CLAIMS

WHAT IS CLAIMED IS:

1. A fluidized bed reactor, wherein the fluidized bed reactor comprises a main shell and a coke control zone shell;

the main shell comprises an upper shell and a lower shell;

the upper shell encloses a gas-solid separation zone, and the lower shell encloses a reaction zone;

the reaction zone axially communicates with the gas-solid separation zone;

the coke control zone shell is circumferentially arranged on an outer wall of the main shell;

the coke control zone shell and the main shell enclose an annular cavity, and the annular cavity is a coke control zone;

n baffles are radially arranged in the coke control zone, and the n baffles divide the coke control zone into n coke control zone subzones, where n is an integer;

the coke control zone subzones are provided with a coke control raw material inlet; and

a catalyst circulation hole is formed in each of n-1 of the baffles, such that a catalyst and a coke control raw material entering the coke control zone flow in an annular direction.

2. The fluidized bed reactor according to claim 1, wherein in the coke control zone, the n baffles comprise a 1^{st} baffle, and a 2^{nd} baffle to an n^{th} baffle;

no catalyst circulation hole is formed in the 1^{st} baffle;

the catalyst circulation hole is formed in each of the 2^{nd} baffle to the n^{th} baffle;

a coke control zone catalyst inlet is formed in a 1^{st} coke control zone subzone formed through division by the 1^{st} baffle and the 2^{nd} baffle;

a coke controlled catalyst delivery pipe is arranged in an n^{th} coke control zone subzone formed through division by the 1^{st} baffle and the n^{th} baffle, and an outlet of the coke controlled catalyst delivery pipe is formed in the reaction zone;

the coke control raw material inlet is formed at bottoms of the coke control zone subzones, and the coke control raw material inlet is a coke control zone distributor; and

a coke control zone gas delivery pipe is arranged at tops of the coke control zone subzones, and an outlet of the coke control zone gas delivery pipe is formed in the gas-solid separation zone.

3. The fluidized bed reactor according to claim 1, wherein n has a value range of $2 \leq n \leq 10$~~.~~;

~~4. The fluidized bed reactor according to claim 1, wherein~~ preferably, a reaction zone distributor is further

arranged at a bottom of the reaction zone; and

the reaction zone distributor is configured to feed a reaction raw material~~.~~;

~~5. The fluidized bed reactor according to claim 4, wherein~~ preferably, the reaction zone is provided with a fluidized bed reactor cooler, and the bottom of the reaction zone is provided with a first stripper;

an inlet of the first stripper is formed inside the lower shell;

an outlet of the first stripper is formed outside the lower shell;

an open end of the inlet of the first stripper is located above an outlet end of the coke controlled catalyst delivery pipe; and

the outlet end of the coke controlled catalyst delivery pipe is located above the reaction zone distributor.

~~6~~4. The fluidized bed reactor according to claim 1, wherein the gas-solid separation zone is provided with a first gas-solid separation unit and a second gas-solid separation unit;

a catalyst outlet pipe of the first gas-solid separation unit penetrates through a top of the coke control zone and is inserted in the 1st coke control zone subzone;

a gas outlet of the first gas-solid separation unit is formed in the gas-solid separation zone;

an inlet of the second gas-solid separation unit is formed in the gas-solid separation zone; ~~and~~

a catalyst outlet end of the second gas-solid separation unit is located in the reaction zone~~.~~;

~~7. The fluidized bed reactor according to claim 6, wherein~~ preferably, a first gas collection chamber is further arranged in an upper part of the gas-solid separation zone;

a gas outlet of the second gas-solid separation unit communicates with the first gas collection chamber; and

the first gas collection chamber further communicates with a product gas delivery pipe.

~~8~~5. A device for preparing low-carbon olefins from an oxygen-containing compound, wherein the device comprises a fluidized bed regenerator and the fluidized bed reactor according to ~~any one of claims 1 to 7~~claim 1.

~~9~~6. The device according to claim ~~8~~5, wherein the fluidized bed regenerator comprises a regenerator shell; the regenerator shell comprises an upper regenerator shell and a lower regenerator shell; the upper regenerator shell encloses a gas-solid separation zone, and the lower regenerator shell encloses a regeneration zone;

a spent catalyst inlet is formed in the regenerator shell; and

the spent catalyst inlet communicates with a first stripper outlet pipe through a spent catalyst delivery pipe.

