FORM 2

THE PATENTS ACT, 1970

(39 of 1970)

&

THE PATENTS RULES, 2006

COMPLETE SPECIFICATION

[See section 10, Rule 13]

1. **TITLE OF THE INVENTION**: PROCESS AND APPARATUS FOR TREATING WASTEWATER

2. **APPLICANT**

i.) **Name**: Rajasthan Urban Infrastructure Development Project (RUIDP)

ii.) **Nationality**: India

iii.) **Address**: c/o RUIDP AVS Building, Jawahar Lal Nehru Marg, Jaipur-302017, Rajasthan India

3. **PREAMBLE TO THE DESCRIPTION**

THE FOLLOWING SPECIFICATION PARTICULARLY DESCRIBES THE INVENTION AND THE MANNER IN WHICH IT IS TO BE PERFORMED

FIELD OF THE INVENTION

[0001] The invention relates to a wastewater treatment. More particularly, the present invention discloses a process for treating wastewater in a bio-reactor.

BACKGROUND OF THE INVENTION

[0002] The discharge of untreated wastewater is not suitable in rivers, since it gives rise to numerous environmental concerns, such as pollution of surface and groundwater resources. Thus, when untreated wastewater is released into either aboveground body of water or subsurface drain fields, a level of dissolved oxygen in the receiving waters begins to deplete, which endangers the water bodies themselves, along with the resident plant and aquatic life.

[0003] Therefore, the treatment of wastewater is required for removal of organic and inorganic contaminants, usually present in solid and/or dissolved form in the wastewater, before their discharge into the receiving waters. The organic contaminants include sources of chemical oxygen demand (COD)/ Biochemical oxygen demand (BOD) such as proteins, lipids and polysaccharides.

[0004] The COD/BOD parameters are used to measure the organic charge in the wastewater. These parameters define the overall oxygen load that a wastewater will impose on the receiving water.

[0005] To treat wastewater, communities in highly populated areas commonly collect wastewater and transport it through a series of underground pipes to a large, centralized wastewater treatment plant.

[0006] However, if there is an absence of a centralized sewerage network, decentralized treatment options for cluster of households become more relevant.

[0007] One such treatment process is biological treatment process which uses a variety of microorganisms such as bacteria, protozoa and metazoa for an efficient and complete biodegradation of contaminating compounds in wastewater and contaminated groundwater and landfill leachates. The removal of Carbonaceous, Nitrogenous and Phosphorus-containing compounds is carried out by bacteria, whereas protozoa and metazoa mostly contribute to the reduction of turbidity since they graze on bacteria as a food source.

[0008] During biological treatment processes, organic substances are removed since these substances serve as the source of carbon in the microbial metabolism. Nitrogen and Phosphorus are also consumed by microorganisms as essential nutrients to support microbial growth during assimilatory processes, while excess amounts of nitrogenous compounds are removed during dissimilatory microbial nitrogen metabolism where they are transformed to molecular nitrogen and released into the atmosphere.

[0009] The remaining Phosphorus may be removed by process where special groups of microorganisms accumulate Phosphorus and store it as poly-phosphorus compounds, thus removing it from the system during sludge disposal.

[0010] Nitrogen and Phosphorus have been recognized as major contributors to eutrophication, a process that supports the growth of algae and other undesirable organisms in the receiving waters and diminishes the concentration of dissolved oxygen, thus threatening aquatic life.

[0011] Therefore, stringent criteria have been introduced demanding the reduction of these nutrients below certain levels that are established by environmental agencies, before the effluent of treatment plants can be safely disposed to the receiving waters.

[0012] The success of biological treatment processes is governed by imminent factors like concentration of biomass and the mean cell residence time (MCRT), as well as the ability of treatment process to solids, primary as well as secondary in nature after treatment. These parameters control the efficiency of treatment and the quality of effluent.

[0013] However, suspended-growth biological treatment units that are based on activated sludge processes have difficulties in maintaining an adequate concentration of active biomass, and to effectively separate solids from liquid.

[0014] Further, these units also produce large amounts of sludge and have a slow adaptation to fluctuating influent conditions.

