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Bureau (10) International Publication Number (43) International Publication Date W O 2017/203505 A1 30 November 2017 (30.11.2017) WIPO I PCT (51) International Patent Classification: (74) Agent: GUTTMANN, Thomas et al.; Luzzatto & Luzzat C02F 9/00 (2006.01) C05F 17/00 (2006.01) to, P.O. Box 5352, 8415202 Beer Sheva (IL). C02F 11/04 (2006.01) A01C3/00 (2006.01) (81) Designated States (unless otherwise indicated, for every C02F 3/30 (2006.01) C02F 1/66 (2006.01) kind of national protection available): AE, AG, AL, AM, C05F 3/00 (2006.01) AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, (21) International Application Number: CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, PCT/IL2016/051177 DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, (22) International Filing Date: HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KW, 01 November 2016 (01.11.2016) KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, (25) Filing Language: English PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, (26) Publication Language: English SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW. (30) Priority Data: (84) Designated States (unless otherwise indicated, for every 245872 26 May 2016 (26.05.2016) IL kind of regional protection available): ARIPO (BW, GH, (71) Applicant: S.G.T.-SUSTAINABLE GREEN TECH- GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, NOLOGIES LTD [IL/IL]; 12 Ha'Melacha Street, P.O. Box 5352, Beer Sheva (IL). TM), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, 8641, 4250547 Netanya (IL). TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, (72) Inventor: LEVIN, Gal; 7 Chitman Uzi Street, 4266105 Netanya (IL). TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG). (54) Title: PROCESS AND FACILITY FOR THE **TREATMENT OF LIVESTOCK WASTE** Irr3 v9 5 Fig.2 (57) Abstract: The invention provides an efficient system for treating livestock **waste**, particularly **waste** from cattle or pig farming. The new facility and method employ special transfers of slurry streams through ASBR, SBR, and a unique pretreatment reactor, resulting in treated **water**, quality compost, and biogas. W O 20 17/203 50 5 A I

||||||| Declarations under Rule 4.17: - of inventorship (Rule 4.17(iv)) Published: - with international search report (Art. 21(3)) WO 2017/203505 PCT/IL2016/051177 PROCESS AND FACILITY FOR THE **TREATMENT OF LIVESTOCK WASTE** Field of the Invention 5 The present invention relates to the **treatment** of livestock **waste**. More particularly, the invention relates to system and process for converting livestock **waste** into compost, treated **water**, and energy. Background of the Invention 10 The **treatment** of wastes, particularly livestock **waste**, is a critical problem in the majority of developed countries, as it causes grave environmental and economic concerns. Large farms - 10,000 and more animals - exert pressure on the ecosystem and present problems difficult to solve both in the short term and the long term. In an attempt to prevent ecological disaster, various 15 countries have legislated limitations to the amount of livestock wastes which may spread per year per surface unit. For example, in Europe a spreading limitation has recently been introduced based on the **nitrogen** contents of wastes, virtually limiting the size of pig farms. 20 Traditionally, organic matter containing excessive **biological** oxygen demand (BOD) has been treated using microbial action. The process begins with the **separation** of the organic matter from the remainder or liquid fraction, forming a mass of solids in the form of an activated sludge. **Treatment** typically involves digestion of the organic material through fermentation of 25 the sludge involving aerobic or **anaerobic bacterial** action or some combination thereof. These processes are used to reduce the chemical oxygen demand (COD) and **biological** oxygen demand (BOD) of the material to an environmentally safe level. It is also necessary to remove undesirable inorganic materials from the **water** fraction, which typically contains WO 2017/203505 PCT/IL2016/051177 -2 undesirable quantities of **phosphorus** and **nitrogen** compounds including **phosphates** and **nitrates**. Conventional wastewater **treatment** systems may include pretreatment, 5 primary **treatment**, secondary **treatment**, and advanced **treatment**. Pretreatment includes screening, comminuting (mechanical cleaning of screens by shredding solids to a size which can pass through screen openings), degritting, and grease and scum removal. Primary **treatment** includes removal of suspended solids from wastewater by clarification and 10

skimming. This typically involves a tank or channel and the steps of reducing flow velocity, settling heavier solids, and skimming relatively light solids. Primary **treatment** may include **anaerobic** digestion processes, aerobic digestion processes, or a combination thereof. Primary **treatment** systems typically include sludge collection mechanisms, sludge suction devices, grit 15 removal devices, and sludge dewatering devices to reduce the volume of sludge to be disposed.

