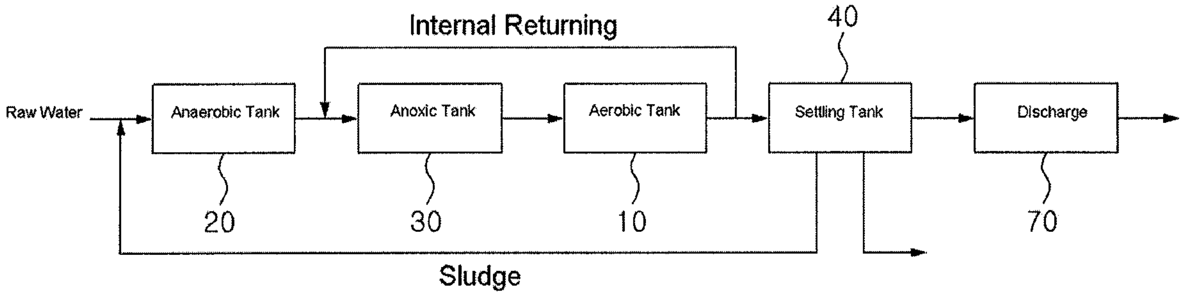
preparing a flow control tank for reserving raw water disposed at an upstream end of the intermittent quantitative supply tank to reserve raw water therein and to discharge a predetermined amount of raw water, an anaerobic tank for receiving raw water from the flow control tank and for allowing dephosphorization therein, and an anoxic tank for receiving the dephosphorized influent water from the anaerobic tank and for allowing denitrification, all of which are spatially separated from each other;

distributing and supplying raw water reserved in the flow control tank to the

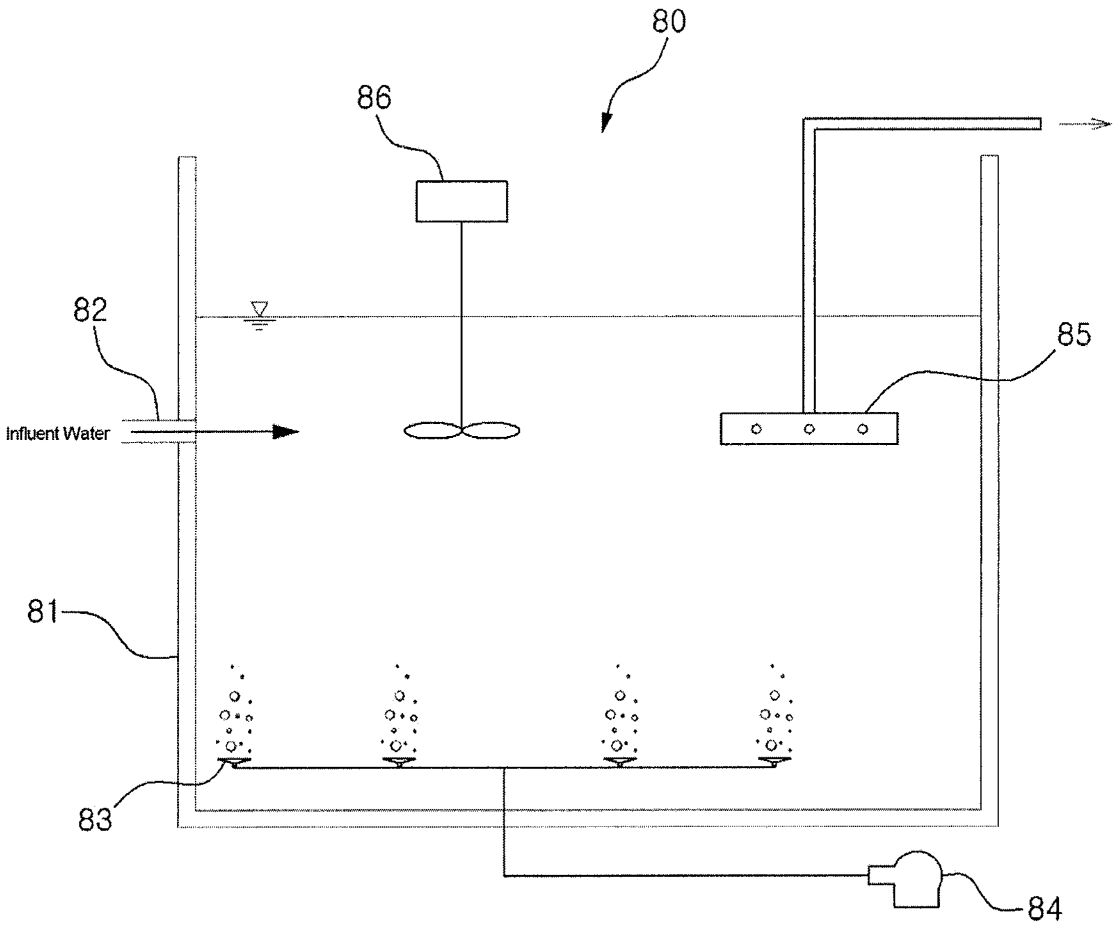
anaerobic tank, the anoxic tank and the intermittent quantitative supply tank;
returning sludge settled in the sequencing batch reactor tank to the anaerobic tank, the anoxic tank and the intermittent quantitative supply tank; and
causing water overflowing through overflow pipes of to the anaerobic tank, the anoxic tank and the intermittent quantitative supply tank to flow into the sequencing batch reactor tank.

