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BIOREACTOR FOR WASTEWATER TREATMENT

[0001] The present application relates to one or more bioreactors for wastewater treatment. The application also relates methods for making, assembling, disassembling, installing, configuring, maintaining, repairing and using the one or more bioreactors.

[0002] Bioreactors often utilises membranes and biological matter (e.g. microorganisms) to produce useful substances, including pharmaceuticals, antibodies or vaccine components. The one or more bioreactors include mechanically agitated bioreactors, pneumatically agitated bioreactors or non-agitated bioreactors. Mechanically agitated bioreactors include: aeration-agitation bioreactors; rotating drum bioreactors; and spin-filter bioreactors. Pneumatically agitated bioreactors include sparge bioreactors, and air-lift bioreactors. Non-agitated bioreactors include gaseous phase bioreactors, oxygen-permeable membrane aerator bioreactors, and overlay aeration bioreactors. In practice, a bioreactor is sometimes used to convert organic wastes into biomass or biofuels, remediate toxic wastes (e.g. toxic chemicals) to inert or non-bioavailable forms, such as precipitation or reduction/oxidation of heavy metals. However, generally speaking, most bioreactors have low efficiency in production, especially when adopting naturally existing microorganisms, such as microalgae.

[0003] The present invention aims to provide one or more new and useful bioreactors. The invention also desires to present one or more new and useful methods for making, assembling, disassembling, installing, configuring, maintaining, repairing and using the bioreactors. Essential features of the invention are provided by one or more independent claims, whilst preferred features are presented by their dependent claims respectively.

[0004] The present invention provides improvement over a bioreactor that has a static sprayer and a static bio membrane structure. The static sprayer and stationary bio membrane structure poses inefficiency with the wastewater treatment because nutrient of the waste water (organic materials) are not spread evenly or widely onto the membrane for effective or efficient treatment. Also, microorganism will tend not to

spread uniformly across all the membranes thus resulted in pockets of overgrown/undergrowth of microorganism.

[0005] The present application provides a helicopter rotating sprayer, instead of static sprayer. The static sprayer is unable to flush down the accumulation of sludge on the top portion of the membrane whereas a helicopter rotating sprayer similar to those found in a dishwasher will be able to seed the wastewater across evenly and at same time work like a dishwasher to wash/flush away the sludge built-up. The helicopter sprayer may not require additional mechanism as the hydrodynamic of the water spraying force is able to cause the rotation of the sprayer similar to the dishwashing or gardening nozzle concept.

[0006] The present application further provides one or more moving beds for holding membrane sheets.

[0007] The moving bed provides a circular layout attached to a centre core. In such manner, membranes on the moving bed are able to make rotating at a slow speed (e.g. clockwise or anti-clockwise to the direction of the sprayer head). Such layout maximises the membranes' treatment surface area and enable rotation of the membrane sheet which promote air circulation uniformly inside a closed chamber of the bioreactor, thus promote better evaporation of the membrane surface at the same time. Rotation of the bed can be wind powered or by the wastewater entering at a tangential to the circular chamber and hitting on the flap causing it to turn like a windmill. Being a circular shape, the construction can be constructed as a cyclonic system to promote better air circulation inside the chamber. Also, the base of the cylindrical design can be conically constructed to allow settling and effective collection of the sludge for recycling or disposal. The circular rotatable arrangement of the sheet also allows easy cleaning, inspection, replacement and maintenance via an opening door and similarly rotating the sheet.

[0008] Additionally, routinely setup high speed spinning of the centre core may dislodge/scrap out excess built-up via centrifugal force. Or in built a circular rim with spike that could lowered or raised to scrap off the membrane surface. Alternatively, installing a vertical spray arm via the centre core support or at the circumference to

spray horizontally into the between-sheet when it is rotating could help and prevent adhesion. Or while rotating, at one point of the setup, each sheet will be lifted up when passing through this point thus created a sheering effect to prevent adhesion, etc.

[0009] The accompanying figures (Figs.) illustrate embodiments and serve to explain principles of the disclosed embodiments. It is to be understood, however, that these figures are presented for purposes of illustration only, and not for defining limits of relevant inventions.