Secondary **treatment** systems are typically aerobic systems including an aeration phase and a clarification phase. Such systems typically include an aeration tank, an air distribution system, a clarifier, sludge collection mechanisms, and sludge removing devices. Advanced 20 **treatment** includes further removal of suspended and dissolved organic solids by means including filtration and removal of pathogens by oxidation, chlorination or heating, precipitation of minerals, adsorption, or other methods. In additional steps of the advanced **treatment**, the purified liquor from the clarifier is typically filtered and refined through chlorination, 25 oxidation, or heating. In the activated sludge process of primary or secondary **treatment**, microorganisms are contained in an activated sludge and mixed with incoming wastewater, which provides food for the microorganisms whereby 30 more activated sludge is produced. Such mixing is accomplished in an aeration tank or channel. In the aerobic activated sludge process, oxygen is WO 2017/203505 PCT/IL2016/051177 - 3 intrinsically mixed with the activated sludge and the wastewater. The microorganisms use the solids as nutrients for their growth and reproduction, converting the suspended organic solids into **biomass**, carbon dioxide and **water**. The aerobic activated sludge process therefore typically 5 includes mixing wastewater, activated sludge, and oxygen in an aeration tank; consuming suspended organic solids by **bacteria**; settling activated sludge in a clarifier; returning the activated sludge to the aeration tank for further **treatment**; removing purified liquor from the clarifier; and removing and disposing of the final, inert sludge. Existing processes and installations for the **treatment** of such livestock wastes, especially for large farms, have generally been large scale operations having high installation costs. There exists a need to provide a compact, low cost system and method for treating wastewater.

Summary of the Invention  
The invention provides a facility for treating a daily volume of livestock **waste water**, comprising a) a collecting basin for continually collecting and stirring raw livestock liquid wastes; b) a pretreatment channel having an 20 inlet end and an outlet end, capable to contain at least said daily volume of **waste water**, connected at said inlet end with said collecting basin and accepting said raw wastes, which flow through the channel and form a pretreated **waste water** while allowing for partial settling of dispersed solids and enriching the lower part of the channel with said solids relatively to the 25 upper part; c) an **anaerobic** reactor connected with said channel at said outlet end and accepting said pretreated **waste water** from the middle or upper part of said channel in **separate** batches, each batch allowed to react in the tank and partially settle, forming **anaerobically** treated **waste water** being enriched with solids in the lower part of the reactor relatively to the upper 30 part, wherein a portion of said **anaerobically** treated **waste water** from said lower part is fed to said channel at said inlet end where it combines with said WO 2017/203505 PCT/IL2016/051177 -4 raw wastes; d) an aerobic stirred reactor connected with said channel at said outlet end and accepting said pretreated **waste water** from the middle or upper part of said channel in **separate** batches, and further connected with said **anaerobic** reactor and accepting said **anaerobically** treated **water** from 5 the upper part of said **anaerobic** reactor in **separate** batches, each batch allowed to react in the tank and partially settle, forming aerobically treated **waste water** being enriched with solids in the lower part of the reactor relatively to the upper part, wherein a portion of said aerobically treated **waste water** from said lower part is fed back to said **anaerobic** reactor, and 10 said aerobically treated **water** from the upper part being removed as a safe **water** product; and e) a compost basin to which cellulose based **solid waste** is fed, connected with said pretreatment channel at said outlet end and accepting said pretreated **waste water** from the lower part of said channel, the basin provided with mixing means, whereby providing a quality compost; 15 wherein said daily volume of livestock **waste water** is converted to a quality compost and safe **water** for release into municipal

system or for use in agriculture. In one embodiment of the invention, the facility comprises a) said basin which has a volume to contain at least two of said daily volumes of **waste water**; b) said pretreatment channel which has a length of at least 10 to 20 times greater than its width, and a volume to contain at least two of said daily volumes of **waste water**; c) said **anaerobic** reactor which has a volume to contain at least one said daily volume of **waste water**, preferably at least two said daily volumes, and is provided with collecting means to collect and process biogas to provide energy for running the facility; d) said aerobic reactor which has a volume to contain at least one said daily volume of **waste water**, preferably at least two said daily volumes, and is provided with air dispersing means; and e) said compost basin which has a volume to contain at least two, preferably at least five, of said daily volumes, and is provided with mixing means which regularly mix said cellulose **waste** and said **waste water**, and transport means which transport the cellulose **waste** into the basin and the ready compost out; wherein said daily volume of livestock **WO 2017/203505 PCT/IL2016/051177 -5 waste water** is converted to a quality compost and safe **water** for use in agriculture or for disposal. The system of the invention is very efficient but also economically less demanding; among others, the sediment channel, possibly a simple long rectangular parallelepiped dug in the ground and made **water**-proof, even though it is technically a simplest possible element, without any expensive technical means of usual reactors, substantially contributes to the efficiency of the process. The facility according to the invention may be adjusted to any need in a flexible way, typically being configured to treat from 50 to 400 M3 per day, but possibly up to 2000 M3 per day or more. Said **anaerobic** reactor is advantageously **anaerobic** sequencing batch reactor (ASBR) and said aerobic reactor is advantageously sequencing batch reactor (SBR). The facility according to the invention further comprises transfer means for transferring the treated liquid from said collector, via said channel and said **anaerobic** reactor, into said aerobic reactor and to said compost basin, the means comprising pumps, and possibly gravity driven means. In a preferred embodiment, the facility of the invention comprises automation means, comprising at least one microprocessor, and analytical measuring means, liquid level sensors, analytical means for automatic sampling and measuring the concentration of components, including the amount of solids, in the treated **water**, and the means to analyze the liquid parameters, including the concentration of solids, along the height of said **anaerobic** and aerobic reactors. Said microprocessor(s) advantageously manage transferring the materials in the system, and manage the steps of the process. The processed **waste** may originate in any animal farming. Advantageously, the system of the invention is employed in cattle farming or piggeries. In a preferred embodiment, the facility and the method of the invention are employed in pig farming. **WO 2017/203505 PCT/IL2016/051177 -6**