【DRAWINGS】

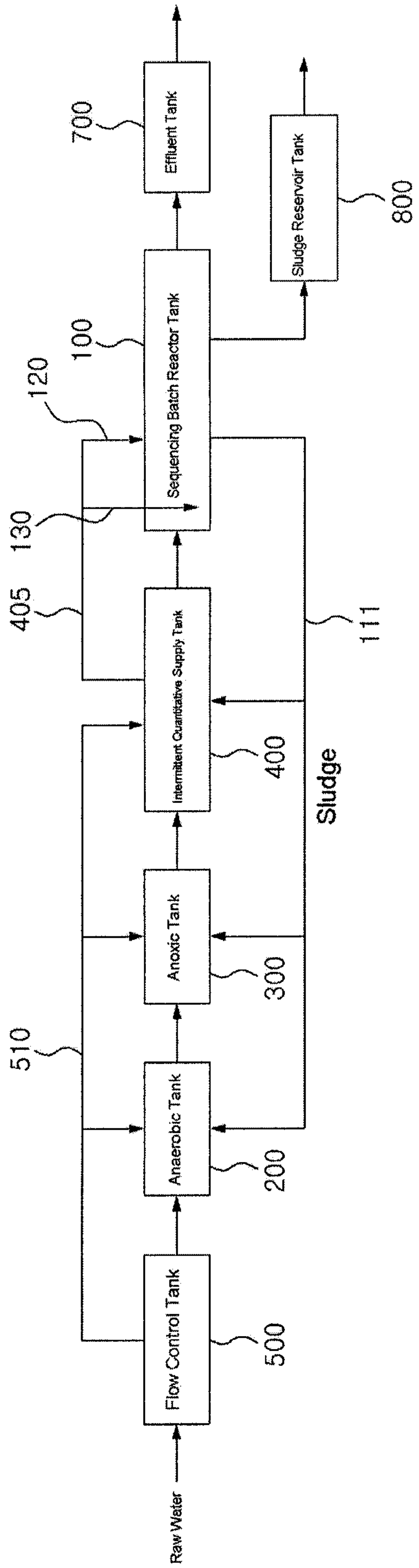
【Figure 1】



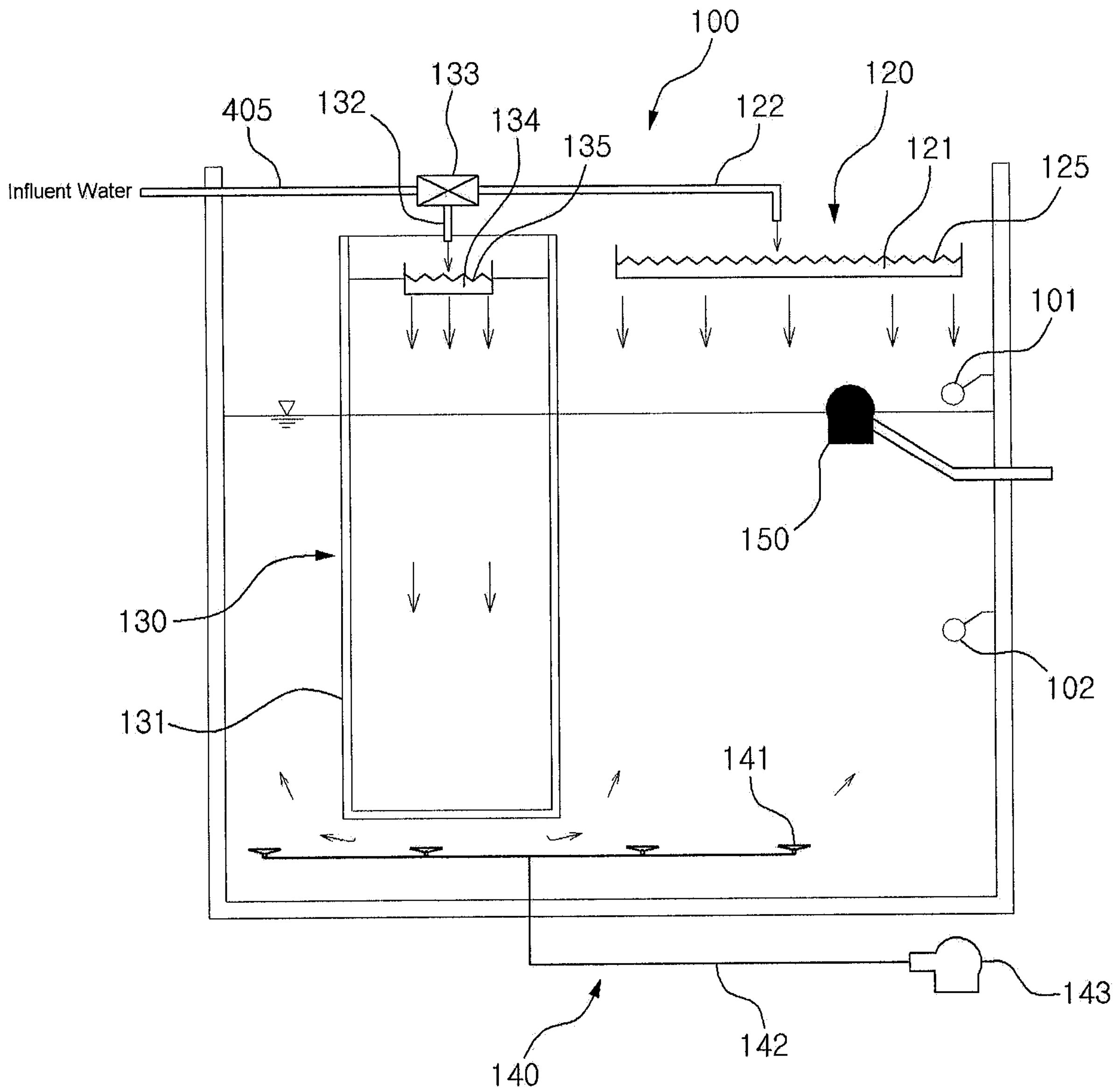
【Figure 2】



