Claims

1. A channel plate comprising at least two rows of units, at least one turning box, at least one inlet and at least one outlet, wherein each unit has one planar surface opposite a channel forming surface and that the units are alternating in each row that a planar surface is adjacent to a channel forming surface in the same row forming a channel when the channel plate is in use, wherein the turning box is arranged between two adjacent rows of units forming two compartments in a space between two adjacent rows of units in the channel plate and one inner side of the channel plate, which compartments are divided by a wall to create a three dimensional flow resulting in an enhanced mixing, and that fluids may flow from a first row of units to a second row of units in turning box.

2. The channel plate according to claim 1, wherein the channel plate constitutes one part and the rows of units are integrated in the plate, or the channel plate is divided in midplane and constitutes two parts, corresponding to each other and put together form the process channel of the channel plate, or the channel plate constitutes a frame and two formed sheets or two pressed plates, which frame and two formed sheets or two pressed plates put together form the process channel of the channel plate.

3. The channel plate according to claim 1 or 2, wherein the channel forming surface in the row is selected from curved convex surface, trapezoid surface, rectangular surface, square surface, triangular surface, and the rows of units have all channel forming surfaces selected from the same channel forming surface type or are the channel forming surfaces of the rows of units one or more combinations of curved convex surfaces, rectangular surfaces, square surfaces, and triangular surfaces.

4. The channel plate according to any one of the preceding claims, wherein the planar surface of each unit in the row of units are arranged in parallel rows perpendicular to channel of the channel plate.

5. The channel plate according to any one of the preceding claims, the channel plate has a number of ports connected to channel or to the turning boxes, the ports are arranged on at least one side of the channel plate, the ports are either plugged or equipped with different equipments or the ports are combinations of plugged and equipped ports, which equipment are introduced through the ports to the channel or to the empty space of the turning boxes.

6. The channel plate according to any one of the preceding claims, wherein the equipped ports are equipped with one or more equipments selected from the group consisting of inlets for reactants, inlets for additional fluids, outlets for process fluids, outlets for intermediate products to be fed into the channel at a later stage, outlets for test samples, inlet dispersers, security devices for pressure release instant or controlled, sensor units, thermocouples, resistance thermometers, or nozzles selected from injection nozzles, dispersion nozzles, re-dispersion nozzles, re-mixing nozzles, coaxial nozzles, tube nozzles or combinations of equipments.

7. The channel plate according to any one of the preceding claims, wherein the channel plate comprises a process flow inlet and an additional flow inlet at the inlet part of the channel plate, the process flow inlet and the additional flow inlet are combined in a straight part connecting a port and the channel of the channel plate, or the channel plate comprises a process flow inlet and an additional flow inlet which are combined outside channel of the channel plate.

8. The channel plate according to any one of the preceding claims, wherein a dispersion nozzle is arranged at least one inlet or at least one port, which dispersion nozzle has one or more holes at the outlet of the dispersion nozzle and wherein the holes are arranged on concentric circles.

9. A flow section comprising a channel plate according to any one of claims 1 to 8, barrier plates or utility plates, or combinations of barrier plates and utility plates, wherein at least one channel plate is arranged between two barrier plates, which are sealing a channel formed by the channel plate and the two barrier plates, or wherein the channel plate is arranged between two utility plates, having turbulator inserts, which are sealing a channel formed by the channel plate and the two utility plates, or wherein the channel plate is arranged between one barrier plate and one utility plate, which are sealing a channel formed by the channel plate and the barrier plates and the utility plates, or the flow section comprises two channel plates and the two channel plates have a membrane or have a filter applied between the two channel plates and the two channel plates are between two barrier plates, or are between two utility plates having turbulator inserts, or the two channel plates are between one barrier plate and one utility plate having a turbulator insert.

10. The flow section according to claim 9, wherein the flow section also comprises gaskets having a pattern corresponding to the planar surfaces of the units of the rows of units or wherein the turbulator insert of the utility plates has a pattern corresponding to the planar surfaces of the units of the rows of units, or both the gaskets and the turbulator of the utility plates have pattern corresponding to the planar surfaces of the units of the rows of units.

11. The flow section according to claim 10, wherein the flow of media or the flow of fluids in the formed channel has no contact with the gasket's planar face and little or minimized contact with any of the gaskets edges.

12. The flow section according to any one of claims 9 to 11, wherein each turbulator insert provides a support to the planar sides of the row of units of the channel plate.

