As used herein, the term "inlet side" denotes an inlet side of the flow direction of the raw material fluid, the product or the heat medium, and the term "outlet side" denotes an outlet side of the flow direction of the raw material fluid, the product or the heat medium.

[0010]

According to the present disclosure, the raw material fluid is supplied to the pre-reactor core, so that the raw material fluid flows through the main reaction flow channels via the pre-reaction flow channels. In addition, the heat medium is supplied to the main reactor core, so that the heat medium flows through the main temperature control flow channels along the flow direction (for example, in the counter or same direction) of the raw material fluid flowing in the main reaction flow channels. The heat exchange is then carried out between the raw material fluid and the heat medium, so as to increase the temperature of the raw material fluid sufficient to cause a reaction of the raw material fluid, so as to produce a product.

[0011]

As described above, the raw material fluid supplied to the pre-reactor core flows through the pre-reaction flow channels. The product led out of the main reaction flow channels flows through the pre-temperature control flow channels along the flow direction (for example, in the counter or same direction) of the raw material fluid flowing in the pre-reaction flow channels. The heat exchange is then carried out between the product serving as a heat medium and the raw material fluid, so as to preheat the raw material fluid in the pre-reactor core and cool the product.

[0012]

Since the product can be cooled in the pre-reactor core, the reactor can recover the heat to decrease the temperature of the product, so as to prevent an increase in the amount of the heat recovered from the product outside the reactor.

[0013]

According to the present disclosure, heat energy (input energy) of the heat medium supplied to the reactor can be reduced, and an excessive amount of steam generated outside the reactor can be suppressed, so as to improve the energy efficiency in the entire plant.

BRIEF DESCRIPTION OF DRAWINGS

[0014]

[FIG. 1] FIG. 1 is a schematic front view of a reactor according to one embodiment of

respective main reaction flow channels 11 is introduced to the pre-temperature control flow channels 43 via the connection member 87.

[0071]

FIG. 9B illustrates temperature conditions when the reactor core 1A is in operation in the case in which the reaction of the raw material fluid M is an endothermic reaction. FIG. 10B illustrates temperature conditions when the reactor 1A is in operation in the case in which the reaction of the raw material fluid M is an exothermic reaction.

[0072]

Other embodiments can also achieve the same operations and effects as the embodiment described above.

[0073]

The present disclosure is not intended to be limited to the description of the embodiments described above, and may be applicable to various modes. For example, more than one pre-reactor core 29 may be provided. The flow direction of the heat medium HC flowing in the main temperature control flow channels 17 may be changed from the direction opposite to the flow direction of the raw material fluid M flowing in the main reaction flow channels 11 so that the heat medium HC flows in the same direction. The flow direction of the product P serving as a heat medium HC flowing in the pre-temperature control flow channels 43 may be changed from the direction opposite to the flow direction of the raw material fluid M flowing in the pre-reaction flow channels 37 so that the product P flows in the same direction. The case in which the flow direction of the heat medium HC flowing in the main temperature control flow channels 17 is the same as the flow direction of the raw material fluid M flowing in the main reaction flow channels 11 is illustrated below.

[0074]

For example, the raw material fluid M subjected to an exothermic reaction to produce a product is supplied to the main temperature control flow channels 17. The raw material fluid HC subjected to an endothermic reaction to produce a product is supplied to the main reaction flow channels 11. As the raw material fluid M flows through the main temperature control flow channels 17, the exothermic reaction is caused to generate heat of reaction. The heat of reaction thus generated can be used for a heat source for the endothermic reaction to be caused in the main reaction flow channels 11. Accordingly, the heat can be used effectively.

[0075]

CLAIMS

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

a main reactor core including a main reaction flow channel through which the raw material fluid flows, and a main temperature control flow channel through which the heat medium flows along a flow direction of the raw material fluid flowing in the main reaction flow channel; and

a pre-reactor core including a pre-reaction flow channel of which an outlet side connects with an inlet side of the main reaction flow channel and through which the raw material fluid flows, and a pre-temperature control flow channel of which an inlet side connects with an outlet side of the main reaction flow channel and through which the product serving as the heat medium flows along a flow direction of the raw material fluid flowing in the pre-reaction flow channel,

wherein the main reactor core includes:

main reactor structures each provided with the main reaction flow channel; and

main temperature control structures alternately stacked on the main reactor structures and each provided with the main temperature control flow channel, and

the pre-reactor core includes:

pre-reactor structures each provided with the pre-reaction flow channel; and

pre-temperature control structures alternately stacked on the pre-reactor structures and each provided with the pre-temperature control flow channel.

2. The reactor according to claim 1, further comprising a connection member connecting the outlet side of the pre-reaction flow channel and the inlet side of the main reaction flow channel.

3. The reactor according to claim 1, further comprising a connection member connecting the outlet side of the main reaction flow channel and the inlet side of the pre-temperature control flow channel.

4. The reactor according to claim 2, wherein the inlet side of the pre-temperature control flow channel is directly connected to the outlet side of the main reaction flow channel.

5. The reactor according to claim 3, wherein the outlet side of the pre-reaction flow channel is directly connected to the inlet side of the main reaction flow channel.

6. The reactor according to any one of claims 1 to 5, wherein a catalyst for promoting the reaction of the raw material fluid is supported in each of the main reaction flow channel and the pre-reaction flow channel.

7. The reactor according to claim 6, wherein a main catalyst member supporting the catalyst is removably provided in the main reaction flow channel, and a pre-catalyst member supporting the catalyst is removably provided in the pre-reaction flow channel.

8. The reactor according to any one of claims 1 to 7, wherein a main fin is removably provided in the main temperature control flow channel, and a pre-fin is removably provided in the pre-temperature control flow channel.

9. The reactor according to any one of claims 1 to 8, further comprising a heat medium adjustment device for adjusting a flow rate or a temperature of the heat medium supplied to the main temperature control flow channel.

10. The reactor according to any one of claims 1 to 9, wherein the pre-reactor core is removably integrated with the main reactor core.

11. The reactor according to any one of claims 1 to 10, wherein the heat medium flows through the main temperature control flow channel in a direction opposite to or identical to the flow direction of the raw material fluid flowing in the main reaction flow channel.

12. The reactor according to any one of claims 1 to 11, wherein the product serving as the heat medium flows through the pre-temperature control flow channel in a direction opposite to or identical to the flow direction of the raw material fluid flowing in the pre-reaction flow channel.

13. The reactor according to any one of claims 1 to 12, wherein, in the pre-reactor core, when a temperature of the raw material fluid is increased through the heat

exchange with the product serving as a heat medium, part of the raw material fluid is preliminarily reacted.