~~10~~7. The device according to claim ~~8~~5, wherein a regeneration zone distributor is further arranged at a bottom of the regeneration zone; ~~and~~

the regeneration zone distributor is configured to feed a regeneration gas~~.~~;

~~11. The device according to claim 10, wherein~~ preferably, a second stripper is arranged at the bottom of the regeneration zone;

an inlet of the second stripper is formed inside the regenerator shell;

an outlet of the second stripper is formed outside the regenerator shell;

the second stripper communicates with a first gas-solid separation unit through a regenerated catalyst delivery pipe; and

an open end of the inlet of the second stripper is located above the regeneration zone distributor.

~~12~~8. The device according to claim ~~8~~5, wherein a third gas-solid separation unit and a second gas collection chamber are further arranged in the regenerator shell;

the second gas collection chamber is located at an inner top of the regenerator shell;

a gas outlet of the third gas-solid separation unit communicates with the second gas collection chamber;

the second gas collection chamber communicates with a flue gas delivery pipe; and

a catalyst outlet end of the third gas-solid separation unit is located above an open end of a second stripper inlet pipe.

~~13. A method for preparing low-carbon olefins from an oxygen-containing compound, comprising an on-line modification of a dimethyl ether/methanol to olefins (DMTO) catalyst through a coke control reaction using the fluidized bed reactor according to any one of claims 1 to 7,~~

~~wherein the method comprises the following step:~~

~~feeding a catalyst and a coke control raw material into the coke control zone, wherein the catalyst reacts with the coke control raw material while flowing in an annular direction along the coke control zone subzones to generate a product comprising a coke controlled catalyst, and the coke controlled catalyst is a modified DMTO catalyst.~~

14. The method according to claim 13, wherein the catalyst flows in an annular direction along the catalyst circulation hole on the baffles; and

the coke control raw material enters the coke control zone subzones from the coke control zone distributor to react with the catalyst.

15. The method according to claim 14, wherein the coke controlled catalyst prepared enters the reaction zone through the coke controlled catalyst delivery pipe, and then contacts and reacts with a raw material comprising the oxygen-containing compound fed through a reaction zone distributor to generate a stream A with low-carbon olefins and a spent catalyst; and

the product further comprises a coke control product gas, and the coke control product gas enters the gas-solid separation zone through a coke control zone gas delivery pipe.

16. The method according to claim 15, wherein the stream A is mixed with the coke control product gas entering the gas-solid separation zone to produce a stream B;

the stream B enters a second gas-solid separation unit to undergo gas-solid separation to obtain a gas-phase stream C and a solid-phase stream D;

the gas-phase stream C is a low-carbon olefin-containing product gas; and

the solid-phase stream D comprises the spent catalyst.

17. The method according to claim 16, wherein the gas-phase stream C enters a first gas collection chamber, and then enters a downstream working section through a product gas delivery pipe;

the solid-phase stream D is returned to the reaction zone of the fluidized bed reactor; and

the catalyst in the reaction zone enters a first stripper through an open end of a first stripper inlet pipe to undergo stripping, and then enters a downstream zone.

18. The method according to claim 13, wherein the coke control raw material comprises C_1-C_6 hydrocarbon compounds.

19. The method according to claim 18, wherein the hydrocarbon compounds are at least one selected from the group consisting of C_1-C_6 alkanes and C_1-C_6 olefins.

20. The method according to claim 18, wherein the coke control raw material further comprises at least one selected from the group consisting of hydrogen, alcohol compound, and water; and

~~a proportion of a total mass of the alcohol compound and the water in a mass of the coke control raw material is greater than or equal to 10 wt% and less than or equal to 50 wt%.~~

~~21. The method according to claim 20, wherein the alcohol compound is at least one selected from the group consisting of methanol and ethanol.~~

~~22. The method according to claim 20, wherein the coke control raw material comprises 0 wt% to 20 wt% of hydrogen, 0 wt% to 50 wt% of methane, 0 wt% to 50 wt% of ethane, 0 wt% to 20 wt% of ethylene, 0 wt% to 50 wt% of propane, 0 wt% to 20 wt% of propylene, 0 wt% to 90 wt% of butane, 0 wt% to 90 wt% of butene, 0 wt% to 90 wt% of pentane, 0 wt% to 90 wt% of pentene, 0 wt% to 90 wt% of hexane, 0 wt% to 90 wt% of hexene, 0 wt% to 50 wt% of methanol, 0 wt% to 50 wt% of ethanol, and 0 wt% to 50 wt% of water; and a total amount of the hydrocarbon compounds is greater than 0%.~~