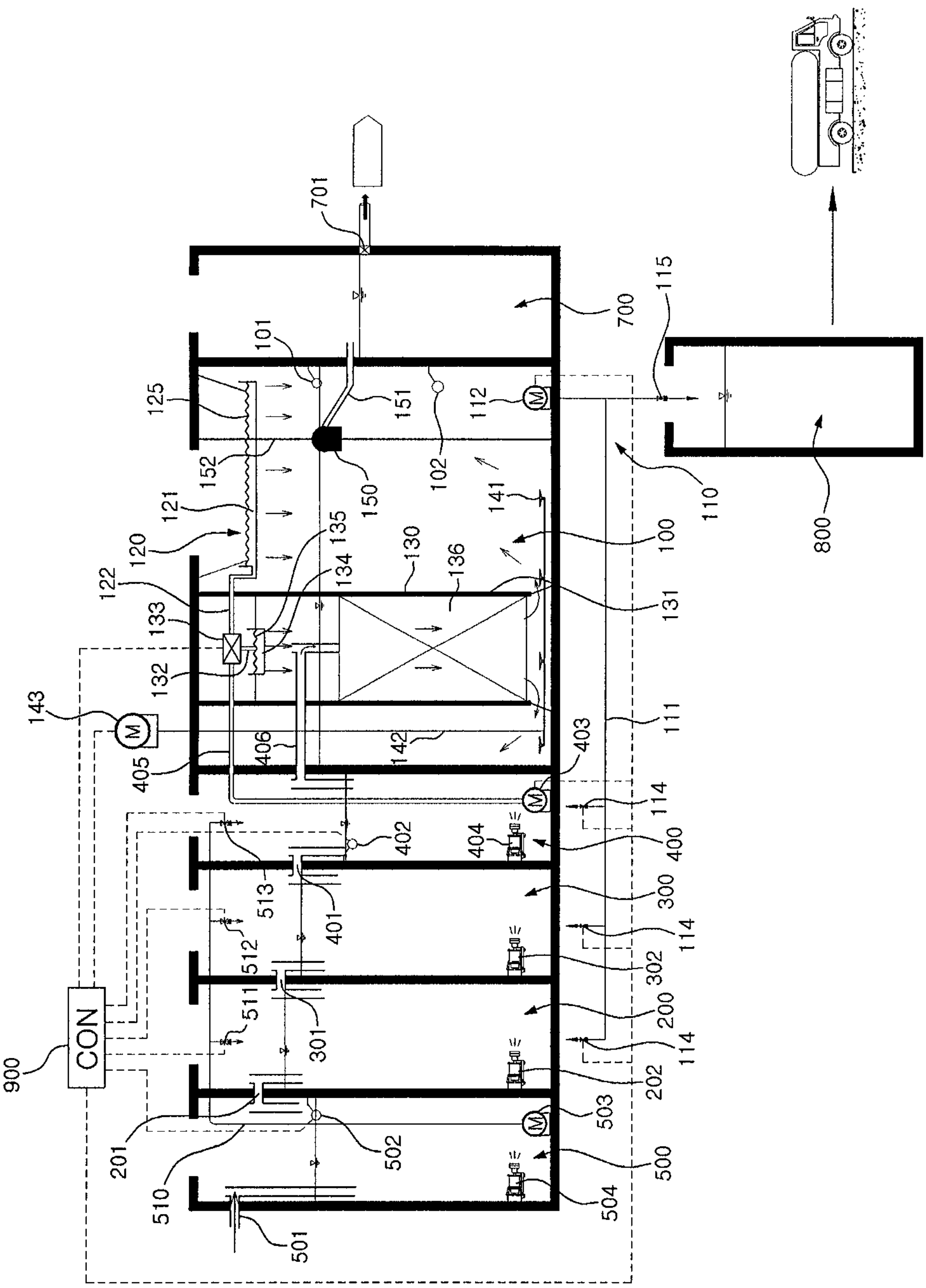
【Figure 3】


Raw Water
Flow Control Tank
500
Anaerobic Tank
200
510
Anoxic Tank
300
Intermittent Quantitative Supply Tank
400
Sludge
405
111
130
Sequencing Batch Reactor Tank
120
100
Sludge Reservoir Tank
800
Effluent Tank
700