[0015] These problems have been addressed in the design of fixed-film treatment systems that use attached microbial biomass, immobilized on a support material. The immobilized cells grow and produce microbial biofilm, containing a consortium which is highly volatile and sensitive, the biological footprint keeps changing rapidly ranging from flagellates and fibrous micro-organisms. A little shift in the dissolved Oxygen changes predominantly from aerobic to anaerobic.

[0016] These fixed-film systems can operate in aerobic, anoxic or anaerobic modes depending on the nature of the contaminating compounds. These systems offer microbial diversity and prevent the washout of biomass. They also offer a higher MCRT and ease of operation relative to the separation of biomass from liquid.

[0017] However, fixed film systems are also disadvantageous attributable to mass transfer limitations and diffusion within microbial film. These systems also have a limited capacity due to oxygen transfer limitations.

[0018] Further, excessive development of biofilm while treating heavily organically loaded effluents may also cause clogging, seriously disrupting the treatment process.

[0019] Another disadvantage of fixed-film treatment systems is that they usually operate in plug-flow mode and do not offer the homogenous environment provided by completely mixed reactors.

[0020] Furthermore, in these systems, there is a high concentration of contaminants at the influent end of the reactor and the microorganisms are subjected to the full concentration of contaminants that may be toxic.

[0021] On the other hand, suspended biomass-based systems occupy much larger space and shall be non-purposeful for a decentralized – fully mobile -skid mounted unit.

[0022] The abovementioned processes were originally designed for treatment of night soil laden effluent and ignores the kitchen wastes, i.e., removal of Carbonaceous compounds and solid-liquid separation and not to remove nutrients.

[0023] These technologies also may not stabilize the produced sludge and need supplementary vessels for this process.

[0024] Therefore, there is a need to develop a reactor which may carry out the whole treatment of the wastewater without need of a grid electricity.

[0025] Further, there is need to develop a process which may efficiently remove nitrogenous and carbonaceous compounds along with solid-liquid separation, without removing essential nutrients.

[0026] Additionally, there is need to develop a treatment solution which is suitable to be applied in urban, sub-urban, group housings, cluster of houses, rural areas specially in micro-zones, more specifically, in areas where water supply level is less than 135 liters per capita per day.

[0027] In nutshell, there is a need for a process and an apparatus which may overcome the above discussed drawbacks in a cost effective and efficient manner.

SUMMARY OF THE INVENTION

[0028] In an aspect of the present invention, a process for treating wastewater in a bioreactor is disclosed. The said process is capable of treating the wastewater in a cost effective and efficient manner.

[0029] The said process includes introducing the wastewater in a first chamber of the bio-reactor.

[0030] Further, the said process includes pre-treating the wastewater in the said first chamber. The said first chamber includes a primary settling unit for removal of particulate and organic matter.

[0031] In the embodiment of the present invention, the said primary settling unit includes a tube settler deck media tube settler deck media coated with the immobilized anaerobic bacterial strains utilizing macro porous hydrogel.

[0032] (In the embodiment of the present invention, the said immobilized anaerobic bacterial strains including but not limited to Methanosarcina and Methanobrevibacter.

[0033] In one embodiment of the present invention, the said hydrogel is of hydrophilic nature with adhesive properties for prolonged adhesion to the tube deck settler media surface. The pore size of the microporous hydrogel lattice structure ranging from 50 microns to 150 microns.

[0034] In one embodiment of the present invention, the process includes transferring the pre-treated wastewater in a second chamber of the said bio-reactor from the said first chamber.

[0035] Further, the process includes treating the said pre-treated wastewater in the said second chamber operating at predefined conditions for obtaining filtered water.

[0036] In the embodiment of the present invention, the second chamber includes a secondary unit includes aerobic zone, multiple anaerobic baffled zones, and microaerophilic zone for removal of pollutants form the said pre-treated wastewater, thereby obtaining filtered water.

[0037] In the said multiple anaerobic baffled zones are partially filled with biocarriers for effective circulation of the said wastewater within the said second chamber.