The invention provides a process of treating a livestock **waste water**, comprising i) collecting raw liquid **waste** in a stirred collecting tank; ii) transferring said raw liquid **waste** from said collecting tank to a non-stirred, flow-through channel reactor, said raw liquid **waste** providing a pretreated liquid **waste** in said channel; iii) transferring said pretreated liquid **waste** from said channel via a first outlet to an ASBR and to a SBR at a transfer rate of  $v_3$ , and via a second outlet to a compost basin at a transfer rate of  $v_4$ , where said pretreated liquid **waste** is mixed in said basin with a cellulose **waste** regularly added to said basin, wherein said  $v_4$  is at most 20% of said  $v_3$ , for example about 10% of said  $v_3$ , and wherein said second outlet is closer to the bottom of said basin than said first outlet, thereby obtaining compost; iv) transferring a part of said pretreated **water** from said first outlet to said SBR at a transfer rate of  $v_{II}$  and a part to said ASBR at a transfer rate of  $(v_3 - v_{II})$  wherein said  $v_{II}$  is either zero or up to  $v_3/3$ , usually zero or up to  $15 v_3/5$ , and reacting said pretreated **waste water** in said ASBR, allowing said **waste water** to settle, thereby obtaining an **anaerobically** treated **waste water**, the solids being more concentrated in the lower part of ASBR (sludge) than in the upper part of ASBR; v) optionally collecting biogas via a gas collector; vi) transferring said **anaerobically** treated **waste water** from said upper part of ASBR via a third outlet to said SBR at a transfer rate of  $v_5$ , and transferring said **anaerobically** treated **waste water** from said lower part of ASBR via a fourth outlet to said channel at a transfer rate of  $v_6$ , wherein