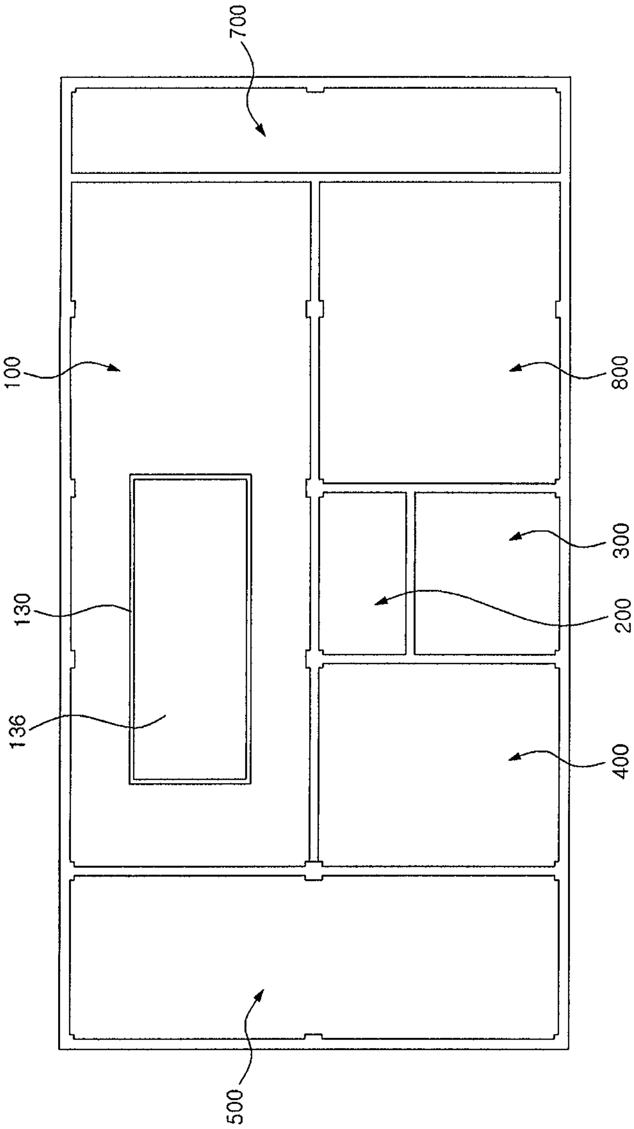
【Figure 4】


100
133
132
134
405
135
122
120
121
125
Influent Water
101
150
130
102
131
141
143
142
140

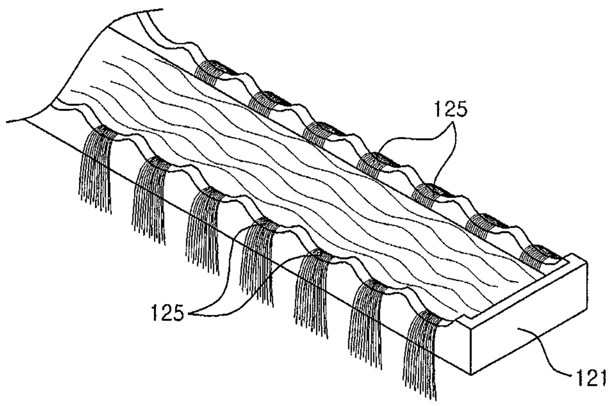
【Figure 5】


CON
900
M
143
701
700
115
800
110
100
111
114
400
300
200
500
504
503
502
501
510
201
202
301
302
401
402
403
404
405
406
511
512
513
101
102
112
125
152
121
120
122
133
132
134
135
130
136
131
141
142
150
151