[0038] In one embodiment of the present invention, the said microaerophilic zone includes hydrophilic plants embedded on a buoyant support material at the top of the said reactor.

[0039] In the embodiment of the present invention, the said material has fibrous structures for harboring necessary micro-organisms.

[0040] In one embodiment of the present invention, the said secondary unit is partially filled with aerobic sludge granules for effective treatment of the said wastewater.

[0041] In various embodiments of the present invention, the said pollutants comprise Carbonaceous compounds, Nitrogenous compounds, Phosphorus compounds, or the like.

[0042] This together with the other aspects of the present invention along with the various features of novelty that characterized the present disclosure is pointed out with particularity in claims annexed hereto and forms a part of the present invention. For better understanding of the present disclosure, its operating advantages, and the specified objective attained by its uses, reference should be made to the accompanying descriptive matter in which there are illustrated exemplary embodiments of the present invention.

DESCRIPTION OF THE DRAWINGS

[0043] The advantages and features of the present invention will become better understood with reference to the following detailed description taken in conjunction with the accompanying drawings, in which:

[0044] **Fig. 1** illustrates a flowchart depicting exemplary process for treating wastewater in a bio-reactor, according to various embodiments of the present invention;

[0045] **Fig. 2** illustrates a illustrates an exemplary block diagram representing the bio-reactor, according to various embodiments of the present invention;

[0046] **Fig. 3** illustrates structural views representing macroporous hydrogel inoculating with Methanosarcina, according to various embodiments of the present invention;

[0047] **Fig. 3A** illustrates a microscopic view representing the macroporous hydrogel inoculated with Methanosarcina, according to various embodiments of the present invention;

[0048] **Fig. 3B** illustrates a microscopic view representing the macro porous hydrogel inoculated with Methanosarcina after full maturation, according to various embodiments of the present invention;

[0049] **Fig. 4A** illustrates a microscopic view representing the macro porous hydrogel inoculated with Methanosarcina after full maturation, according to various embodiments of the present invention;

[0050] **Fig. 4B** illustrates a picture representing the adhesion of the macro porous hydrogel in a surface of tube deck settler media, according to various embodiments of the present invention;

[0051] **Fig. 5A** illustrates a plan view of a microaerophilic zone that includes a Floating Bio-rack having hydrophilic plants, according to various embodiments of the present invention;

[0052] Fig. 5B illustrates an isometric view of a microaerophilic zone that includes a Floating Bio-rack having hydrophilic plants, according to various embodiments of the present invention;

[0053] Fig. 5C illustrates a picture representing a microaerophilic zone that includes a Floating Bio-rack having hydrophilic plants, according to various embodiments of the present invention; and

[0054] Fig. 6 illustrate structural views of aerobic sludge granules filled in bio-reactor of Fig. 2, according to various embodiments of the present invention.

[0055] Like numerals denote like elements throughout the figures.

DESCRIPTION OF THE INVENTION

[0056] The exemplary embodiments described herein detail for illustrative purposes are subjected to many variations. It should be emphasized, however, that the present invention is not limited to a wastewater treatment as disclosed. It is understood that various omissions and substitutions of equivalents are contemplated as circumstances may suggest or render expedient, but these are intended to cover the application or implementation without departing from the spirit or scope of the present invention.

[0057] Specifically, the following terms have the meanings indicated below.

[0058] The terms "a" and "an" herein do not denote a limitation of quantity, but rather denote the presence of at least one of the referenced items.

[0059] The terms "having", "comprising", "including", and variations thereof signify the presence of a component.

[0060] The present invention relates to wastewater treatment. More specifically, the present invention discloses a process for treating wastewater in a bio-reactor.

[0061] In an embodiment of the present invention, the wastewater containing homogenized domestic sewage waste, which is generated from a cluster of households, residential complexes, group housing schemes or originated from municipal or landfill leachate contaminated with organic and/or inorganic chemicals.

[0062] The organic chemicals may contain sources of Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD), biodegradable fats, oil, grease, solids, and inorganic material notably Nitrogen and Phosphorus. The ingenuity of the preposition holds in the non-discriminative form of treatment while receiving the domestic waste coming from all types of activities, urban or rural.

