Claims

1. A flow-plate (1) which is dividable in mid plane, comprises two parts, each part comprises a channel side (2) and a utility side (3), the two parts of the flow plate are counter parts and complementing each other, each channel side (2) comprises parallel rows of obstacles (4), sidewalls (5) and parallel rows of channel floors (6), said sidewalls (5) are separating said parallel rows of curved obstacles (4), and said sidewalls (5) are separating said parallel rows of channel floors (6), and said rows of curved obstacles (4) are complementing said rows of channel floors (6) to form a channel (7) between the two channel sides (2) of said flow plate (1), the utility sides (3) of the rows of curved obstacles (4) have deep machined grooves (8), said deep machined grooves (8) are lined up in parallel rows on the utility sides (3) of flow-plate (1), and the rows of deep machined grooves (8) are perpendicular to the channel (7), and the rows of deep machined grooves (8) are for flow of heat transfer fluids on the utility sides (3).

2. A flow-plate according to claim 1, wherein flow-plate (1) further comprises two barrier plates (14) and two turbulator plates (12) said turbulator plates (12) are designed to cover the deep machined grooves (8), and the two barrier plates (14) are closing the utility sides (3), one barrier plate on each utility side (3) opposite utility sides (3) creating utility channels (15), each barrier plate have cut-open parts (17) for distribution of heat transfer fluids, and arranged in the cut-open parts are inlets (19) or outlets (19) respectively for heat transfer fluids.

3. A flow-plate according to claim 1 or 2, wherein each turbulator plate (12) has two sets of holes (18) lined up in rows one row on each end of turbulator plate (12), said sets of holes (18) together with cut-open parts (17) are for distributing heat transfer fluids to the deep machined grooves (8) and to utility channels (15) for heat transfer to or from channel (7).

4. A flow-plate according to any one of claim 1, 2 or 3, wherein one or more access ports (16) or one or more port holes (16), or combinations thereof are providing access to channel (7), at least one of access ports (16) or one port holes (16), or combinations thereof, is an inlet connected to channel (7), and at least one of access ports (16) or one port holes (16), or combinations thereof, is an outlet connected to channel (7).

5. A flow-plate according to any one of the preceding claims, wherein sidewalls (5) are fitted in bars (9) in the deep machined grooves (8).

6. A flow-plate according to any one of the preceding claims, wherein the two counter parts of flow plate (1) are moulded, are machined or are combinations of moulded and machined.

7. A flow-plate according to any one of the preceding claims, wherein clearance slots (10) between sidewalls (5) and bars (9) are for small bypass to keep clean during operation and for improving handling of flow plates (1) during assembling and during dissembling.

8. A flow-plate according to any one of the preceding claims, wherein the flow-plate also have turning boxes (39), which turning box comprises two compartments (40) divided by a wall (41), in each compartment is one mini-obstacle (42) arranged for creating a three dimensional flow and enhanced mixing in channel (7), and that fluids flow from a first channel row to a second channel row in turning box (39).

9. A flow-plate according to any one of the preceding claims, wherein the deep machined grooves (8) have inserted turbulators selected from metallic foam, offset strip fin turbulators, or turbulator wings (43) arranged on strips (44) connected to turbulator (12), preferably the inserted turbulators are turbulator wings (43) arranged on strips (44) connected to turbulator (12), and wherein the turbulators are for enhancing turbulence within the deep machined grooves.

10. An assembled flow-plate section comprising a flow-plate (1) said flow-plate (1) is dividable in mid plane and is the core of the flow-plate section, which flow-plate (1) comprises two channel sides (2) and two utility sides (3), between the two channel sides (2) is channel (7) formed by curved sides of obstacles (4), channel (7) is sealed by gasket (11) between the two counter parting channel sides (2), the two utility sides (3) are lined up by the backsides of the rows of curved obstacles (4), the backsides have deep machined grooves (8) for heat transfer fluids and on each utility side (3) is a frame plate (21), an O-ring (20), a turbulator plate (12), and also a barrier plate (14) arranged, the two barrier plates (14) are closing the assembled flow-plate section.

11. An assembled flow-plate section according to claim 10, wherein the flow-plate is according to any one of claims 1 to 9.

12. An assembled flow-plate section according to claim 10 or 11, wherein each barrier plate have cut-open parts (17) for distribution of heat transfer fluids into the deep machined grooves (8) and into utility channels (15) formed by turbulator plates (12) and barrier plate (14), and arranged in the cut-open parts are inlets (19) or outlets (19) respectively for heat transfer fluids.

13. A flow module, preferably a plate reactor, comprising one or more assembled flow plate sections, according to claim 10, 11, or 12, and a clamping device, which clamping device comprises a frame (23), two end plates (25), disc springs (24), and tension rods (30), wherein piles of disc springs (24) are arranged as a grid of springs supported on end plates (25) to distribute clamping forces on flow plates (1), which flow plates are placed between the two end plates (25).