said v6 is at most 15% of said v5, and wherein said fourth outlet is closer to the bottom of said ASBR than said third outlet, thereby supplying to said 25 channel an activated sludge; and vii) reacting said **anaerobically** treated **waste water** in said SBR, allowing said **waste water** to settle, thereby obtaining an aerobically treated **waste water**, the solids being more concentrated in the lower part of SBR (sludge) than in the upper part of SBR, and transferring said aerobically treated **waste water** from said upper part of 30 SBR via a fifth outlet at a transfer rate of v7 to obtain safe treated **water**, and transferring said aerobically treated **waste water** from said lower part of WO 2017/203505 PCT/IL2016/051177 -7 SBR via a sixth outlet back to said ASBR at a transfer rate of v8, wherein v8 is at most 5% of said v7, and wherein said sixth outlet is closer to the bottom of said SBR than said fifth outlet; thereby obtaining safe **water** for release into municipal system or for use in agriculture, and further a quality 5 compost, and optionally biogas. Said steps of transferring materials in the process of the invention usually comprise portions, which are processed sequentially, usually in 2 to 6 batches a day. Said step iv) comprises homogenization of the reactor content which is attained by inflow and outflow of the liquids. Said transferring the pretreated liquid **waste** from said 10 first outlet to the ASBR and SBR in steps iii) and iv) comprises branching the stream of said **water**, preferably via a regulated valve, so that only up to 1/3 of the stream is transferred to the SBR and only at certain periods; usually, the **water** is allowed to flow into the SBR when the pH in SBR has decreased under the value of 6.5, and the flow is stopped when the pH reaches a 15 predetermined value, for example at least 6.9, such as at least 7.4, so that said v11 is usually either zero or up to v3/3, such as up to v3/5. Said step vii) comprises homogenization of the reactor content which is attained by an intensive air influx and dispersion, and by an intensive mechanical stirring. The mixtures in said steps iv) and vii) are usually allowed to settle for a 20 period of time between about 1 to about 12 hours. The process of the invention is preferably employed for livestock **waste water** comprising pigs or cattle. In a preferred embodiment of the invention, provided is a process for treating 25 a piggery **waste water**, comprising passing said **water** through a system comprising - a pretreatment, flow-through, non-stirred, settling channel at least 10 times longer than wide, - an ASBR, and - a SBR, WO 2017/203505 PCT/IL2016/051177 - 8 wherein a portion of sludge from said SBR is returned to said ASBR, a portion of sludge from said ASBR is returned to said channel, and a portion of sludge from said channel is mixed with a cellulose based **waste** to form compost; thereby providing a safe **water** and a high-quality compost. Brief Description of the Drawings The above and other characteristics and advantages of the invention will be more readily apparent through the following examples, and with reference to the appended drawings, wherein: 10 Fig. 1. is a schematic representation of one embodiment of the system according to the invention, which converts animal **water waste** and cellulose-based **waste** to safely treated **water**, high-quality compost, and biogas; Fig. 2. is a schematic representation of one embodiment of the system 15 according to the invention; equipment elements 1 to 6 and outlets 12 to 18 constitute the base of a facility according to the invention, materials 7 and 8 enter the process of the invention, and materials 9 to 11 are produced in the process, and transfer rates vi to vii characterize the movement of the materials in the process of the 20 invention; and Fig. 3. is a schematic representation of one embodiment of the system according to the invention, which provides clean **water** from animal liquid **waste**, and which further provides compost and biogas as side products while utilizing cellulose **waste**; the system comprises 25 collecting basin 1 and compost basin 5, primary **treatment** elements 2 and 3 (channel reactor and ASBR), secondary **treatment** element 4 (SBR), tertiary **treatment** element 19 (sand filter), and quaternary **treatment** elements 20-24 (microfilter, carbon filter 1, carbon filter 2, RO device, carbon filter 3). WO 2017/203505 PCT/IL2016/051177 -9 Detailed Description It has now been found that piggery liquid **waste** can be cost-effectively and efficiently treated in two sequencing batch reactors connected in series, of which the first one is **anaerobic** sequencing batch reactor (ASBR) and the 5 second one is aerobic sequencing batch reactor (SBR), wherein a) collected raw liquid **waste** is first pretreated in a non-stirred channel reactor, providing a pretreated liquid **waste** to be fed to said ASBR, b) a small part

of sludge from said ASBR is dosed to said channel, where it combines with said raw liquid **waste**;