[0063] The inventive aspects of the invention along with various components and engineering involved will now be explained with reference to **Figs. 1-6** herein.

[0064] Referring to **Figs. 1 & 2**, at step (12), the process (50) includes introducing the wastewater in the first chamber (110) of the bio-reactor (100).

[0065] In the said embodiment of the present invention, the said wastewater is introduced from houses, industries etc. via underground sewage pipes.

[0066] Further, at step (14), the process (50) includes pre-treating the wastewater in the said first chamber (110) that includes a primary settling unit (112) for removal of particulate and organic matter.

[0067] In one embodiment of the present invention, the said primary settling unit separates the solid sludge from the wastewater, and settle it down at the bottom of the reactor (100).

[0068] In an embodiment of the present invention, the said primary settling unit includes a tube settler deck media (112) which is coated with immobilized anaerobic bacterial strains utilizing macro porous hydrogel (Refer **Fig. 3**).

[0069] In the said embodiment of the present invention, the said anaerobic bacterial strains are immobilized on the hydrogel, thereby providing resistant to shear forces that might be experienced during peak flow scenarios or during unprecedented backwash flow inside the primary settler unit.

[0070] In above embodiments of the present invention, the said immobilized anaerobic bacterial strains include but not limited to Methanosarcina and Methanobrevibacter.

[0071] Referring to **Fig. 4**, the said hydrogel is of hydrophilic nature having adhesive properties for prolonged adhesion to the tube deck settler media surface (112). The adhesion properties of the hydrogel to the tube deck settler media may last upto not less than 3 years from the date of commencement of the operations.

[0072] In one embodiment of the present invention, the pore size of the microporous hydrogel lattice structure is ranging from 50 microns to 150 microns.

[0073] The hydrogels are basically triple dimension existent polymer networks that accumulate, swell and hold large quantities of water. Hydrogels may be biologically derived (ranging from polysaccharides to heavier glycoproteins) as well as synthetic polymer based.

[0074] Both synthetic as well as biologically derived polymers with different chemically active groups have been used successfully for persistent and permanent immobilization of the desired micro-organisms.

[0075] Macro porous hydrogels have been made to serve as scaffolds or supports for immobilization of bacteria, viruses, cell tissues etc., chemical resistance to environment, improved swell ability (capacity to hold water and solutes), mechanical stability, porosity, elasticity and bio compatibility are the critical factors which encourage hydrogels or cryogel for industrial and field applications.

[0076] These hydrogels also respond to number of stimuli for eg. electricity, pH, temperature, pressure, etc. and shrink and expand based on the physio-chemical properties of the network forming matrix.

[0077] By adopting different methods for immobilization, number of cells, viable cells and hence the performance of the biocatalytic / bioremediation process may be varied. Immobilized cells are easy to be segregated, possess higher tolerance to pH variations which is predictable in the considered environment referring to this invention, and can be reutilized for regrowth during replenishment phase.

[0078] The macro porous hydrogel including Poly Vinyl Alcohol crossed linked using Maleic Acid doped with Chitosan.

[0079] Poly Vinyl Alcohol is a semi-crystalline polymer of vinyl acetate and alcohol. In its original form it is water soluble and has excellent rheological and elastomeric characteristics.

[0080] The composition of the said hydrogel is shown as below:

-PVA (Mw = 190000–350000 Da, 98% hydrolyzed), Chitosan (CS) with degree of deacetylation >75%, sodium bicarbonate (NaHCO3), Phosphate Buffered Sline (PBS), Hydrochloric acid (HCl), Ethanol, Tetraethoxysilane.

[0081] Firstly, a separate partially polymerized solution of Chitosan-Silica composite (theoretical mass ratio of 1:15 to 1:30) was realized through hydrolysis of Tetraethoxysilane (TEOS) in Chitosan solution in presence of alcohol, organic acid and constant slow rpm stirring for 30-40 min. The viscosity and consistency were constantly observed, and added gently drop wise to separate solution comprising of PVA with Maleic Acid as cross linking agent (dose range from 5 to 15% w/w).

