CLAIMS

WHAT IS CLAIMED IS:

1. A fluidized bed reactor comprising a reactor shell, a reaction zone, a coke control zone and a deliverypipe;

wherein the reactor shell comprises a lower shell and an upper shell, the lower shell enclose the reaction zone, the delivery pipe is disposed above the reaction zone and in communication with the reaction zone, an outer periphery of the delivery pipe is provided with the upper shell, the upper shell and the delivery pipe enclose to form a cavity comprising the coke control zone;

an upper part of the delivery pipe is provided with a gas outlet;

the reaction zone comprises a reaction raw material inlet and a coke controlled catalyst inlet;

the coke control zone comprises a catalyst inlet, a coke controlled catalyst outlet, a coke control gas outlet, and a coke control raw material inlet;

the coke control zone is an annular cavity;

there are n baffles arranged in the coke control zone, and the n baffles divide the coke control zone into n sub-coke control zones which comprise a first sub-coke control zone, a second sub-coke control zone, and an nth sub-coke control zone;

at least one catalyst circulation hole is provided on each of n-1 baffles so that the catalyst flows in an annular shape in the coke control zone, wherein n is an integer; and

the catalyst inlet is arranged in the first sub-coke control zone, the coke controlled catalyst outlet is arranged in the nth sub-coke control zone, and the coke control gas outlet is arranged between two adjacent baffles.

2. The fluidized bed reactor according to claim 1, wherein, $2 \leq n \leq 10$~~.~~;

preferably, a cross section of the coke control zone is annular in shape, and a cross section of the sub-coke control zone is fan in shape;

preferably, the coke control gas outlet is connected to the delivery pipe by a coke control zone gas delivery pipe;

preferably, a coke control zone distributor is provided at the bottom of the sub-coke control zone; the coke control raw material inlet is in communication with the coke control zone distributor, or the coke control raw material inlet is located below the coke control zone distributor;

preferably, a reaction zone distributor is arranged at the reaction raw material inlet, and the reaction zone distributor is arranged at the bottom of the reaction zone.

~~3. The fluidized bed reactor according to claim 1, wherein, a cross section of the coke control zone is annular in shape, and a cross section of the sub-coke control zone is fan in shape.~~

~~4. The fluidized bed reactor according to claim 1, wherein, the coke control gas outlet is connected to the delivery pipe by a coke control zone gas delivery pipe.~~

~~5. The fluidized bed reactor according to claim 1, wherein, a coke control zone distributor is provided at the bottom of the sub-coke control zone;~~

~~the coke control raw material inlet is in communication with the coke control zone distributor, or the coke control raw material inlet is located below the coke control zone distributor.~~

~~6. The fluidized bed reactor according to claim 1, wherein, a reaction zone distributor is arranged at the reaction raw material inlet, and the reaction zone distributor is arranged at the bottom of the reaction zone.~~

~~7~~3. The fluidized bed reactor according to claim 1 further comprising a spent catalyst zone which is arranged above the coke control zone and sleeved on the outer periphery of the delivery pipe, wherein a partition plate is provided between the spent catalyst zone and the coke control zone; and

a spent catalyst zone distributor is arranged at the bottom of the spent catalyst zone~~.~~;

preferably, the spent catalyst zone contains a heat extractor for fluidized bed reactor;

preferably, the fluidized bed reactor further comprises a gas-solid separation zone which is arranged above the spent catalyst zone and sleeved on the outer periphery of the delivery pipe; wherein, the gas-solid separation zone is provided with a gas-solid separation device; and the spent catalyst zone is in communication with the gas-solid separation zone;

preferably, the gas-solid separation device comprises a first gas-solid separation device and a second gas-solid separation device; an inlet of the first gas-solid separation device is in communication with the delivery pipe, and a catalyst outlet of the first gas-solid separation device is located in the spent catalyst zone; and a catalyst outlet of the second gas-solid separation device is also provided in the spent catalyst zone;

preferably, the fluidized bed reactor further comprises a product gas delivery pipe and a gas collection chamber which are arranged on an upper part of the reactor shell, wherein the product gas delivery pipe is arranged at the top of the reactor shell, and the product gas delivery pipe is connected to the top of the gas collection chamber; and a gas outlet of the second gas-solid separation device is connected to the gas collection chamber, and a gas outlet of the first gas-solid separation device is connected to the gas collection chamber;

preferably, the fluidized bed reactor further comprises a spent catalyst circulation pipe which is arranged outside the reactor shell; wherein an inlet of the spent catalyst circulation pipe is connected to the spent catalyst zone, and an outlet of the spent catalyst circulation pipe is connected to the bottom of the reaction zone.