13. The flow section according to any one of claims 9 to 12, wherein one or two heat exchanger plates are connected to the channel plate and the heat exchanger plate being a non-fluid heat transfer member, or a Peltier element.

14. The flow section according to any one of claims 9 to 12, wherein the utility plate has compartment for the channel plate and a compartment for a turbulator insert.

15. A flow module comprising a stack of flow sections according to any one of claims 9 to 14, wherein the flow module has at least one inlet for process fluids and at least one outlet for process products, wherein one inlet is connected to the first channel plate and one outlet is connected to the last channel plate, and wherein the channel is connected parallel or is the channel connected in series, or both, the channel is connected externally or the channel is connected internally, preferably the channel is connected externally, and wherein internal and/or external conduits are connecting the utility plates and the utility plates are connected in series or parallel or both to each other.

16. The flow module according to claim 15, wherein a clamping device, is connected to the flow module, the clamping device comprises two end

plates, disc springs, pistons, and tension rods, wherein piles of disc springs are thread on the pistons and are arranged as a grid of springs, one or more grids of springs are comprised in the flow module, at least one grid of springs is supported on at least one of the endplates to distribute clamping forces on one or more flow sections or one or more channel plates, which flow sections are placed between the two end plates, and wherein the pistons are guided through holes in the endplates having the arrangement of the grid of springs.

17. Use of a flow module according to claim 15 or 16 as a continuous plate reactor.

Amended Claims

1. A channel plate comprising at least two rows of units, at least one turning box, at least one inlet and at least one outlet, wherein each unit has one planar surface opposite a channel forming surface and that the units are alternating in each row that a planar surface is adjacent to a channel forming surface in the same row forming a channel when the channel plate is in use, wherein the turning box is arranged between two adjacent rows of units forming two compartments in a space between two adjacent rows of units in the channel plate and one inner side of the channel plate, which compartments are divided by a wall to create a three dimensional flow resulting in an enhanced mixing, and that fluids may flow from a first row of units to a second row of units in the turning box, and wherein the planar surfaces of the units are arranged in rows perpendicular to the formed channel of the channel plate.

2. The channel plate according to claim 1, wherein the channel plate constitutes one part and the rows of units are integrated in the plate, or the channel plate is divided in midplane and constitutes two parts, corresponding to each other and put together form the process channel of the channel plate, or the channel plate constitutes a frame and two formed sheets or two pressed plates, which frame and two formed sheets or two pressed plates put together form the process channel of the channel plate.

3. The channel plate according to claim 1 or 2, wherein the channel forming surface in the row is selected from curved convex surface, trapezoid surface, rectangular surface, square surface, triangular surface, and the rows of units have all channel forming surfaces selected from the same channel forming surface type or are the channel forming surfaces of the rows of units one or more combinations of curved convex surfaces,

rectangular surfaces, square surfaces, and triangular surfaces, and preferably the rows of planar surfaces of the units are arranged in parallel rows perpendicular to the formed channel of the channel plate.

4. The channel plate according to any one of the preceding claims, the channel plate has a number of ports connected to channel or to the turning boxes, the ports are arranged on at least one side of the channel plate, the ports are either plugged or equipped with different equipments or the ports are combinations of plugged and equipped ports, which equipment are introduced through the ports to the channel or to the empty space of the turning boxes.

5. The channel plate according to any one of the preceding claims, wherein the equipped ports are equipped with one or more equipments selected from the group consisting of inlets for reactants, inlets for additional fluids, outlets for process fluids, outlets for intermediate products to be fed into the channel at a later stage, outlets for test samples, inlet dispersers, security devices for pressure release instant or controlled, sensor units, thermocouples, resistance thermometers, or nozzles selected from injection nozzles, dispersion nozzles, re-dispersion nozzles, re-mixing nozzles, coaxial nozzles, tube nozzles or combinations of equipments.

6. The channel plate according to any one of the preceding claims, wherein the channel plate comprises a process flow inlet and an additional flow inlet at the inlet part of the channel plate, the process flow inlet and the additional flow inlet are combined in a straight part connecting a port and the channel of the channel plate, or the channel plate comprises a process flow inlet and an additional flow inlet which are combined outside channel of the channel plate.

7. The channel plate according to any one of the preceding claims, wherein a dispersion nozzle is arranged at least one inlet or at least one port, which dispersion nozzle has one or more holes at the outlet of the dispersion nozzle and wherein the holes are arranged on concentric circles.

