CLAIMS

1. A method for the purification of substrate-containing wastewater in a continuous flow-through aerobic biologically activated sludge reactor B, wherein at least part of biological sludge 6 is conditioned in a selector S under anaerobic or anoxic conditions with at least part of the substrate-containing, to-be-purified wastewater 2, optionally after a pre-treatment step VB of the supplied wastewater 1,
   such that at least 20 wt% of the sludge in the selector S has a residence time in the selector which is at least 20% greater than the hydraulic residence time of the sludge/water mixture in the selector,
   after which the thus conditioned sludge/water mixture 3, optionally after an additional anaerobic or anoxic contact step, is fed to the aerobic purification reactor B and subjected to aerobic treatment B,
   wherein the treated wastewater 4 after aerobic treatment is optionally separated from the sludge by settling NB , flotation or mechanical separation, and wherein (at least a portion of) the sludge separated from the aerobically treated wastewater is returned to the selector as return sludge 6.
2. The method according to claim 1, wherein in the selector the sludge 6 with the wastewater 2 is subjected under anaerobic or anoxic conditions to discrete changes in flow velocity and/or a flow gradient.
3. The method according to claim 2, wherein discrete changes in flow velocity are accomplished by discrete variation in flux in the flow direction of the selector and/or by discrete variation in flow rate.
4. The method according to any one of the preceding claims, wherein at least 40% and more preferably 50 - 90% of the sludge in the selector has a residence time in the selector which is at least 20% greater than the hydraulic residence time of the sludge/water mixture in the selector.
5. The method according to any one of the preceding claims, wherein at least 40%, and more preferably 50-90%, of the sludge in the selector has a residence time in the selector which is at least 40% greater than the hydraulic residence time of the sludge/water mixture in the selector.
6. The method according to any one of the preceding claims, wherein the selector conditions the sludge-wastewater mixture such that at least 20%, and more preferably 40 - 100%, of the sludge in the aerobic biological purification reactor B is granular sludge with a minimum granule size of 0.212 mm.
7. The method according to any one of the preceding claims, wherein the selector conditions the sludge-wastewater mixture such that the proportion of granular sludge is at least 25 wt%, preferably at least 30 wt% and most preferably at least 40 wt%, particularly at least 50 wt%; and preferably such that at least 20 wt% of this granular sludge (i.e. sludge with a size of at least 0.212 mm), or more preferably at least 25 wt%, preferably at least 30 wt% and most

preferably at least 40 wt%, particularly at least 50 wt% of this granular sludge in the aerobic biological purification reactor **B** has a particle size of at least 0.4 – 1.0 mm.

8. The method according to any one of the preceding claims, wherein at least the 10 wt% of largest sludge particles are contacted in the selector with the highest substrate concentration for at least 20% longer than the average contact time of the sludge and wherein this substrate concentration is at least 50% higher than the substrate concentration to which 15 wt% of the smallest sludge particles in the selector are in contact with.
9. The method according to any one of the preceding claims, wherein, in addition to, or instead of return sludge 6 from the secondary settling tank NB , the selector S is fed with the sludge fraction received from mechanical or gravity separators deployed to selectively discharge the slowest settling sludge within the biological purifications or within the return sludge to the sludge processing line.
10. The method according to any one of the preceding claims, wherein the concentration of rapidly biodegradable substrate is increased by dosing an external carbon source, by a side stream from the sludge processing line that is part of the treatment plant where the biological purification reactor is in use, or by pre-treating the wastewater wholly or partially by means of hydrolysis or fermentation.
11. The method according to any one of the preceding claims, wherein the selector S is an upflow reactor with a concentric collection of compartments, with an inner, first compartment Sa and at least one or more further compartments (Sb, Sc etc.) oriented concentrically around the inner compartment, which further compartments are connected at the bottom and top with the preceding compartment, in which a supply for (return) sludge 6 is located at the lower part of the first compartment Sa, and each subsequent compartment has an inlet into the bottom part for wastewater 2 such that the sludge and wastewater are brought into contact with each other, whereby the selector provides a vertical flow ('upflow') in the compartments.
12. The method according to any one of claims 1 to 10, wherein the selector S is an upflow reactor with 3 adjacent and interconnected compartments Sa, Sb and optionally Sc with adjusted volumes, where the effective volume of compartment Sa is smaller than that of Sb , wherein biological sludge 6 and to-be-purified, substrate- containing wastewater 2 flow successively from Sa to Sb and from Sb to Sc, which compartments are in fluid connection at the bottom and top with the previous compartment, and wherein a supply for (return) sludge 6 is located in the bottom part of the first compartment Sa, and each subsequent compartment has an inlet into the bottom part **2** for wastewater such that sludge and wastewater are into contact with each other, whereby the selector provides a vertical flow ('upflow') in the compartments.
13. The method according to any one of claims 1 - 10, wherein the selector S is an upflow reactor with multiple, preferably 3, adjacent and interconnected compartments Sa, Sb and optionally Sc with adjusted volumes, wherein the effective volume of compartment Sa is smaller than that of Sb, wherein sludge 6 and to-be-purified, substrate- containing wastewater 2 flow successively from Sa to Sb and from Sb to Sc, which compartments are connected at the top with the preceding compartment, and wherein inlet of