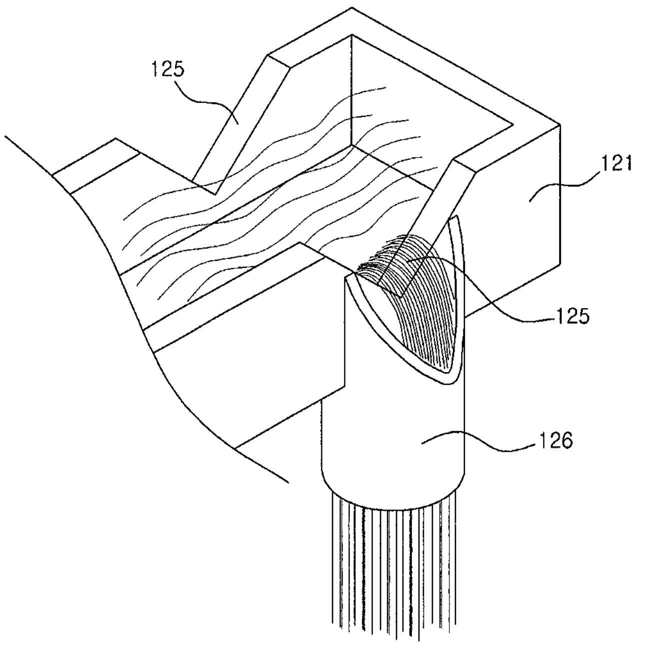
【Figure 6】



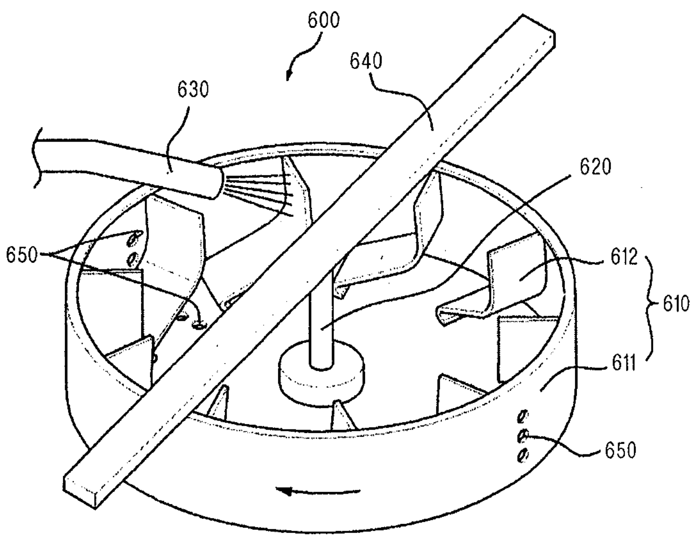
【Figure 7】



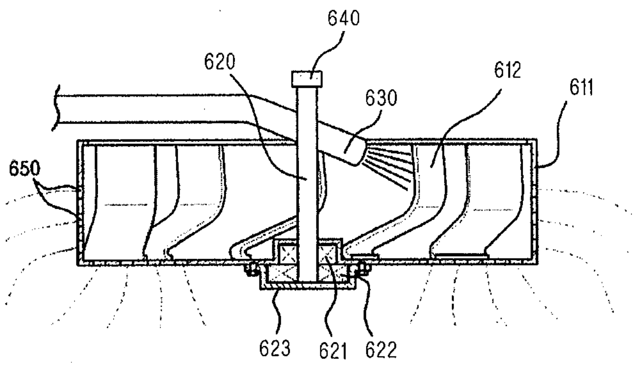
【Figure 8】



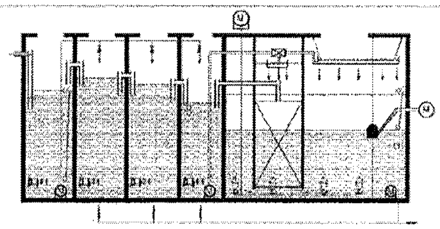
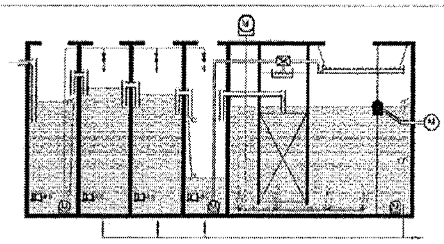
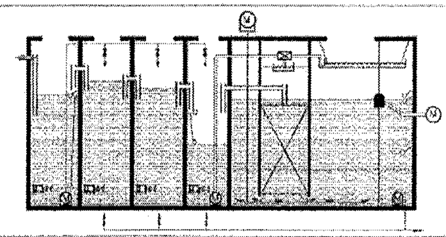
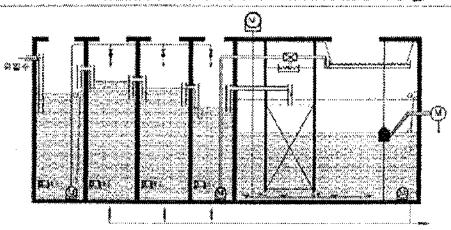
【Figure 9】