c) a small part of sludge from said SBR is dosed to said 10 ASBR, and d) a small part of said pretreated liquid **waste** is fed to a compost basin where it is mixed with a cellulose **waste**; thereby producing purified **water** from said SBR and compost from said basin. The term sludge in this context means that the liquid comprises more suspended materials than the average content in the reactor from which it flows, as a result of 15 sedimentation. The facility according to the invention comprises at least elements as schematically depicted in Fig. 1. Livestock **waste water** flows through collecting basin (1) and through settling flow-through channel reactor (2), 20 and further in parallel to ASBR (3) and SBR (4) to produce treated **water**, and to compost basin (5) to be mixed with cellulose-comprising **waste** and produce compost; in parallel, a relatively small amount of sludge flows from SBR to ASBR and from ASBR to the channel. Said channel enables preliminary **anaerobic** hydrolytic decomposition of **waste**. Said ASBR reactor 25 is advantageously provided with a gas collector (6) to produce biogas. Thus, in the facility according to the invention, and according to the method of the invention, livestock **waste** and cellulose **waste** are processed to produce treated **water**, compost, and biogas. 30 In a preferred embodiment, the facility and the process according to the invention comprise elements as the system schematically depicted in Figs. 1 WO 2017/203505 PCT/IL2016/051177 - 10 and 2 to which the following description relates. A preferred process of treating liquid piggery **waste** (7) comprises i) collecting raw liquid **waste** in a stirred collecting tank (1) at a rate  $v_1$  (all rates are in  $M^3$  per day), wherein  $v_1$  is usually between 20 and 200  $m^3/d$ ; ii) transferring said raw liquid **waste** 5 from said collecting tank to a non-stirred, flow-through channel reactor (2) at a second transfer rate  $v_2$ , said raw liquid **waste** providing a pretreated liquid **waste** in said channel; iii) transferring said pretreated liquid **waste** from said channel via a first outlet (12) to an ASBR (3) at a third transfer rate  $v_3$ , and via a second outlet (13) to a compost basin at a fourth transfer rate  $v_4$ , where 10 said pretreated liquid **waste** is mixed in said basin with a cellulose **waste** (8) added at a ninth transfer rate  $v_9$ , wherein said fourth transfer rate is at most 20% of said third transfer rate, and preferably at most 15% of said third transfer rate, for example about 10% of said third rate, and wherein said second outlet is closer to the bottom of said basin than said first outlet, 15 thereby obtaining compost (11) at a tenth rate  $v_{10}$ ; iv) reacting said pretreated **waste water** in said ASBR, allowing said **waste water** to settle, thereby obtaining an **anaerobically** treated **waste water**, the solids being more concentrated in the lower part of ASBR (sludge) than in the upper part of ASBR; v) optionally collecting biogas (9) via a gas collector (6); vi) 20 transferring said **anaerobically** treated **waste water** from said upper part of ASBR via a third outlet (14) to said SBR at a fifth transfer rate  $v_5$ , and transferring said **anaerobically** treated **waste water** from said lower part of ASBR via a fourth outlet (15) to said channel at a sixth transfer rate  $v_6$ , wherein said sixth transfer rate is at most 15% of said fifth transfer rate, for 25 example about 10% of said fifth rate, and wherein said fourth outlet is closer to the bottom of said ASBR than said third outlet, thereby supplying to said channel an activated sludge; vii) reacting said **anaerobically** treated **waste water** in said SBR, allowing said **waste water** to settle, thereby obtaining an aerobically treated **waste water**, the solids being more concentrated in the 30 lower part of SBR (sludge) than in the upper part of SBR, and transferring said aerobically treated **waste water** from said upper part of SBR via a fifth WO 2017/203505 PCT/IL2016/051177 - 11 outlet (16) at a seventh transfer rate (7) to obtain treated **water** (10), and transferring said aerobically treated **waste water** from said lower part of SBR via a sixth outlet back to said ASBR at an eighth transfer rate  $v_8$ , wherein said eighth transfer rate is at most 5% of said seventh transfer rate, for 5 example about 2% of said seventh rate, and wherein said sixth outlet is closer to the bottom of said SBR than said fifth outlet. Said transfer rates usually comprise portions (batches) in which the liquid is transferred from one part of the system to the other. Particularly, said steps iv) to vi) usually comprise from 2 to 6 batches a day. As is usual in sequencing batch reactors, a part of 10 the maximal volume of said ASBR and SBR, such as from 1/10 to 1/2 is added in one batch, the content of the reactor is homogenized, the reaction is allowed to run. The homogenization in said ASBR is achieved at least by inflow and outflow of the liquid, optionally by a stirrer. The

homogenization said SBR is achieved by an intensive air influx and dispersion, and by an 15 intensive mechanical stirring. In each batch, the mixture is allowed to settle for a period of between 3 and 12 hours in said ASBR, such as between 4 and 6 hours; each cycle usually takes between about a quarter to a half a of the day. In said SBR, the mixture is allowed to settle usually between 0.5 and 3 hours, such as 1-2 hours. Since the second, the fourth, and the sixth outlets 20 are closer to the bottom than the average liquid part in the system, fractionations occur in the involved stages. The raw liquid **waste** usually comprises 1-3 solids; the **waste** usually contains between 1.2% and 1.8% non aqueous materials, such as 1.5%, usually comprising from about 0.6 to 0.9% suspended particles. The liquid in said second, fourth, and sixth outlets may 25 contain up to 10% non-aqueous materials, typically between 4% and 8%, for example 6%. The first, the third, and the fifth outlets drain away decanted liquids, and their contents of non-aqueous materials may be, in some embodiments of the invention, for example less than about 0.8%, less than about 0.2%, and less than about 0.08% respectively. WO 2017/203505 PCT/IL2016/051177 - 12 In one aspect, the invention provides a semicontinual effective process for cleaning livestock **waste water**, at any scale, during which sewage is continually collected, and processed in repeated batches to purified **water**, compost, and biogas. When relating to Fig. 2, **waste** materials (7) and (8) 5 provide products (9), (10), and (11). Regarding material flows and transfer rates, v1 to v8 comprise aqueous liquids, usually aqueous suspensions, whereas v9 and v10 comprise wet solids; practically, also v9 and v10 may be conveniently expressed in m<sup>3</sup>/d. Practically, in the semicontinual process of the invention, v1+ v9 v7+ v10, since the weight of biogas is relatively small, 10 and the densities of the cellulose based **waste** and the compost are not too far from 1. In one embodiment of the invention, v9 is from about v4/2 to about 2\*v4, such as about v4. The pretreated **water** from the channel may be distributed to ASBR and the compost basin at transfer rates v3 and v4 in a ratio of about 10:1; the activated sludge from ASBR may be distributed to 15 SBR and the channel at transfer rates v5 and v6 in a ratio of about 10:1; the activated sludge from SBR may be transferred to ASBR at transfer rate v8 of about 0.02\*v7. In any case, the following relations will approximately hold: v2+ v6= v3+ v4 for the channel; v4+ v9 = v10 for the compost basin; v3+ v8 v11 = v5+v6 for the ASBR; and v5+ v11 = v7+v8 for the SBR. In an important aspect of the invention, animal liquid **waste** flows through the purification system of the invention and provides safe **water**, for example as seen in Fig. 3, or in Fig. 1 in which **waste** liquid 7 provides safe **water** 10. Superb results of the system according to the invention are attained through 25 a plurality of tuned fractionating steps and a plurality of tuned backflows, as seen in Fig. 2: such a partition occurs in the channel reactor at the outlet of which a smaller part of the stream is removed (v4<v3), and the tuned backflows occur in ASBR from which a smaller part returns to the channel reactor (v6<v5), and in SBR from which a smaller part returns to the ASBR 30 (v8<v7); the ratios of v4/v3, v6/v5, and v8/v7 being important regulation parameters. WO 2017/203505 PCT/IL2016/051177 - 13 In one preferred embodiment of the invention, the system for treating livestock **waste** waters, including the facility and the process according to the invention, comprises additional stages of **water** purification according to the external requirements and according to the desired use of the final **water** 5 product; said additional stages preferably follow the aerobic **treatment**, for example the **treatment** in a SBR. Said additional stages preferably comprise filtration steps, such as sand filtration and reverse osmosis filtration (RO). In a preferred embodiment, **water** treated in a SBR flows to a sand filter and then to an RO system. The whole process, comprising a primary, **anaerobic** 10 stage (preferably employing a pretreatment channel and an ASBR) and a secondary, aerobic stage (preferably employing a SBR), thus comprises in one embodiment a tertiary stage (sand filter) and a quaternary