[0082] The prepared blend solution is now crosslinked using Maleic Acid with various weight percentages as mentioned above and stirred moderately at 65-85 °C until the solution achieved optimum desired viscosity.

[0083] Thereafter, by introducing PVA cross linked with Maleic Acid and Silica using TEOS as precursor, highly amorphous end product was achieved, where in the Chitosan biopolymer added flexibility for the Hydrogel which is essentially required for long term durability in a hard environment.

[0084] Again, referring to **Figs. 1 & 2**, at step (16), the process (50) includes transferring the pre-treated wastewater in a second chamber (120) of the said bio-reactor (100) from the said first chamber (110).

[0085] Further, at step (18), the process (50) involves treating the said wastewater for obtaining the filtered water.

[0086] In the embodiment of the present invention, the said second chamber (120) includes a secondary unit including aerobic zone (122), multiple anaerobic baffled zones (124), and microaerophilic zone (126) (refer **Fig. 2**).

[0087] In the embodiment of the present invention, the said aerobic zone (122) having an inlet to receive the pretreated wastewater from the primary settling unit for carrying out aerobic digestion of the said wastewater in the said bio-reactor (100) (refer **Fig. 2**).

[0088] Thereafter, the said wastewater is transferred to the multiple anaerobic baffled zones for carrying out the anaerobic digestion of the said wastewater (refer **Fig. 2**).

[0089] In the embodiment of the present invention, the multiple anaerobic baffled zones (124) are partially filled with bio-carriers for effective circulation of the said wastewater within the said second chamber (120) (refer **Fig. 2**).

[0090] The 'biocarriers' are also known as biofilm carriers are solids that allow the good attachment of microbes during wastewater treatment.

[0091] In various embodiments of the present invention, the said aerobic (122) and multiple anaerobic baffled zones (124) are partially filled with aerobic sludge granules for effective treatment of the said wastewater (refer **Fig. 2**).

[0092] In the embodiment of the present invention, the aerobic sludge granules are filled to eliminate the need for the wastewater pumping and recycling. These aerobic sludge granules either may be generated onsite or distributed to these off-site locations periodically.

[0093] The Aerobic sludge granules are tightly aggregated mass of microorganisms, extracellular polymeric substances (EPS), and inorganic material.

[0094] These dense chemical-microbial consortia are typically spherical or ellipsoidal in shape and ideally have a smooth outer surface. Average granule diameter has been reported between 0.2-5 mm, and more specifically, the granules cultivated on municipal wastewater typically have diameters between 0.2-1.3 mm (refer to **Fig. 6**).

[0095] Referring to **Figs. 1, 2 & 5A-5C**, the said microaerophilic zone (126) of the said bio-reactor (100) is shown, the said microaerophilic zone (126) includes a Floating Bio-rack that including hydrophilic plants (126a) which are embedded on a buoyant support material (126b) at the top of the said reactor (100).

[0096] In one embodiment of the present invention, the said buoyant support material (126b) hold the hydrophilic plants (126a) from getting fully submerged into the reactor (100) (refer **Figs. 5B & 5C**)

[0097] In the said embodiment of the present invention, the said material (126b) has fibrous structures for harboring necessary micro-organisms.

[0098] In one embodiment of the present invention, the buoyant support materials are made of coir, thermocol, inflated pods, or the like.

[0099] In various embodiments of the present invention, said filtered water is transferred to water bodies such as rivers, lakes etc.

[00100] In various embodiments of the present invention, the said reactor (100) is incorporated with siphon assisted vacuum pumps to create flocculation without adding any addition of coagulant or flocculant.

[00101] Further, the incorporation of the said siphon assisted vacuum pumps is adapted to lift the sewage from the ground level to the operating level.

Microbial investigation

[00102] The most probable number (MPN) of total coliform at the outlet of the integrated process at overall Hydraulic retention time (HRTs) of 28 h is derived. The average reduction of these parameters was observed approximately 99% at the outlet end of the process (50).

[00103] "Most probable number (MPN)" is a statistical estimate of the number of coliform-group organisms per unit volume of sample water.