~~23. The method according to claim 13, wherein the catalyst comprises an SAPO molecular sieve;~~

~~a coke content in the catalyst is less than or equal to 3 wt%;~~

~~a coke content in the coke controlled catalyst is 4 wt% to 9 wt%;~~

~~a quartile deviation of a coke content distribution in the coke controlled catalyst is less than 1 wt%.~~

~~24. The method according to claim 13, wherein coke species in the coke controlled catalyst comprise polymethylbenzene and polymethylnaphthalene;~~

~~a total mass of the polymethylbenzene and the polymethylnaphthalene accounts for greater than or equal to 70 wt% of a total mass of coke;~~

~~a mass of coke species with a molecular weight greater than 184 accounts for less than or equal to 25 wt% of the total mass of coke; and~~

~~the total mass of coke refers to a total mass of coke species.~~

~~25. The method according to claim 15, wherein a coke content in the spent catalyst is 9 wt% to 13 wt%.~~

~~26. The method according to claim 15, wherein the oxygen-containing compound is at least one selected from the group consisting of methanol and dimethyl ether (DME).~~

~~27. The method according to claim 13, wherein process conditions of the coke control zone are as follows: apparent gas linear velocity: 0.1 m/s to 0.5 m/s; reaction temperature: 300°C to 700°C; reaction pressure: 100 kPa to 500 kPa; and bed density: 400 kg/m^3 to 800 kg/m^3.~~

~~28. The method according to claim 15, wherein process conditions of the reaction zone are as follows: apparent gas linear velocity: 0.5 m/s to 2.0 m/s; reaction temperature: 350°C to 550°C; reaction pressure: 100 kPa to 500 kPa; and bed density: 150 kg/m^3 to 500 kg/m^3.~~

~~29~~9. A method for preparing low-carbon olefins, wherein the method for preparing low-carbon olefins comprises preparing low-carbon olefins using the device according to ~~any one of claims 8 to 12~~claim 5;

the method for preparing low-carbon olefins ~~comprises the method according to any one of claims 13 to 28;~~ preparing low-carbon olefins from an oxygen-containing compound, wherein an on-line modification of a dimethyl ether/methanol to olefins (DMTO) catalyst through a coke control reaction is performed using the fluidized bed reactor; wherein the method comprises the following step: feeding a catalyst and a coke control raw material into the coke control zone, wherein the catalyst reacts with the coke control raw material while flowing in an annular direction along the coke control zone subzones to generate a product comprising a coke controlled catalyst, and the coke controlled catalyst is a modified DMTO catalyst; and

the method for preparing low-carbon olefins further comprises the following steps:

allowing a spent catalyst in the reaction zone of the fluidized bed reactor to enter the fluidized bed regenerator and undergo a regeneration treatment to generate a regenerated catalyst, and allowing the regenerated catalyst to enter the coke control zone of the fluidized bed reactor and to contact and react with the coke control raw material.

10. The method according to claim 9, wherein the catalyst flows in an annular direction along the catalyst circulation hole on the baffles; and the coke control raw material enters the coke control zone subzones from the coke control zone distributor to react with the catalyst;

preferably, the coke controlled catalyst prepared enters the reaction zone through the coke controlled catalyst delivery pipe, and then contacts and reacts with a raw material comprising the oxygen-containing compound fed through a reaction zone distributor to generate a stream A with low-carbon olefins and a spent catalyst; and the product further comprises a coke control product gas, and the coke control product gas enters the gas-solid separation zone through a coke control zone gas delivery pipe;

preferably, the stream A is mixed with the coke control product gas entering the gas-solid

separation zone to produce a stream B; the stream B enters a second gas-solid separation unit to undergo gas-solid separation to obtain a gas-phase stream C and a solid-phase stream D; the gas-phase stream C is a low-carbon olefin-containing product gas; and the solid-phase stream D comprises the spent catalyst;

preferably, the gas-phase stream C enters a first gas collection chamber, and then enters a downstream working section through a product gas delivery pipe; the solid-phase stream D is returned to the reaction zone of the fluidized bed reactor; and the catalyst in the reaction zone enters a first stripper through an open end of a first stripper inlet pipe to undergo stripping, and then enters a downstream zone.