~~8. The fluidized bed reactor according to claim 7, wherein, the spent catalyst zone contains a heat extractor for fluidized bed reactor.~~

~~9. The fluidized bed reactor according to claim 7 further comprising a gas-solid separation zone which is arranged above the spent catalyst zone and sleeved on the outer periphery of the delivery pipe;~~

~~wherein, the gas-solid separation zone is provided with a gas-solid separation device; and the spent catalyst zone is in communication with the gas-solid separation zone.~~

~~10. The fluidized bed reactor according to claim 9, wherein, the gas-solid separation device comprises a first gas-solid separation device and a second gas-solid separation device;~~

~~an inlet of the first gas-solid separation device is in communication with the delivery pipe, and a catalyst outlet of the first gas-solid separation device is located in the spent catalyst zone; and~~

~~a catalyst outlet of the second gas-solid separation device is also provided in the spent catalyst zone.~~

~~11. The fluidized bed reactor according to claim 9 further comprising a product gas delivery pipe and a gas collection chamber which are arranged on an upper part of the reactor shell, wherein the product gas delivery pipe is arranged at the top of the reactor shell, and the product gas delivery pipe is connected to the top of the gas collection chamber; and~~

~~a gas outlet of the second gas-solid separation device is connected to the gas collection chamber, and a gas outlet of the first gas-solid separation device is connected to the gas collection chamber.~~

~~12. The fluidized bed reactor according to claim 7 further comprising a spent catalyst circulation pipe which is arranged outside the reactor shell;~~

~~wherein an inlet of the spent catalyst circulation pipe is connected to the spent catalyst zone, and an outlet of the spent catalyst circulation pipe is connected to the bottom of the reaction zone.~~

4. An apparatus comprising a fluidized bed reactor and a fluidized bed regenerator, wherein the fluidized bed reactor is in communication with the fluidized bed regenerator; wherein the fluidized bed reactor is the fluidized bed reactor according to claim 1.

5. The apparatus according to claim 4, wherein the fluidized bed regenerator comprises a regenerator shell; the regenerator shell is provided with a spent catalyst inlet; the spent catalyst

inlet is in communication with the spent catalyst zone of the fluidized bed reactor;

preferably, the spent catalyst inlet is in communication with the spent catalyst zone of the fluidized bed reactor through a first stripper;

preferably, the bottom of the regenerator shell is in communication with the coke control zone;

preferably, the bottom of the regenerator shell is in communication with the coke control zone through a second stripper.

6. The apparatus according to claim 5, wherein, a regenerator heat extractor is provided in the second stripper;

preferably, a regenerator distributor is provided in the regenerator shell; and one end of the second stripper extends into the regenerator shell;

preferably, the fluidized bed regenerator further comprises a regenerator gas-solid separation device, a regenerator gas collection chamber, and a flue gas delivery pipe; the regenerator gas-solid separation device is provided in the regenerator shell, the regenerator gas collection chamber and the flue gas delivery pipe are provided on an upper part of the regenerator shell, the flue gas delivery pipe is provided on the top of the regenerator shell, and the flue gas delivery pipe is connected to the top of the regenerator gas collection chamber; and a gas outlet of the regenerator gas-solid separation device is connected to the regenerator gas collection chamber, and a regenerated catalyst outlet of the regenerator gas-solid separation device is provided at a lower part of the regenerator shell.

~~13~~7. A method for producing low-carbon olefins from oxygen-containing compound which is employed ~~by at least one of~~ the fluidized bed reactor~~s~~ according to ~~any one of~~ claim~~s~~ 1 ~~to 12~~.