[00104] The term Hydraulic retention time (HRT) indicates the mean residence time of the wastewater within a biological reactor, thus determining the contact time between the pollutant and the microorganisms.

[00105] In wetland units, there is a reduction of the E-Coli level at the outlet, and biological mass gets attached to the surface of the Floating Reed Racks in the initial stage of operation.

[00106] At steady state condition, there may be uniform growth of biomass on the Bio-rack surfaces, and biomass may slough and come out with the flowing water.

[00107] The microflora surrounds with extracellular polymeric substance which is responsible for their adhesion to develop the biofilm and bio-oxidation mechanism.

[00108] Total viable count (TVC) concentrations were also found to be high both on the root surface of Phragmites sp. and Typha sp. It should be realized that Phragmites sp. with its extensive root system enhanced bacterial population throughout the Floating Bio-rack unit.

[00109] In the Floating Bio-rack wetland, the vicinity of the support matrix, stems and roots of the plants are a preferred environment for many micro-organisms to attach and to degrade pollutants in a phytoremediation process.

[00110] Correspondingly, the microflora on the surface of Floating Bio-racks may have the presence of approximately 12 bacterial strains grown on nutrient agar medium i.e. Acinetobacter lwoffii, Aeromonas sobria, Escherichia coli, Pseudomonas stutzeri, Aeromonas hydrophila, Citrobacter koseri, Acienetobacter johnsonni, Entrobacter intermedius, Alcaligenes faecalis, Pantoea sp., Pseudomonas putida, Acinetobacter baumanni.

Advantageous effects of the present invention

[00111] In various embodiments of the present invention, the whole treatment of the wastewater is carried out in a single reactor, thereby reducing the cost of the wastewater treatment unit.

[00112] Further, the process and reactor of the present invention provides ready to plug, no grid electricity requirement, and updated with the latest disposal norms for the population who don't have access to the centralized sewage disposal infrastructure.

[00113] Furthermore, the bio-reactor of the present invention uses siphon assisted vacuum pumps, needed initially to lift the raw wastewater, which drastically reduces the energy requirement by over 80%.

[00114] Additionally, the treatment solution of the present invention is suitable to be applied in urban, sub-urban, group housings, cluster of houses, rural areas specially in micro-zones, more specifically, at sewage treatment solution in areas where water supply level is less than 135 liters per capita per day.

[00115] Moreover, the process of the present invention is suitable for treatment of all kinds of domestic effluent in decentralized manner, thereby promoting local reuse.

[0001] In nutshell, the process and bio-reactor the present invention is capable of overcoming the drawbacks for treating the wastewater in a cost effective and efficient manner.

[0002] The foregoing descriptions of specific embodiments of the present invention have been presented for purposes of description. They are not intended to be exhaustive or to limit the present invention to the precise forms disclosed, and obviously many modifications and variations are possible in light of the above teaching.

[0003] Further, the embodiments were chosen and described in order to best explain the principles of the present invention and its practical application, and thereby enable others skilled in the art to best utilize the present invention and various embodiments with various modifications as are suited to the particular use contemplated. It is understood that various omissions and substitutions of equivalents are contemplated as circumstances may suggest or render expedient, but such omissions and substitutions are intended to cover the application or implementation without departing from the spirit or scope of the present invention.

[0004] REFERENCE NUMERALS LIST

50	-	Process
100	-	Bio-reactor
110	-	First chamber
112	-	Tube deck settler media
120	-	Second chamber
122	-	Aerobic zone
124	-	Multiple Anaerobic baffled zones
126	-	Microaerophilic Zone
126a	-	Hydrophilic plants
126b	-	Buoyant support material

We Claim:

1. A process (50) for treating wastewater, the process comprising:

introducing the wastewater in a first chamber (110) of a bio-reactor (100);

pre-treating the wastewater in the said first chamber (100) comprising treating the wastewater in a primary settling unit of the said first chamber (110) for removal of particulate and organic matter;

transferring the pre-treated wastewater in a second chamber (120) of the said bio-reactor (100) from the said first chamber (110); and

treating the said pre-treated wastewater in the said second chamber (120) operating at predefined conditions for obtaining filtered water,

characterized in that,

the said primary settling unit comprising immobilized strains of anaerobic bacteria, and

the second chamber (120) comprises a secondary unit comprising at least one of an aerobic zone (122), a plurality of anaerobic baffled zones (124), and microaerophilic zone (126), for removal of pollutants form the said pre-treated wastewater, thereby obtaining filtered water.