Fig. 1 illustrates a bioreactor that has radial fins, rotatable fluid dispenser and a vertical wind turbine;

Fig. 2 illustrates the bioreactor that has a housing and a waste water circulation pump;

Fig. 3 illustrates a radial fin that supports convoluted porous membrane;

Fig. 4 illustrates a top view of the bioreactor having a cylindrical frame for supporting porous membranes; and

Fig. 5 illustrates another bioreactor that has short fins and long fins evenly distributed around a circumference of the cylindrical frame.

[0010] Exemplary, non-limiting embodiments of the present application will now be described with references to the above-mentioned figures.

[0011] Figs. 1 to 4 provides a first embodiment of the application. Fig. 1 illustrates a bioreactor that has radial fins, rotatable fluid dispenser and a vertical wind turbine. The radial find extends from a longitudinal axis or core of the bioreactor, which has a cylindrical profile. A rotatable dispenser is mounted on top of a cylindrical frame. Two arms extend from a centre of the rotatable dispenser such that the two arms are able to discharge liquid (e.g. waste water) onto the porous membranes below. Besides, the vertical turbine is propelled by external wind and further direct the external wind downwards, supplying fresh oxygen onto the membrane below, greatly improving biochemical reaction efficient for waste water treatment.

[0012] Fig. 2 illustrates the bioreactor that has a housing and a waste water circulation pump. The housing prevents direct sunshine from inhibiting growth of

microorganism on the porous membrane. The housing further collects treated waste water, which recirculated back to an entrance on top, for repeated treatment.

[0013] Fig. 3 illustrates a radial fin that supports convoluted porous membrane. Hence, the porous membrane has many creases which greatly extends surface areas for biochemical reaction.

[0014] Fig. 4 illustrates a top view of the bioreactor having a cylindrical frame for supporting porous membranes. Each radial arm of the bioreactor hangs a porous membrane that is convoluted. Effectively, the bioreactor is more productive because each of these porous membrane has larger surface areas available for handling waste water.

[0015] The bioreactor incorporates an aeration pump that utilises ceramic-based ultra-fine pores to create ultra-fine/nano-bubbles into waste water. When a liquid flow is supplied into the boundary of this special ceramic nozzle, a gas phase is ejected from the nozzle. The gas phase is cut so finely that it results in the creation of ultra-fine/nano-bubbles. Bubbles of 50microns or less will shrink by the sheer force of the ions created at the gas-liquid interface. Due to the contraction, the ion concentration of the gas-liquid interface is being enhanced, while the pressure and temperature inside rises, leading to the occurrence of a variety of phenomena. This unique technology is able to provide a range of compact and economical systems to cover small or large scale applications, from small ponds to the open sea.

[0016] Alternatively, the bioreactor incorporates a micro bubble generator that is able to

1. remove impurities from waste water in preparation for various industries;
2. pre-treat of kitchen waste water;
3. treat excrement (of livestock) treatment after rough separation by vibratory screen;
4. recycle high-grade paper fibre;
5. remove crystal and chemical impurities;
6. remove sediments, sludge and algae for pond/lake purification; and
7. provide a micro bubbled bath;

[0017] The bioreactor can include a microbubble generating pump in efficiency for reducing the footprint of dissolved air flotation (DAF) / induced gas flotation (IGF) and other gas / liquid, liquid / liquid mixing applications.

[0018] The bioreactor can be included for conducting following tasks.

1. Primary Treatment e.g. fine and coarse screen into the membrane unit;
2. Tertiary Treatment e.g. disinfection, we could use the nano-bubble injection, electrolysis, etc. at outlet or energy-saving RO system

[0019] The bioreactor provides an ONE-stop Pri-Sec-Tertiary 3-in-1 compact standalone treatment system or apparatus.

[0020] Fig. 5 provides a second embodiment of the application. Particularly, Fig. 5 illustrates another bioreactor that has short fins and long fins evenly distributed around a circumference of the cylindrical frame. Shot fins that extend from a circumference of the cylindrical frame provides more room for fluid circulation around the longitudinal axis. Fluid circulation within the bioreactor becomes smooth and experience less resistance. The short fins can hang smooth membranes or convoluted membranes.