11. The method according to claim 9, wherein the coke control raw material comprises C_1-C_6 hydrocarbon compounds;

preferably, the hydrocarbon compounds are at least one selected from the group consisting of C_1-C_6 alkanes and C_1-C_6 olefins;

preferably, the coke control raw material further comprises at least one selected from the group consisting of hydrogen, alcohol compound, and water; and a proportion of a total mass of the alcohol compound and the water in a mass of the coke control raw material is greater than or equal to 10 wt% and less than or equal to 50 wt%;

preferably, the alcohol compound is at least one selected from the group consisting of methanol and ethanol;

preferably, the coke control raw material comprises 0 wt% to 20 wt% of hydrogen, 0 wt% to 50 wt% of methane, 0 wt% to 50 wt% of ethane, 0 wt% to 20 wt% of ethylene, 0 wt% to 50 wt% of propane, 0 wt% to 20 wt% of propylene, 0 wt% to 90 wt% of butane, 0 wt% to 90 wt% of butene, 0 wt% to 90 wt% of pentane, 0 wt% to 90 wt% of pentene, 0 wt% to 90 wt% of hexane, 0 wt% to 90 wt% of hexene, 0 wt% to 50 wt% of methanol, 0 wt% to 50 wt% of ethanol, and 0 wt% to 50 wt% of water; and a total amount of the hydrocarbon compounds is greater than 0%.

12. The method according to claim 9, wherein the catalyst comprises an SAPO molecular sieve;

a coke content in the catalyst is less than or equal to 3 wt%;

a coke content in the coke controlled catalyst is 4 wt% to 9 wt%;

a quartile deviation of a coke content distribution in the coke controlled catalyst is less than 1 wt%.

13. The method according to claim 9, wherein coke species in the coke controlled catalyst

comprise polymethylbenzene and polymethylnaphthalene;

a total mass of the polymethylbenzene and the polymethylnaphthalene accounts for greater than or equal to 70 wt% of a total mass of coke;

a mass of coke species with a molecular weight greater than 184 accounts for less than or equal to 25 wt% of the total mass of coke; and

the total mass of coke refers to a total mass of coke species.

14. The method according to claim 10, wherein a coke content in the spent catalyst is 9 wt% to 13 wt%.

15. The method according to claim 10, wherein the oxygen-containing compound is at least one selected from the group consisting of methanol and dimethyl ether (DME).

16. The method according to claim 9, wherein process conditions of the coke control zone are as follows: apparent gas linear velocity: 0.1 m/s to 0.5 m/s; reaction temperature: 300°C to 700°C; reaction pressure: 100 kPa to 500 kPa; and bed density: 400 kg/m^3 to 800 kg/m^3.

17. The method according to claim 10, wherein process conditions of the reaction zone are as follows: apparent gas linear velocity: 0.5 m/s to 2.0 m/s; reaction temperature: 350°C to 550°C; reaction pressure: 100 kPa to 500 kPa; and bed density: 150 kg/m^3 to 500 kg/m^3.

~~30~~18. The method according to claim 29, wherein the method comprises: allowing the spent catalyst in the reaction zone to enter the fluidized bed regenerator through the first stripper and the spent catalyst delivery pipe, and to contact and react with the regeneration gas to obtain a stream E with a flue gas and a regenerated catalyst; allowing the stream E to enter the third gas-solid separation unit to separate the flue gas and the regenerated catalyst; and

allowing the separated regenerated catalyst to enter the coke control zone of the fluidized bed reactor through the second stripper, the regenerated catalyst delivery pipe, and the first gas-solid separation unit, and to contact and react with the coke control raw material.

~~31~~19. The method according to claim 29, wherein a coke content in the regenerated catalyst is less than or equal to 3 wt~~%.~~%;

~~32. The method according to claim 30, wherein~~preferably, the regeneration gas is at least one selected from the group consisting of oxygen, nitrogen, water vapor, and air.

33. ~~The method according to claim 32, wherein~~preferably, the regeneration gas comprises 0 wt% to 100 wt% of air, 0 wt% to 50 wt% of oxygen, 0 wt% to 50 wt% of nitrogen, and 0 wt% to 50 wt% of water vapor; and

contents of the air, the oxygen, the nitrogen, and the water vapor are not simultaneously zero.

~~34~~20. The method according to claim 29, wherein process conditions of the regeneration zone are as follows: apparent gas linear velocity: 0.5 m/s to 2.0 m/s; regeneration temperature: 600°C to 750°C; regeneration pressure: 100 kPa to 500 kPa; and bed density: 150 kg/m^3 to 700 kg/m^3.