14. A flow module according to claim 13, wherein the clamping device comprises two U-formed end sections (32) comprising end plates (25), two beam webs (33) at each end plate (25), wherein each long sides of beam webs

(33) has at least one notch (35) in which at least one tongue (34) of end plate (25) is fitted, in such a way that an U-formed end section (32) is formed.

15. A flow module according to claim 13 or 14, wherein the flow module also comprises one or more residence time plates comprising two or more chambers connected in series, the chambers are separated by parallel walls, each wall has a hole or a passage, which hole or passage is a communication between two chambers, the holes or the passages are alternating on the right hand side or the left hand side of residence time plate (45), and residence time plate (45) has at least one inlet and at least one outlet, the chambers are equipped with inserts selected from the group consisting of folded sheet inserts (46), baffle ladder sheet inserts, stacked sheets inserts, metallic foam, offset strip fin turbulators or combinations thereof.

16. A flow module according to claim 15, wherein the inserts are folded sheet inserts (46), comprising baffles which are shifting place in each fold in an alternating fashion that they form a zigzag pattern with alternating heights of the baffles.

17. Use of a flow module according to any one of claims 13 to 16 as a reactor for chemical reactions.

Claims

1. A flow-plate (1) which is dividable in mid plane, comprises two parts, each part comprises a channel side (2) and a utility side (3), the two parts of the flow plate are counter parts and complementing each other, each channel side (2) comprises parallel rows of obstacles (4), sidewalls (5) and parallel rows of channel floors (6), said sidewalls (5) are separating said parallel rows of curved obstacles (4), and said sidewalls (5) are separating said parallel rows of channel floors (6), and said rows of curved obstacles (4) are complementing said rows of channel floors (6) to form a channel (7) between the two channel sides (2) of said flow plate (1), the utility sides (3) of the rows of curved obstacles (4) have deep machined grooves (8), said deep machined grooves (8) are lined up in parallel rows on the utility sides (3) of flow-plate (1), and the rows of deep machined grooves (8) are perpendicular to the channel (7), and the rows of deep machined grooves (8) are for flow of heat transfer fluids on the utility sides (3).

2. A flow-plate according to claim 1, wherein flow-plate (1) further comprises two barrier plates (14) and two turbulator plates (12) said turbulator plates (12) are designed to cover the deep machined grooves (8), and the two barrier plates (14) are closing the utility sides (3), one barrier plate on each utility side (3) opposite utility sides (3) creating utility channels (15), each barrier plate have cut-open parts (17) for distribution of heat transfer fluids, and arranged in the cut-open parts are inlets (19) or outlets (19) respectively for heat transfer fluids.

3. A flow-plate according to claim 1 or 2, wherein each turbulator plate (12) has two sets of holes (18) lined up in rows one row on each end of turbulator plate (12), said sets of holes (18) together with cut-open parts (17) are for distributing heat transfer fluids to the deep machined grooves (8) and to utility channels (15) for heat transfer to or from channel (7).

4. A flow-plate according to any one of claim 1, 2 or 3, wherein one or more access ports (16) or one or more port holes (16), or combinations thereof are providing access to channel (7), at least one of access ports (16) or one port holes (16), or combinations thereof, is an inlet connected to channel (7), and at least one of access ports (16) or one port holes (16), or combinations thereof, is an outlet connected to channel (7).

5. A flow-plate according to any one of the preceding claims, wherein sidewalls (5) are fitted in bars (9) in the deep machined grooves (8).

6. A flow-plate according to any one of the preceding claims, wherein the two counter parts of flow plate (1) are moulded, are machined or are combinations of moulded and machined.

7. A flow-plate according to any one of the preceding claims, wherein clearance slots (10) between sidewalls (5) and bars (9) are for small bypass to keep clean during operation and for improving handling of flow plates (1) during assembling and during dissembling.

8. A flow-plate according to any one of the preceding claims, wherein the flow-plate also have turning boxes (39), which turning box comprises two compartments (40) divided by a wall (41), in each compartment is one mini-obstacle (42) arranged for creating a three dimensional flow and enhanced mixing in channel (7), and that fluids flow from a first channel row to a second channel row in turning box (39).

9. A flow-plate according to any one of the preceding claims, wherein the deep machined grooves (8) have inserted turbulators selected from metallic foam, offset strip fin turbulators, or turbulator wings (43) arranged on strips (44) connected to turbulator (12), preferably the inserted turbulators are turbulator wings (43) arranged on strips (44) connected to turbulator (12), and wherein the turbulators are for enhancing turbulence within the deep machined grooves.