[0021] In the application, unless specified otherwise, the terms "comprising", "comprise", and grammatical variants thereof, intended to represent "open" or "inclusive" language such that they include recited elements but also permit inclusion of additional, non-explicitly recited elements.

[0022] As used herein, the term "about", in the context of concentrations of components of the formulations, typically means +/- 5% of the stated value, more typically +/- 4% of the stated value, more typically +/- 3% of the stated value, more typically, +/- 2% of the stated value, even more typically +/- 1% of the stated value, and even more typically +/- 0.5% of the stated value.

[0023] Throughout this disclosure, certain embodiments may be disclosed in a range format. The description in range format is merely for convenience and brevity and

should not be construed as an inflexible limitation on the scope of the disclosed ranges. Accordingly, the description of a range should be considered to have specifically disclosed all the possible sub-ranges as well as individual numerical values within that range. For example, description of a range such as from 1 to 6 should be considered to have specifically disclosed sub-ranges such as from 1 to 3, from 1 to 4, from 1 to 5, from 2 to 4, from 2 to 6, from 3 to 6 etc., as well as individual numbers within that range, for example, 1, 2, 3, 4, 5, and 6. This applies regardless of the breadth of the range.

[0024] It will be apparent that various other modifications and adaptations of the application will be apparent to the person skilled in the art after reading the foregoing disclosure without departing from the spirit and scope of the application and it is intended that all such modifications and adaptations come within the scope of the appended claims.

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Claims

1. A bioreactor for waste water treatment, the bioreactor comprising:
   - at least one porous membrane that has an air surface for receiving oxygen and a liquid surface for growing microorganism;
   - a holder for supporting the at least one porous membrane;
   - a distributor for dispensing oxygen or organic material onto the at least one porous membrane; and
   - an agitator for circulating fluid at the porous membrane;

   wherein the air surface and the liquid surface are provided on opposite sides of the at least one porous ceramic membrane.

2. The bioreactor of claim 1, wherein
the porous membrane comprises ceramic material with nano-sized pores.

3. The bioreactor of claim 1 or 2 further comprising
a housing that prevents ultraviolet light from inhibiting microorganism growth on the at least one porous membrane.

4. The bioreactor of claim 3, wherein
the housing comprises ventilation slots for receiving oxygen from exterior.

5. The bioreactor of any of the preceding claims, wherein
the holder comprises a cylinder having arms radiating from a longitudinal axis of the shaft, at least one of the arms being configured to support the at least porous membrane aligned with the longitudinal direction.

6. The bioreactor of any of the preceding claims further comprising
a fan for propelling oxygen onto the air surface of the at least one porous membrane.

7. The bioreactor of any of the preceding claims, wherein
the agitator is connected to the holder, the distributor, the fan or a combination of any of these for rotating the holder, the distributor, the fan or a combination of any of these.

8. The bioreactor of any of the preceding claims, wherein
the agitator comprises an energy harvester for powering the bioreactor.

9. The bioreactor of claim 8, wherein
the energy harvester comprises a wind turbine, a battery charger, a solar panel, or a combination of any of these.

10. The bioreactor of any of the preceding claims, wherein
the agitator comprises a pump, a motor or a combination of both.

11. The bioreactor of any of the preceding claims, wherein
the air surface, the liquid surface or both the air and liquid surfaces of the at least one porous membrane are convoluted.

12. The bioreactor of any of the preceding claims, wherein
the holder comprises a detachable arm for replacing the at least one porous membrane.

13. The bioreactor of any of the preceding claims, wherein
the at least one porous membrane comprises a wide porous membrane and a narrow porous membrane that are neighbouring each other.

14. The bioreactor of any of the preceding claims, wherein
at least a part of the bioreactor is detachable.

15. The bioreactor of any of the preceding claims, wherein
the holder comprises a cylindrical frame for hanging the at least one porous membrane.

16. A bioreactor substantially as hereinbefore described with reference to or as illustrated in any of the accompanying drawings.

17. A method of using a bioreactor substantially as hereinbefore described with reference to or as illustrated in any of the accompanying drawings.

18. A method of making a bioreactor substantially as hereinbefore described with reference to or as illustrated in any of the accompanying drawings.