8. A flow section comprising a channel plate according to any one of claims 1 to 7, barrier plates or utility plates, or combinations of barrier plates and utility plates, wherein at least one channel plate is arranged between two barrier plates, which are sealing a channel formed by the channel plate and the two barrier plates, or wherein the channel plate is arranged between two utility plates, having turbulator inserts, which are sealing a channel formed by the channel plate and the two utility plates, or wherein the channel plate is arranged between one barrier plate and one utility plate, which are sealing a channel formed by the channel plate and the barrier plates and the utility plates, or the flow section comprises two channel plates and the two channel plates have a membrane or have a filter applied between the two channel plates and the two channel plates are between two barrier plates, or are between two utility plates having turbulator inserts, or the two channel plates are between one barrier plate and one utility plate having a turbulator insert.

9. The flow section according to claim 8, wherein the flow section also comprises gaskets having a pattern corresponding to the planar surfaces of the units of the rows of units or wherein the turbulator insert of the utility plates has a pattern corresponding to the planar surfaces of the units of the rows of units, or both the gaskets and the turbulator of the utility plates have pattern corresponding to the planar surfaces of the units of the rows of units.

10. The flow section according to claim 9, wherein the flow of media or the flow of fluids in the formed channel has no contact with the gasket's planar face and little or minimized contact with any of the gaskets edges.

11. The flow section according to any one of claims 8 to 10, wherein each turbulator insert provides a support to the planar sides of the row of units of the channel plate.

12. The flow section according to any one of claims 8 to 11, wherein one or two heat exchanger plates are connected to the channel plate and the heat exchanger plate being a non-fluid heat transfer member, or a Peltier element.

13. The flow section according to any one of claims 8 to 12, wherein the utility plate has compartment for the channel plate and a compartment for a turbulator insert.

14. A flow module comprising a stack of flow sections according to any one of claims 8 to 13, wherein the flow module has at least one inlet for process fluids and at least one outlet for process products, wherein one inlet is connected to the first channel plate and one outlet is connected to the last channel plate, and wherein the channel is connected parallel or is the channel connected in series, or both, the channel is connected externally or the channel is connected internally, preferably the channel is connected externally, and wherein internal and/or external conduits are connecting the utility plates and the utility plates are connected in series or parallel or both to each other.

15. The flow module according to claim 14, wherein a clamping device, is connected to the flow module, the clamping device comprises two end plates, disc springs, pistons, and tension rods, wherein piles of disc springs are thread on the pistons and are arranged as a grid of springs, one or more grids of springs are comprised in the flow module, at least one grid of springs is supported on at least one of the endplates to distribute clamping forces on one or more flow sections or one or more channel plates, which flow sections are placed between the two end plates, and wherein the pistons are guided through holes in the endplates having the arrangement of the grid of springs.

16. Use of a flow module according to claim 14 or 15 as a continuous plate reactor.

Amended Claims

1. A channel plate comprising at least two rows of units, at least one turning box, at least one inlet and at least one outlet, wherein each unit has one planar surface opposite a channel forming surface and that the units are alternating in each row that a planar surface is adjacent to a channel forming surface in the same row forming a channel when the channel plate is in use, wherein the turning box is arranged between two adjacent rows of units forming two compartments in a space between two adjacent rows of units in the channel plate and one inner side of the channel plate, which compartments are divided by a wall to create a three dimensional flow resulting in an enhanced mixing, and that fluids may flow from a first row of units to a second row of units in the turning box, and wherein the planar surfaces of the units are arranged in rows perpendicular to the formed channel of the channel plate.

2. The channel plate according to claim 1, wherein the channel plate constitutes one part and the rows of units are integrated in the plate, or the channel plate is divided in midplane and constitutes two parts, corresponding to each other and put together form the process channel of the channel plate, or the channel plate constitutes a frame and two formed sheets or two pressed plates, which frame and two formed sheets or two pressed plates put together form the process channel of the channel plate.

3. The channel plate according to claim 1 or 2, wherein the channel forming surface in the row is selected from curved convex surface, trapezoid surface, rectangular surface, square surface, triangular surface, and the rows of units have all channel forming surfaces selected from the same channel forming surface type or are the channel forming surfaces of the rows of units one or more combinations of curved convex surfaces,

rectangular surfaces, square surfaces, and triangular surfaces, and preferably the rows of planar surfaces of the units are arranged in parallel rows perpendicular to the formed channel of the channel plate.

