CLAIMS

1. A reactor for causing a reaction of a first fluid by a heat exchange between the first fluid and a second fluid to generate a product, the reactor comprising:

a plurality of first structures each including: first side walls provided on both sides in a first direction on one surface of a first base plate and extending in a second direction perpendicular to the first direction; a plurality of first middle walls arranged at intervals in the first direction between the paired first side walls on the one surface of the first base plate and extending in the second direction; and first flow channels provided between each first side wall and the adjacent first middle wall and between the respective first middle walls adjacent to each other so that the first fluid flows therethrough;

a plurality of second structures coexisting with and stacked on the plural first structures in a third direction perpendicular to the first direction and the second direction, the second structures each including: second side walls provided on both sides in the first direction on one surface of a second base plate and extending in the second direction; a plurality of second middle walls arranged at intervals in the first direction between the paired second side walls on the one surface of the second base plate and extending in the second direction; and second flow channels provided between each second side wall and the adjacent second middle wall and between the respective second middle walls adjacent to each other so that the second fluid flows therethrough; and

a lid structure provided on the second structure located on one end side in the third direction to cover the plural second flow channels,

wherein a catalyst for accelerating the reaction of the first fluid is placed in the respective first flow channels,

a catalyst member placing the catalyst is removably provided in the respective first flow channels,

end surfaces of the first side walls and end surfaces of the first middle walls are joined to the adjacent second structure,

end surfaces of the second side walls and end surfaces of the second middle walls are joined to the adjacent first structure or the lid structure,

a thickness of the first side walls is greater than a thickness of the first middle walls, and

a thickness of the second side walls is greater than a thickness of the second middle walls.

2. The reactor according to claim 1, wherein a predetermined number of the first structures corresponding to a reactor capacity coexist with and are stacked on the plural second structures, and the first structures, the second structures, and the lid structure are joined together simultaneously in a state in which the lid structure is provided on the second structure located on the one end side in the third direction.

3. The reactor according to claim 1 or 2, wherein the plural first structures and the plural second structures are alternately stacked in the third direction.

4. The reactor according to any one of claims 1 to 3, wherein a ratio of the thickness of the first side walls to the thickness of the first middle walls and a ratio of the thickness of the second side walls to the thickness of the second middle walls are each set at 4.0 or greater.

5. The reactor according to any one of claims 1 to 4, wherein the first flow channels and the second flow channels each have a rectangular shape in cross section, and a ratio of a long-side length to a short-side length of the first flow channels in cross section and a ratio of a long-side length to a short-side length of the second flow channels in cross section are each set at 18.0 or less.

6. The reactor according to any one of claims 1 to 5, wherein a ratio of a width of the first flow channels to the thickness of the first middle walls and a ratio of a width of the second flow channels to the thickness of the second middle walls are each set at 1.0 or greater.

7. The reactor according to any one of claims 1 to 6, wherein a ratio of a thickness of the first base plate below a bottom of the respective first flow channels to the thickness of the first middle walls and a ratio of a thickness of the second base plate below a bottom of the respective second flow channels to the thickness of the second middle walls are each set at 0.2 to 5.0.

8. The reactor according to any one of claims 1 to 7, wherein the thickness of the second side walls is set to be the same as the thickness of the first side walls, and the thickness of the second middle walls is set to be the same as the thickness of the first middle walls.

9. The reactor according to any one of claims 1 to 8, wherein a fin is removably provided in the respective second flow channels.

10. The reactor according to any one of claims 1 to 9, wherein:

a first end wall for preventing the second fluid from flowing into the respective first flow channels is provided on an one side in the second direction on the one surface of the respective first base plates, a first leading-out port for leading the product out of the first flow channels is provided on the one side in the second direction on at least one of the first side walls in the respective first structures, and a first connection flow channel by which the first leading-out port connects with the respective first flow channels on the one side in the second direction is provided on the first side in the second direction on one surface of the respective first structures;

a second end wall for preventing the first fluid from flowing into the respective second flow channels is provided on another side in the second direction on the one surface of the respective second base plates, a second leading-out port for leading the second fluid out of the second flow channels is provided on the other side in the second direction on at least one of the second side walls in the respective second structures, and a second connection flow channel by which the second leading-out port connects with the respective second flow channels on the other side in the second direction is provided on the second side in the second direction on one surface of the respective second structures;

an end surface of the first end wall is joined to the adjacent second structure or the adjacent first structure; and

an end surface of the second end wall is joined to the adjacent first structure, the adjacent second structure, or the lid structure.

11. The reactor according to claim 10, further comprising:

a hollow first distribution flow channel removably attached to a reactor core on the other side in the second direction so as to introduce the first fluid into the respective

first flow channels, the reactor core having a configuration in which the plural first structures coexist with and are stacked on the plural second structures;

a hollow first exhaust member attached to the reactor core so as to collect and exhaust the product led out of the respective first leading-out ports;

a hollow second introduction member removably attached to the reactor core on the one side in the second direction so as to introduce the second fluid into the respective second flow channels; and

a hollow second exhaust member attached to the reactor core so as to collect and exhaust the second fluid led out of the respective leading-out ports.

12. The reactor according to any one of claims 1 to 9, wherein:

a first end wall for preventing the second fluid from flowing into the respective first flow channels is provided on a one side in the second direction on the one surface of the respective first base plates, a first introduction port for introducing the first fluid is provided on the one side in the second direction on at least one of the first side walls in the respective first structures, and a first connection flow channel by which the first introduction port connects with the respective first flow channels on the one side in the second direction is provided on the second side in the second direction on one surface of the respective first structures;

a second end wall for preventing the first fluid from flowing into the respective second flow channels is provided on another side in the second direction on the one surface of the respective second base plates, a second introduction port for introducing the second fluid is provided on the other side in the second direction on at least one of the second side walls in the respective second structures, and a second connection flow channel by which the second introduction port connects with the respective second flow channels on the other side in the second direction is provided on the first side in the second direction on one surface of the respective second structures;

an end surface of the first end wall is joined to the adjacent second structure or the adjacent first structure; and

an end surface of the second end wall is joined to the adjacent first structure, the adjacent second structure, or the lid structure.

13. The reactor according to claim 12, further comprising:

a hollow first introduction member attached to a reactor core so as to introduce the first fluid into the respective first flow channels from the respective first

introduction ports, the reactor core having a configuration in which the plural first structures coexist with and are stacked on the plural second structures;

a hollow first exhaust member removably attached to the reactor core on the one side in the second direction so as to collect and exhaust the product led out of the respective first flow channels;

a hollow second introduction member attached to the reactor core so as to introduce the second fluid into the respective second flow channels from the respective second introduction ports; and

a hollow second exhaust member removably attached to the reactor core on the other side in the second direction so as to collect and exhaust the second fluid led out of the respective second structures.

14. The reactor according to any one of claims 10 to 13, wherein a joining method regarding the end surfaces of the first side walls, the end surfaces of the first middle walls, and the end surface of the first end wall in each first plate is diffusion bonding, and a joining method regarding the end surfaces of the second side walls, the end surfaces of the second middle walls, and the end surface of the second end wall in each second base plate is diffusion bonding.

15. The reactor according to any one of claims 1 to 14, wherein a maximum pressure in the respective first flow channels and the respective second flow channels when the reactor is in operation is set at 0.0 to 20.0 MPaG.