~~14~~8. The method according to claim ~~13~~ 7 comprising following steps:

feeding a coke control raw material and a catalyst from the regenerator into the coke control zone to react to generate coke controlled catalyst and coke control product gas;

the catalyst forms annular flow through catalyst circulation hole(s) on the baffle~~.~~;

preferably, the method comprises following steps:

(1) feeding the coke control raw material from the coke control zone distributor into the coke control zone, and feeding the catalyst from the catalyst inlet to the coke control zone, wherein the coke control raw material and the catalyst contact to react in the coke control zone to generate a coke controlled catalyst and a coke control product gas; wherein the coke controlled catalyst enters the reaction zone via the coke controlled catalyst outlet, and the coke control product gas enters the delivery pipe via the coke control gas outlet; and

(2) feeding a raw material containing an oxygen-containing compound into the reaction zone via the reaction raw materials inlet, to contact with the coke controlled catalyst, to obtain a stream A comprising low-carbon olefins.

~~15. The method according to claim 14, wherein the method comprises following steps:~~

~~(1) feeding the coke control raw material from the coke control zone distributor into the coke control zone, and feeding the catalyst from the catalyst inlet to the coke control zone, wherein the coke control raw material and the catalyst contact to react in the coke control zone to generate a coke controlled catalyst and a coke control product gas; wherein the coke controlled catalyst enters the reaction zone via the coke controlled catalyst outlet, and the coke control product gas enters the delivery pipe via the coke control gas outlet;~~

~~(2) feeding a raw material containing an oxygen-containing compound into the reaction zone via the reaction raw material inlet, to contact with the coke controlled catalyst, to obtain a stream A comprising low-carbon olefins.~~

~~16~~9. The method according to claim ~~15~~8, wherein, the coke control raw material comprises C_1-C_6 hydrocarbon compound~~.~~;

preferably, the hydrocarbon compound is at least one of C1-C6 alkanes and C1-C6 olefins.

~~17. The method according to claim 16, wherein, the hydrocarbon compound is at least one~~

~~of C_1-C_6 alkanes and C_1-C_6 olefins.~~

~~18~~10. The method according to claim ~~16~~9, wherein, the coke control raw material further comprises at least one of hydrogen, alcohol compound, and water; and

a total content of the alcohol compound and water in 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 of methanol and ethanol.

~~19. The method according to claim 18, wherein, the alcohol compound is at least one of methanol and ethanol.~~

~~20~~11. The method according to claim ~~18~~10, 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 weight content of the hydrocarbon compound is not zero.

~~21~~12. The method according to claim ~~15~~8, wherein, the oxygen-containing compound is at least one of methanol and dimethyl ether~~.~~;

preferably, the catalyst comprises SAPO molecular sieve; a coke content in the coke controlled catalyst ranges from 4 wt% to 9 wt%; and a quartile deviation of a coke content distribution in the coke controlled catalyst is less than 1 wt%.

~~22. The method according to claim 15, wherein, the catalyst comprises SAPO molecular sieve;~~

~~a coke content in the coke controlled catalyst ranges from 4 wt% to 9 wt%; and~~

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

~~23~~13. The method according to claim ~~22~~12, wherein, coke species in the coke controlled catalyst comprise polymethylbenzene and polymethylnaphthalene;

a total weight content of the polymethylbenzene and polymethylnaphthalene in the total coke weight is ≥70 wt%;

a weight content of the coke species with a molecular weight greater than 184 in the total coke is ≤25 wt%;

wherein, a total coke weight refers to a total weight of the coke species.

~~24~~14. The method according to claim ~~15~~8, wherein, process operating conditions in the coke control zone are as follows: an apparent linear velocity of gas ranges from 0.1 m/s to 0.5 m/s, a reaction temperature ranges from 300℃ to 700℃, a reaction pressure ranges from 100 kPa to 500 kPa, and a bed density ranges from 400 kg/m^3 to 800 kg/m^3;

process operating conditions in the reaction zone are as follows: an apparent linear velocity of gas ranges from 0.5 m/s to 7.0 m/s, a reaction temperature ranges from 350℃ to 550℃, a reaction pressure ranges from 100 kPa to 500 kPa, and a bed density ranges from 100 kg/m^3 to

500 kg/m^3.