wastewater **2** is located at the bottom part of the compartment and the inlet of return sludge **6** is located at the liquid level, whereby the selector provides a vertical flow ('upflow') in the compartments.

14. The method according to any one of the preceding claims, wherein the selector S contains at least 2 compartments **Sa** and **Sb** in which feeding wastewater 2 and (return) sludge 6 alternates with discharge of the conditioned sludge**,** and wherein the desired distribution in sludge residence time in the selector **S** is obtained by feeding the compartments with wastewater **2** at the bottom of the compartment and wherein discharge of the conditioned sludge can be achieved by applying variation in flow velocity, and/or applying mixing, and/or takes place through withdrawing at least a part of the sludge/wastewater at the level of the bottom of the compartment (**3a**), while optionally providing sludge **6** at the level of the liquid in the compartment (**6b**) and/or somewhere in between the bottom level (**6a**) and the liquid level of the compartment.
15. The method according to claim 14 wherein the selector S is operated intermittently.
16. The method according to any one of the preceding claims, wherein variation of flow velocity in the selector is achieved by varying the feed flow rate of the wastewater.
17. The method according to any one of the preceding claims, wherein variation of flow velocity in the selector is achieved by varying the feed rate of the sludge 6 .
18. The method according to any one of the preceding claims, wherein the selector S is also fed with a part of the return sludge and/or surplus sludge originating from another purification line.
19. The method according to any one of the preceding claims, wherein the selector S is followed by or integrated with a granular sludge reactor operating based on sequential batch principle.
20. Method according to any one of the preceding claims, wherein the formation of granular sludge is accelerated and/or its maintenance is supported by the addition of a carrier material, said carrier material having an average size of 0.05 – 2.5 mm and a relative density or specific gravity equal to or greater than that of the wastewater.
21. A system for purifying substrate-containing wastewater, comprising a selector S and a continuous flow-through aerobic biologically activated sludge reactor **B**, wherein the selector S has
    - a substrate-containing wastewater inlet 2,
    - a biological sludge inlet 6 at the level of the bottom (**6a**) or at the level of the liquid (**6b**) or somewhere in between,
    - a conditioned sludge/water mixture discharge 3 at the level of the bottom (**3a**), at the level of the liquid (**3b**) and/or somewhere in-between the bottom or the level of the liquid, and
    - optionally a sludge discharge outlet 7,

    wherein the outlet 3 is in fluid connection with the inlet of the continuous flow-through aerobic biologically activated sludge reactor B, which reactor further has
    - a biological sludge inlet 6,
    - an inlet which is in fluid connection via the outlet of a selector S,

- a purified wastewater outlet 4 and
- a sludge discharge outlet 7, and

wherein outlet 4 is optionally in fluid connection with the inlet of a clarifier NB, and

wherein inlet 2 is optionally in fluid connection with the outlet of a pre-treatment tank VB, wherein the system is suitable for carrying out the method according to any one of claims 1-15.

22. The system according to claim 21, wherein the selector S is operated under anaerobic or anoxic conditions and is equipped with means that actively provide, or control, that the sludge with larger size and/or higher settling velocity is contacted in the selector for a longer time period with the substrate-containing wastewater, which is achieved for example by equipping the selector with means that create (i) multiple phases with discrete or discontinuous changes in flow velocity, (ii) an ascending flow velocity gradient, or a combination of (i) and (ii).
23. A system according to claim 21 or 22, wherein the system operates in parallel to one or more other wastewater purification process lines and wherein selector S receives biological sludge 6 and part of biological sludge 9 from these parallel other wastewater purification process lines, and wherein optionally a part of the biological sludge 6 is directed into these parallel other wastewater purification process lines.
24. A system according to any one of claims 20 - 23, wherein the selector S is in fluid connection or integrated with a granular sludge reactor operating based on sequential batch principle.