4. The channel plate according to any one of the preceding claims, the channel plate has a number of ports connected to channel or to the turning boxes, the ports are arranged on at least one side of the channel plate, the ports are either plugged or equipped with different equipments or the ports are combinations of plugged and equipped ports, which equipment are introduced through the ports to the channel or to the empty space of the turning boxes.

5. The channel plate according to any one of the preceding claims, wherein the equipped ports are equipped with one or more equipments selected from the group consisting of inlets for reactants, inlets for additional fluids, outlets for process fluids, outlets for intermediate products to be fed into the channel at a later stage, outlets for test samples, inlet dispersers, security devices for pressure release instant or controlled, sensor units, thermocouples, resistance thermometers, or nozzles selected from injection nozzles, dispersion nozzles, re-dispersion nozzles, re-mixing nozzles, coaxial nozzles, tube nozzles or combinations of equipments.

6. The channel plate according to any one of the preceding claims, wherein the channel plate comprises a process flow inlet and an additional flow inlet at the inlet part of the channel plate, the process flow inlet and the additional flow inlet are combined in a straight part connecting a port and the channel of the channel plate, or the channel plate comprises a process flow inlet and an additional flow inlet which are combined outside channel of the channel plate.

7. The channel plate according to any one of the preceding claims, wherein a dispersion nozzle is arranged at least one inlet or at least one port, which dispersion nozzle has one or more holes at the outlet of the dispersion nozzle and wherein the holes are arranged on concentric circles.

8. A flow section comprising a channel plate according to any one of claims 1 to 7, barrier plates or utility plates, or combinations of barrier plates and utility plates, wherein at least one channel plate is arranged between two barrier plates, which are sealing a channel formed by the channel plate and the two barrier plates, or wherein the channel plate is arranged between two utility plates, having turbulator inserts, which are sealing a channel formed by the channel plate and the two utility plates, or wherein the channel plate is arranged between one barrier plate and one utility plate, which are sealing a channel formed by the channel plate and the barrier plates and the utility plates, or the flow section comprises two channel plates and the two channel plates have a membrane or have a filter applied between the two channel plates and the two channel plates are between two barrier plates, or are between two utility plates having turbulator inserts, or the two channel plates are between one barrier plate and one utility plate having a turbulator insert.

9. The flow section according to claim 8, wherein the flow section also comprises gaskets having a pattern corresponding to the planar surfaces of the units of the rows of units or wherein the turbulator insert of the utility plates has a pattern corresponding to the planar surfaces of the units of the rows of units, or both the gaskets and the turbulator of the utility plates have pattern corresponding to the planar surfaces of the units of the rows of units.

10. The flow section according to claim 9, wherein the flow of media or the flow of fluids in the formed channel has no contact with the gasket's planar face and little or minimized contact with any of the gaskets edges.

11. The flow section according to any one of claims 8 to 10, wherein each turbulator insert provides a support to the planar sides of the row of units of the channel plate.

12. The flow section according to any one of claims 8 to 11, wherein one or two heat exchanger plates are connected to the channel plate and the heat exchanger plate being a non-fluid heat transfer member, or a Peltier element.

13. The flow section according to any one of claims 8 to 12, wherein the utility plate has compartment for the channel plate and a compartment for a turbulator insert.

14. A flow module comprising a stack of flow sections according to any one of claims 8 to 13, wherein the flow module has at least one inlet for process fluids and at least one outlet for process products, wherein one inlet is connected to the first channel plate and one outlet is connected to the last channel plate, and wherein the channel is connected parallel or is the channel connected in series, or both, the channel is connected externally or the channel is connected internally, preferably the channel is connected externally, and wherein internal and/or external conduits are connecting the utility plates and the utility plates are connected in series or parallel or both to each other.

15. The flow module according to claim 14, wherein a clamping device, is connected to the flow module, the clamping device comprises two end plates, disc springs, pistons, and tension rods, wherein piles of disc springs are thread on the pistons and are arranged as a grid of springs, one or more grids of springs are comprised in the flow module, at least one grid of springs is supported on at least one of the endplates to distribute clamping forces on one or more flow sections or one or more channel plates, which flow sections are placed between the two end plates, and wherein the pistons are guided through holes in the endplates having the arrangement of the grid of springs.

16. Use of a flow module according to claim 14 or 15 as a continuous plate reactor.