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PA - WATERS CO LTD [KR]

TI - APPARATUS FOR WASTEWATER **TREATMENT** WITH SUBMERGED MEMBRANE

AB - The present invention relates to an advanced **waste water treatment** apparatus using a submerged-type **separation** membrane which **biologically** processes **waste water** and **separates waste water** into a **solid** material and a liquid material by using a submerged-type **separation** membrane without additional settlement equipment. More particularly, the present invention relates to an advanced **waste water treatment** apparatus comprising an **anoxic** tank, an **anaerobic** tank, an aerobic tank, and a membrane **separation** tank. A flow volume adjustment tank performs a **nitrogen** removal function by denitrification by a buffering effect for impact load of quality of inserted raw **water** and return of **nitrification** liquid in the aerobic tank. The **anoxic** tank having an MLSS concentration adjustment device prepares for the impact load of the inserted raw **water** and low temperatures in winter by freely adjusting an FM ratio. **Phosphorus** is removed as the **anaerobic** tank discharges **phosphorous** and the aerobic tank excessively receives **phosphorus**. Finally, the membrane **separation** tank having the submerged-type **separation** membrane produces treated **water** from which floating materials and **bacteria** have been **separated**. The aerobic tank including a fine bubble supply device increases an oxygen dissolving rate by using the fine bubble supply device and circulates returned sludge liquid including a large amount of dissolved oxygen resulting from excessively supplied air of the membrane **separation** tank. Therefore, operation of a blower, which consumes a large amount of power, is minimized. Consequently, the advanced **waste water treatment** apparatus can automatically manage change in load of the raw **water** and minimize energy consumption.

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CT - || STSE (A)  
[CN103663693](#) A 20140326 [A] (GUANGZHOU GEOCHEMISTRY RES TECHNOLOGY AND DEV CO LTD OF CHINESE ACADEMY OF SCIENCES);  
[CN101585602](#) A 20091125 [A] (ZHENGZHOU LANDE ENVIRONMENTAL [CN]);  
[CN201809250U](#) U 20110427 [A] (ZHENGZHOU LAND ENVIRONMENTAL PROT TECHNOLOGY CO LTD);  
[JP2002192186](#) A 20020710 [A] (FUJI PHOTO FILM CO LTD);  
[CN101591065](#) A 20091202 [A] (QIANWU SONG [CN])

CNOI - (A)  
[C02F3/302](#) ; [C02F3/308](#) ; [C02F9/00](#) ; [C02F3/307](#)

CNOA - (A)  
[C02F1/52](#) ; [C02F3/02](#) ; [C02F3/28](#) ; [C02F2101/105](#) ; [C02F2101/16](#) ; [C02F2101/163](#) ;  
[C02F2101/166](#) ; [C02F2301/08](#)