~~25~~15. The method according to claim ~~15~~ 8 further comprising following step after step (2):

(3) mixing the stream A comprising low-carbon olefins and the coke control product gas flowing out of the coke control gas outlet to form a mixed stream B in the delivery pipe by which the mixed stream B enters the first gas-solid separation device, and is then divided into a gas phase stream C and a solid phase stream D after gas-solid separation, wherein the gas phase stream C is gas comprising low-carbon olefins, and the solid phase stream D is a spent catalyst~~.~~;

preferably, the method further comprises following step after step (3): (4) feeding the gas phase stream C into a gas collection chamber, and the solid phase stream D into a spent catalyst zone, feeding a fluidizing gas for the spent catalyst zone into the spent catalyst zone from the fluidizing gas inlet for the spent catalyst zone to contact with the spent catalyst such that the fluidized gas for the spent catalyst zone and the spent catalyst carried by such gas form a stream E;

preferably, the method further comprises following step after step (4): (5) feeding the stream E into a second gas-solid separation device to divide it into a gas phase stream F and a solid phase stream G after gas-solid separation, wherein the gas phase stream F is the fluidizing gas for the spent catalyst zone, and the solid phase stream G is the spent catalyst; feeding the gas phase stream F into the gas collection chamber, and the solid phase stream G into the spent catalyst zone, and mixing the gas phase stream C and the gas phase stream F in the gas collection chamber to form product gas which then enters a section downstream via a product gas delivery pipe;

preferably, the method further comprises following step after step (5): (6) returning one part of the spent catalyst in the spent catalyst zone to the bottom of the reaction zone of the fluidized bed reactor through a spent catalyst circulation pipe.

~~26~~16. The method according to claim ~~22~~12, wherein, a coke content in the spent catalyst ranges from 9 wt% to 13 wt%.

~~27. The method according to claim 25 further comprising following step after step (3):~~

~~(4) feeding the gas phase stream C into a gas collection chamber, and the solid phase stream D into a spent catalyst zone, feeding a fluidizing gas for the spent catalyst zone into the spent catalyst zone from the fluidizing gas inlet for the spent catalyst zone to contact with the spent catalyst such that the fluidizing gas for the spent catalyst zone and the spent catalyst carried by such gas form a stream E.~~

~~28~~17. The method according to claim ~~27~~15, wherein, the fluidizing gas for the spent catalyst zone comprises at least one of nitrogen and water vapor.

~~29. The method according to claim 27 further comprising following step after step (4):~~

~~(5) feeding the stream E into a second gas-solid separation device to divide it into a gas phase stream F and a solid phase stream G after gas-solid separation, wherein the gas phase stream F is the fluidizing gas for the spent catalyst zone, and the solid phase stream G is the spent catalyst; feeding the gas phase stream F into the gas collection chamber, and the solid phase stream G into the spent catalyst zone, and mixing the gas phase stream C and the gas phase stream F in the gas collection chamber to form product gas which then enters a section~~

~~downstream via a product gas delivery pipe.~~

~~30. The method according to claim 29 further comprises following step after step (5):~~

~~(6) returning the spent catalyst in the spent catalyst zone to the bottom of the reaction zone of the fluidized bed reactor through a spent catalyst circulation pipe.~~

~~31~~18. The method according to claim ~~27~~15, wherein, process operating conditions in the spent catalyst zone are as follows: an apparent linear velocity of gas ranges from 0.1 m/s to 1.0 m/s, a reaction temperature ranges from 350℃ to 550℃, a reaction pressure ranges from 100 kPa to 500 kPa, and a bed density ranges from 200 kg/m^3 to 800 kg/m^3.

~~32. A device comprising a fluidized bed reactor and a fluidized bed regenerator, wherein the fluidized bed reactor is in communication with the fluidized bed regenerator;~~

~~the fluidized bed reactor is at least one of the fluidized bed reactors according to any one of claims 1 to 12.~~

~~33. The device according to claim 32, wherein the fluidized bed regenerator comprises a regenerator shell;~~

~~the regenerator shell is provided with a spent catalyst inlet;~~

~~the spent catalyst inlet is in communication with the spent catalyst zone of the fluidized bed reactor.~~

~~34. The device according to claim 33, wherein, the spent catalyst inlet is in communication with the spent catalyst zone of the fluidized bed reactor through a first stripper.~~