2. The process as claimed in claim 1, wherein the primary settling unit comprises a tube settler deck media (112) coated with the immobilized anaerobic bacterial strains utilizing macro porous hydrogel.

3. The process as claimed in claim 2, wherein the said immobilized anaerobic bacterial strains comprises at least one of Methanosarcina and Methanobrevibacter.

4. The process as claimed in claim 2, wherein the said hydrogel is of hydrophilic nature, wherein the pore size of the microporous hydrogel lattice structure ranging from 50 microns to 150 microns, wherein the said hydrogel has adhesive properties for prolonged adhesion to surface of the said tube deck settler media (112).

5. The process as claimed in claim 1, wherein the said multiple anaerobic baffled zones (124) are partially filled with biocarriers for effective circulation of the said wastewater within the said second chamber.

6. The process as claimed in claim 1, wherein the said microaerophilic zone (126) comprises hydrophilic plants (126a) embedded on a buoyant support material (126b) at a top zone of the said reactor (100), the said material (126b) having fibrous structures for harboring necessary micro-organisms.

7. The process as claimed in claim 1, wherein the said secondary unit is partially filled with aerobic sludge granules for effective treatment of the said wastewater, and wherein the said pollutants comprise carbonaceous Compounds, Nitrogenous compounds, Phosphorus compounds, or the like.

8. A bio-reactor (100) for treating wastewater, comprising:

a first chamber (110) comprising primary settling unit comprising for removing particulate and organic matter from the wastewater;

a second chamber (120) mechanically connected to the said first chamber (120), the second chamber (120) is adapted to,

receive the said pre-treated wastewater from the said first chamber (110),

carry out the treatment of the said wastewater at predefined conditions for obtaining filtered water,

characterized in that,

the said primary settling unit comprises immobilized strains of anaerobic bacteria, and

the said second chamber (120) comprises a secondary unit comprises at least one of an aerobic zone (122), a plurality of anaerobic baffled zones (124), and microaerophilic zone (126), for removal of pollutants form the said pre-treated wastewater, thereby obtaining filtered water.

9. The bio-reactor (100) as claimed in claim 8, wherein the primary settling unit comprises a tube settler deck media (112) coated with the immobilized anaerobic bacterial strains utilizing macro porous hydrogel, and

wherein the said immobilized anaerobic bacterial strains comprises at least one of Methanosarcina and Methanobrevibacter.

10. The bio-reactor (100) as claimed in claim 8, wherein the said hydrogel is of hydrophilic nature, wherein the pore size of the microporous hydrogel lattice structure ranging from 50 microns to 150 microns.

Dated this 8th day of August, 2022

Kshitij Malhotra

On Behalf of the Applicant

Attorney for the Applicant: IN/PA-1683

ABSTRACT

PROCESS AND APPARATUS FOR TREATING WASTEWATER

The present invention provides a process (50) for treating wastewater. The process includes introducing the wastewater in a first chamber (110) of a bio-reactor (100). The process further includes pre-treating the wastewater in the first chamber (110) including treating the wastewater in a primary settling unit that includes immobilized strains of anaerobic bacteria for removal of particulate and organic matter. Further, the process includes transferring the pre-treated wastewater in a second chamber (120) of the bio-reactor (100) from the first chamber (110). The process further includes treating the pre-treated wastewater in the second chamber (120 which is operating at predefined conditions for obtaining filtered water. The second chamber (120) includes a secondary unit including at least one of an aerobic zone (122), a plurality of anaerobic baffled zones (124), and microaerophilic zone (126), for removal of pollutants form the pre-treated wastewater.

Fig.1