PA - (A)  
JIANGSU ATK ENVIRONMENTAL ENGINEERING DESIGN & RES INST CO LTD; UNIV JIANGSU

- TI - (A)  
Efficient biochemical **nitrogen** and **phosphorus** removal method for **waste water**
- AB - (A)  
The invention discloses an efficient biochemical **nitrogen** and **phosphorus** removal method for **waste water**. Ammonia **nitrogen** and **phosphorus** in **waste water** are efficiently removed by combining a modified A2/O **biological nitrogen** and **phosphorus** removal technology and a chemical method, namely, zeolite adsorbing ammonia **nitrogen** method; the denitrification liquid flowing out from an **anoxic** denitrification tank enters an aerobic **nitrification** tank to form internal circulation; the residual denitrification liquid directly enters a sedimentation tank for **solid-liquid separation**; **phosphorus**-accumulating **bacteria** directly flows back to an **anaerobic** tank from the sludge of a sedimentation tank, and then enters the **anoxic nitrification** tank. Ion adsorption and **biological** regeneration **treatment** are combined; **water** outlet total **nitrogen** is less than or equal to 5 mg/L; the removal ratio of total **nitrogen** and total **phosphorus** is more than 90%; requirements that **water** outlet total **nitrogen** in Taihu basin chemical engineering zone is superior to the primary standard, namely, the A standard, of the urban sewage **treatment** plant pollutant discharge standard (GB18918-2002) are met stably.

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- PN - [EP1790732](#) A1 20070530
- PR - CZ20050000534 20050824
- AP - EP20060466012 20060823
- DT - \*; Rep
- CT - || STSE (A1)  
[XP002429757](#) A[A];  
[XP008077925](#) A[A];  
[XP008077942](#) A[A];  
[WO2005036942](#) A2 20050428 [A] (NALCO CO [US])  
[A] 1  
\* See pages 1-2 (Background/centrifuges)  
and page 8 (lines 23-27) \*;  
[XP002429861](#) A[L]
- CTNP - || STSE (A1)  
[A] WILKIE ET AL, "Stillage characterization and anaerobic treatment of ethanol stillage from conventional and cellulosic feedstocks", BIOMASS AND BIOENERGY, (2000), vol. 19, pages 63 - 102, XP002429757  
[A] 1-10  
\* See page 80 (Figure 3) and pages 84-89 (Section 9) \*  
[A] FILHO ET AL, "Evaluation of flocculation and dissolved air flotation as an advanced wastewater treatment", WATER SCIENCE AND TECHNOLOGY, (2001), vol. 43, pages 83 - 90, XP008077925  
[A] 1,3  
\* See page 83 (Abstract) \*  
[A] CELEN ET AL, "Recovery of ammonia as struvite from anaerobic digester effluents", ENVIRONMENTAL TECHNOLOGY, (2001), vol. 22, pages 1263 - 1272, XP008077942  
[A] 1,7  
\* See page 1263 (Abstract) \*  
[L] N.N., BIOSCAN A/S PRESENTATION SET ("CLEAN AIR, CLEAN WATER, CLEAN ENERGY"),  
URL: <http://www.ambwashington.um.dk/NR/rdonlyres/A39A1CF1-578F-4A6D-A62D->

[E12CC2972F2A/0/BioEnergy5BioScan.pdf](#), (20070417), XP002429861

[L] 1

\* See page 19; no publication date  
(to be established, if required) \*

- CCI - [C12M21/04](#) ; [C12M23/58](#) ; [C12M45/02](#) ; [C12M47/18](#) ; [C12P3/00](#) ; [C12P5/023](#) ; [C12P7/00](#)
- CCA - [Y02E50/343](#) ; [Y02P20/129](#)
- PA - PROKOP INVEST A S [CZ]; HYDROTECH S R O [CZ]; WESTFALIA SEPARATOR CZ S R O [CZ]; CKD PRAHA DIZ A S [CZ]
- TI - Use of stillage from alcohol production
- AB - The invention relates to a method of comprehensive use of stillage originating from bio alcohol mass production, while the end products of the process are biogas, dried stillage **waste** with low salt content, granulated sludge from **anaerobic** digestion, **solid** fertilizer on the basis of magnesium ammonium **phosphate**, elementary sulphur, sludge from aerobic final **treatment**, and **waste** heat from process **water**. According to the method, insoluble fraction is removed from the raw stillage by means of centrifugation, while remaining dispersed substances are removed from liquid fraction by air flotation, centrifugation, vacuum filtration, or a combination of these processes in the secondary **separation** step. Thickened dense fractions from both of these steps, having low salt content, are further processed to feed of high nutritional value. Liquid fractions from both of these steps are blended and acidified under controlled conditions at pH ranging between 4.8 and 9.2. Then, they are taken to **anaerobic** digestion to the reactor with granulated **biomass**, wherein the said liquid fractions enter the reactor in its bottom part. The **biomass** consists of acidifying and methanogenic **bacteria** and the **anaerobic** digestion is performed at the temperature between 25 and 40°C, residence time 2 to 50 hours, and the granulated **biomass** loading rate between 5 to 105 COD/m<sup>3</sup> .day<sup>-1</sup>. The accumulated granulated sludge is removed and dried. Biogas exhausted from the **anaerobic** reactor head is **biologically** desulphurized, and elementary sulphur is produced as a by-product. The biogas is then used energetically. From the liquid fraction **nitrogenous** substances are removed by dosing magnesium chloride and **phosphoric** acid resulting in precipitation of insoluble magnesium ammonium **phosphate** that is **separated** and removed as a high-quality fertilizer. The liquid fraction is further taken to the aerobic final **treatment** where sludge is **separated**. After having been thickened, the sludge can be utilized in agriculture. From the aerobic final **treatment** plant treated **water** having parameters meeting requirements for release to watercourse is taken. It is then discharged or re-used in the process after an optional distillation. Furthermore, the invention relates to the device needed to perform the method of the invention.