~~35. The device according to claim 33, wherein, the bottom of the regenerator shell is in communication with the coke control zone.~~

~~36. The device according to claim 35, wherein, the bottom of the regenerator shell is in communication with the coke control zone through a second stripper.~~

~~37. The device according to claim 36, wherein, a regenerator heat extractor is provided in the second stripper.~~

~~38. The device according to claim 33, wherein, a regenerator distributor is provided in the regenerator shell; and~~

~~one end of the second stripper extends into the regenerator shell.~~

~~39. The device according to claim 33, wherein, the fluidized bed regenerator further comprises a regenerator gas-solid separation device, a regenerator gas collection chamber, and a flue gas delivery pipe;~~

~~the regenerator gas-solid separation device is provided in the regenerator shell, the regenerator gas collection chamber and the flue gas delivery pipe are provided on an upper part of the regenerator shell, the flue gas delivery pipe is provided on the top of the regenerator shell, and the flue gas delivery pipe is connected to the top of the regenerator gas collection chamber; and~~

~~a gas outlet of the regenerator gas-solid separation device is connected to the regenerator gas collection chamber, and a regenerated catalyst outlet of the regenerator gas-solid separation device is provided at a lower part of the regenerator shell.~~

~~40. A method for producing low-carbon olefins from oxygen-containing compound which is employed by at least one of the devices according to any one of claims 32 to 39.~~

~~41~~19. The method according to claim ~~40~~ 15 further comprising

feeding ~~a~~ the other part of spent catalyst in ~~a~~ the spent catalyst zone into the fluidized bed regenerator, and then feeding the catalyst regenerated in the fluidized bed regenerator into the coke control zone~~.~~;

preferably, the method comprises the following steps:

(a) passing a spent catalyst through the first stripper, which is then fed into the middle of

the fluidized bed regenerator after stripping;

(b) feeding a regeneration gas from a regeneration gas inlet into the bottom of the fluidized bed regenerator to contact with the spent catalyst to perform a chemical reaction to generate a stream H comprising flue gas and regenerated catalyst, which enters the regenerator gas-solid device and is divided into flue gas and regenerated catalyst after gas-solid separation, feeding the flue gas into a regenerator gas collection chamber and then into the flue gas treatment system downstream through a flue gas delivery pipe, returning the regenerated catalyst to the bottom of the fluidized bed regenerator, then into a second stripper, and into the coke control zone of the fluidized bed reactor after stripping and heat extraction;

preferably, the regeneration gas is at least one of oxygen, nitrogen, water vapor and air;

preferably, the regeneration gas comprises from 0 wt% to 100 wt% air, from 0 wt% to 50wt% oxygen, from 0 wt% to 50wt% nitrogen, and from 0 wt% to 50wt% water vapor.

~~42. The method according to claim 40 comprising following steps:~~

~~(a) passing a spent catalyst through the first stripper, which is then fed into the middle of~~

~~the fluidized bed regenerator after stripping;~~

~~(b) feeding a regeneration gas from a regeneration gas inlet into the bottom of the fluidized bed regenerator to contact with the spent catalyst to perform a chemical reaction to generate a stream H comprising flue gas and regenerated catalyst, which enters the regenerator gas-solid separation device and is divided into flue gas and regenerated catalyst after gas-solid separation, feeding the flue gas into a regenerator gas collection chamber and then into the flue gas treatment system downstream through a flue gas delivery pipe, returning the regenerated catalyst to the bottom of the fluidized bed regenerator, then into a second stripper, and into the coke control zone of the fluidized bed reactor after stripping and heat extraction.~~

~~43. The method according to claim 42, wherein, the regeneration gas is at least one of oxygen, nitrogen, water vapor and air.~~

~~44. The method according to claim 42, wherein, 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.~~

~~45~~20. The method according to claim ~~41~~19, wherein, process operating conditions in the fluidized bed regenerator are as follows: an apparent linear velocity of gas ranges from 0.5 m/s to 2.0 m/s, a regeneration temperature ranges from 600℃ to 750℃, a regeneration pressure ranges from 100 kPa to 500 kPa, and a bed density ranges from 150 kg/m^3 to 700 kg/m^3.

~~46. The method according to claim 42, wherein, a coke content in the regenerated catalyst is ≤3 wt.~~