Claims

1. A bioreactor for the aerobic treatment of wastewater, comprising:
   - a reaction vessel (1) comprising a liquid inlet (4) and a gas outlet (12), the reaction vessel having a lower part which is below half of the effective height of the reactor vessel;
   - means for upward moving of reactor content including one or more aeration means (7) located in the lower part of the vessel;
   - a solids separation device (13) for separating solids from liquid, located in the lower part of the reaction vessel, comprising a liquid inlet (15), a liquid outlet and a solids outlet;
     - the liquid inlet (15) of the solids separation device being located at a height of less than 75% of the effective height of the reactor vessel (1),
     - the liquid outlet of the solids separation device being connected to a liquid outlet line (17) exiting the reactor vessel, and
     - the solids outlet of the solids separation device being connected to a solids outlet line (16) ending above the means for upward moving of reactor content,

     wherein the effective height of the reactor vessel is the maximum reactor (water) level.

2. The bioreactor according to claim 1, wherein the liquid inlet of the solids separation device is located at a height of less than 55%, preferably between 20 and 45%, of the effective reactor vessel height.

3. The bioreactor according to claim 1 or 2, wherein the liquid inlet of the solids separation device is positioned directly above the solids separation device or above a part of the reactor vessel where the means for upward moving of reactor content are not located.

4. The bioreactor according to any one of claims 1-3, wherein the solids outlet of the solids separation device is provided with means for producing liquid or gas flows for upward movement of the solids, preferably wherein the solids separation device comprises a series of parallel inclined structures, in particular lamellae or pipes.

5. The bioreactor according to any one of claims 1-4, wherein the bioreactor further comprises a gas separation device integrated in the solids separation device.

6. The bioreactor according to claim 5, wherein the solids separation device (13) comprises an oblique dividing wall (37) dividing the device into a degassing chamber comprising oblique lamellae (34) below inlet (15) and a solids settling chamber comprising oblique lamellae (14).

7. The bioreactor according to any one of claims 1-6, wherein the reactor is covered at the top, apart from the gas outlet, and the reactor preferably has a height of between 4 and 12 m, and/or, in operation, the reaction vessel water height is 3-9 m.

8. The bioreactor according to any one of claims 1-7, wherein the liquid outlet line (17) is connected to a control valve (27), which controls the rate of discharge of the separated liquid so as to adjust the level of the reactor content, wherein the control valve is preferably connected with a detector for measuring the liquid level in the reaction vessel and controlling the control valve, preferably wherein the liquid outlet line (17) of the separation device is connected to the liquid inlet (4) of the reactor vessel by a return line (20) for recycling part of the separated liquid to the reaction vessel, even more preferably wherein the liquid inlet (4) of the reactor vessel is located in the lower part of the vessel.

9. A process for aerobic treatment of wastewater, comprising:

(a) supplying a liquid influent comprising wastewater to an aerated reactor containing granular biomass to provide a reaction mixture;

(b) subjecting the reaction mixture to aerobic conditions comprising a concentration of dissolved oxygen in the range of from 0.1 mg/L to 4.0 mg/L, and a hydraulic retention time in the range of from 0.5 to 72 hours;

(c) separating the reaction mixture into granular biomass and treated wastewater; and

(d) recycling separated granular biomass to the reaction mixture,

characterised in that in step (c) the reaction mixture is separated in the lower part of the reactor, at a hydrostatic pressure of at least 0.2 bar, and in step (d) granular biomass is recycled to the reaction mixture by upward movement inside the reactor, preferably wherein the process is carried out using the device of claims 1-8.

10. The process according to claim 9, wherein in step (d) granular biomass is recycled to the reaction mixture using low shear, in particular by air lift.

11. The process according to claim 9 or 10, wherein the reactor is aerated at a part of the bottom area resulting in one or more vertical aerated zones and one or more vertical non-aerated zones and in step (d) granular biomass is recycled by introducing it into one or more aerated zones.

12. The process according to any one of claims 9-11, wherein in step (c) reaction mixture is separated in a solids separation device, preferably comprising a series of parallel inclined structures, preferably wherein in step (c) reaction mixture to be separated is collected at a height of less than 75%, preferably less than 55% of the effective reactor height, more preferably wherein the reactor is aerated intermittently, and reaction mixture is collected above the level of the granular biomass when the reactor is not aerated, for separation of biomass in step (c), even more preferably wherein steps (a)-(d) are carried out continuously or intermittently, and/or a part of the treated wastewater provided in step (c) is recycled and added to the liquid influent supplied in step (a).

13. The process according to any one of claims 9-12, wherein the granular biomass has a sludge retention time of at least 4 times the hydraulic retention time, preferably between 10 and 50 times the hydraulic retention time, preferably wherein the reactor further comprises non-granular

biomass, and the retention of the non-granular biomass is no more than 3 times the hydraulic retention time and less than 0.2 times the retention time of the granular biomass.

14. The process according to any one of claims 9-13, wherein the wastewater contains ammonia, preferably between 20 and 4000 mg ammonia (expressed as nitrogen) per L, and the granular biomass comprises granules having a core of Anammox bacteria and an outer rim of ammonia-oxidising nitrite-producing bacteria, and wherein the aerobic conditions preferably comprise a concentration of dissolved oxygen of 0.2 mg/L to 2.0 mg/L, more preferably of 0.3 to 0.7 mg/L.

15. The process according to any one of claims 9-14, wherein the level of the reaction mixture in the reactor can be varied by controlling the discharge of treated wastewater from the reactor.