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- PN - [CZ300046](#) B6 20090114
- PNFP - CZ20050534 A3 20070704
- PR - CZ20050000534 20050824
- AP - CZ20050000534 20050824
- DT - I
- CT - || STSE (B6)  
[CZ287547](#) B6 20001213 [ ] (HOFSCHNEIDER MIROSLAV [CZ])  
[CZ283579](#) B6 19980513 [ ] (KAMPEN WILLEM HEMMO [US])  
[CZ283872](#) B6 19980617 [ ] (MACHEK FRANTISEK [CZ], et al)  
[CZ278603](#) B6 19940316 [ ] (HOFSCHNEIDER MIROSLAV [CZ])

[CZ297094](#) B6 20060913 [ ] (VON NORDENSKJOELD REINHART [DE])

[US6488851](#) B1 20021203 [ ] (PROJECTS LTD [IL])

[GB2167055](#) A 19860521 [ ] (BIOSYSTEM E AB)

[PL159135B](#) B1 19921130 [ ]

[CN1566029](#) A 20050119 [ ] (PANG CHAOAN [CN])

- CCI - [C12M21/04](#) ; [C12M23/58](#) ; [C12M45/02](#) ; [C12M47/18](#) ; [C12P3/00](#) ; [C12P5/023](#) ; [C12P7/00](#)
- CCA - [Y02E50/343](#) ; [Y02P20/129](#)
- PA - (A3 B6)  
PROKOP INVEST [CZ]; HYDROTECH S R O [CZ]; WESTFALIA SEPARATOR CZ S R O [CZ]; CKD PRAHA [CZ]
- TI - (A3)  
Method of comprehensive use of stillage from bioalcohol large scale production
- (B6)  
Method of comprehensive use of stillage from bioalcohol large-scale production
- AB - (B6)  
The present invention relates to a method of comprehensive use of stillage originating from bioalcohol mass production, while the final products of the process are biogas, dried stillage **waste** with low salt content, granulated sludge from **anaerobic** digestion, **solid** fertilizer based on magnesium-ammonium **phosphate**, elementary sulfur, sludge from aerobic final **treatment**, and **waste** heat from process **water**. According to the method, insoluble fraction is removed from the raw stillage by means of centrifugation, while remaining dispersed substances are removed from liquid fraction by air flotation, centrifugation, vacuum filtration, or a combination of these processes in the secondary **separation** step. Thickened dense fractions from both of these steps, having low salt content, are further processed to feed of high nutritional value. Liquid fractions from both of these steps are blended and acidified under controlled conditions at pH value ranging between 4.8 and 9.2. Then, they are taken to **anaerobic** digestion to the reactor with granulated **biomass**, wherein the said liquid fractions enter the reactor in its bottom part. The **biomass** consists of acidifying and methanogenic **bacteria** and the **anaerobic** digestion is performed at the temperature between 25 and 40 degC, dwell time 2 to 50 hours, and the granulated **biomass** loading rate between 5 to 105 COD/me-3 per one day. The accumulated granulated sludge is removed and dried. Biogas exhausted from the **anaerobic** reactor head is **biologically** desulfurized to yield elementary sulfur as a by-product. The biogas is then used energetically. From the liquid fraction, **nitrogenous** substances are removed by proportioning magnesium chloride and **phosphoric** acid resulting in precipitation of insoluble magnesium-ammonium **phosphate** that is **separated** and removed as a high-quality fertilizer. The liquid fraction is further taken to the aerobic final **treatment** where sludge is **separated**. After having been thickened, the sludge can be utilized in agriculture. From the aerobic final **treatment** plant treated **water** having parameters, meeting requirements for release to watercourse is taken. It is then discharged or re-used in the process after an optional distillation. Furthermore, the invention relates to an apparatus used for making the above-described method.