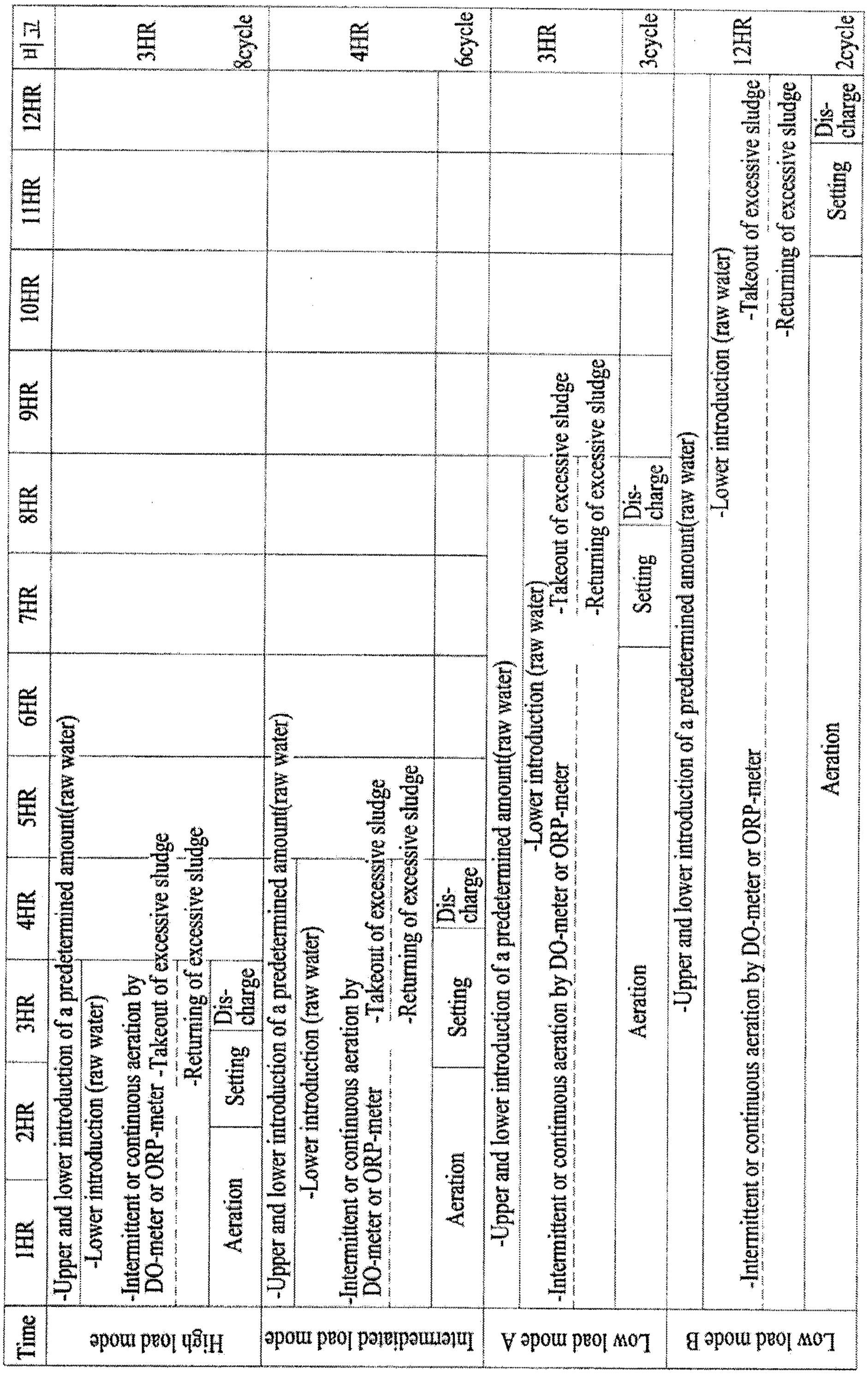
【Figure 10】



【Figure 11】

Stage	Conditions of Tanks	Reaction Conditions
First stage (Inflow & aeration process)		At least 30 minutes - Intermittent inflow through upper and lower raw water supply - Intermittent aeration (in response to DO-meter) - BOD oxidation & nitrification
Second stage (aeration process)		1.5 hours - Intermittent aeration (in response to DO-meter) - BOD oxidation & nitrification - Cease of raw water supply
Third stage (setting process)		1.5 hours - Dephosphorization - Setting
Fourth stage (discharge process)		0.5 hours - Denitrification - Discharge of supernatant water(treated water) - Internal returning & sludge returning - Takeout of excessive sludge

【Figure 12】


Time
1HR
2HR
3HR
4HR
5HR
6HR
7HR
8HR
9HR
10HR
11HR
12HR
비고
High load mode
-Upper and lower introduction of a predetermined amount(raw water)
-Lower introduction (raw water)
-Intermittent or continuous aeration by DO-meter or ORP-meter
-Takeout of excessive sludge
-Returning of excessive sludge
Aeration
Setting
Dis-charge
3HR
8cycle
Intermediated load mode
-Upper and lower introduction of a predetermined amount(raw water)
-Lower introduction (raw water)
-Intermittent or continuous aeration by DO-meter or ORP-meter
-Takeout of excessive sludge
-Returning of excessive sludge
Aeration
Setting
Dis-charge
4HR
6cycle
Low load mode A
-Upper and lower introduction of a predetermined amount(raw water)
-Lower introduction (raw water)
-Intermittent or continuous aeration by DO-meter or ORP-meter
-Takeout of excessive sludge
-Returning of excessive sludge
Aeration
Setting
Dis-charge
3HR
3cycle
Low load mode B
-Upper and lower introduction of a predetermined amount(raw water)
-Lower introduction (raw water)
-Intermittent or continuous aeration by DO-meter or ORP-meter
-Takeout of excessive sludge
-Returning of excessive sludge
Aeration
Setting
Dis-charge
12HR
2cycle