CLAIMS

WHAT IS CLAIMED IS:

1. A regeneration device for activating a catalyst to prepare low-carbon olefins from an oxygen-containing compound, wherein the regeneration device comprises a first regenerator and a second regenerator;

the first regenerator comprises a second activation zone, a first activation zone, and a gas-solid separation zone from bottom to top;

the second activation zone axially communicates with the gas-solid separation zone;

the first activation zone is arranged on a periphery of a junction between the second activation zone and the gas-solid separation zone, and the first activation zone communicates with the second activation zone;

the first activation zone is an annular cavity;

n baffles are radially arranged in the first activation zone, and the n baffles divide the first activation zone into n first activation zone subzones;

a catalyst circulation hole is formed in each of n-1 of the baffles, such that a catalyst entering the first activation zone flows circularly;

the first activation zone of the first regenerator is connected to the second regenerator through a pipeline, such that the catalyst in the first activation zone is configured to be delivered to the second regenerator; and

the second regenerator is connected to the gas-solid separation zone of the first regenerator through a pipeline, such that the catalyst in the second regenerator is configured to be delivered to the gas-solid separation zone.

2. The regeneration device according to claim 1, wherein the regeneration device comprises a second regenerated catalyst inclined pipe, a second regenerated catalyst delivery pipe, and a third regenerated catalyst inclined pipe;

the first activation zone of the first regenerator, the second regenerated catalyst inclined pipe, the second regenerated catalyst delivery pipe, and a middle part of the second regenerator communicate with each other in sequence; and

a bottom of the second regenerator, the third regenerated catalyst inclined pipe, and the gas-solid separation zone of the first regenerator communicate with each other in sequence.

3. The regeneration device according to claim 1, wherein in the first activation zone, the n baffles comprise a 1st baffle, and a 2nd baffle to an nth baffle;

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

a catalyst circulation hole is formed in each of the 2nd baffle to the nth baffle;

a spent catalyst inlet is formed in a 1st first activation zone subzone formed through division by the 1st baffle and the 2nd baffle;

an nth activation zone subzone formed through division by the 1st baffle and the nth baffle is provided with a first activation zone catalyst delivery pipe, and the first activation zone catalyst delivery pipe allows the first activation zone to communicate with the second activation zone;

a first activation zone distributor is arranged at a bottom of each of the first activation zone subzones; ~~and~~

a first activation zone gas delivery pipe is arranged at tops of the first activation zone subzones~~.~~;

preferably, a first gas-solid separation unit of the first regenerator is arranged in an upper part of the first activation zone; and

the first gas-solid separation unit of the first regenerator communicates with the first activation zone through the spent catalyst inlet.

~~4. The regeneration device according to claim 1, wherein a first gas-solid separation unit of the first regenerator is arranged in an upper part of the first activation zone; and~~

~~the first gas-solid separation unit of the first regenerator communicates with the first activation zone through the spent catalyst inlet.~~

~~5.~~ 4. The regeneration device according to claim 1, wherein n has a value range of $2 \leq n \leq 10$.

~~6.~~ 5.The regeneration device according to claim 1, wherein a cross section of each of the first activation zone subzones is sector-annular.

~~7.~~ 6. The regeneration device according to claim 1, wherein m perforated plates are horizontally arranged in the second activation zone,

wherein $1 \leq m \leq 10$~~.~~;

wherein the perforated plates each have a porosity of 5% to 50%;

wherein a second activation zone distributor is arranged at a bottom of the second activation zone.

~~8. The regeneration device according to claim 7, wherein the perforated plates each have a porosity of 5% to 50%.~~

~~9. The regeneration device according to claim 1, wherein a second activation zone distributor is arranged at a bottom of the second activation zone.~~

~~10~~. 7. The regeneration device according to claim 1, wherein the first regenerator comprises a first regenerator gas collection chamber and a first regenerator cooler;

the first regenerator gas collection chamber is located at a top of the first regenerator;

a top of the first regenerator gas collection chamber is provided with a first regenerator product

gas delivery pipe;

the gas-solid separation zone is provided with a second gas-solid separation unit of the first regenerator;

the first regenerator gas collection chamber is connected to a gas outlet of the second gas-solid separation unit of the first regenerator; ~~and~~

the first regenerator cooler is located in a lower part of the second activation zone~~.~~;

preferably, the second regenerator comprises a second regenerator shell, a second regenerator distributor, a second regenerator gas-solid separation unit, and a second regenerator gas collection chamber;

the second regenerator distributor is located at the bottom of the second regenerator;

the second regenerator gas-solid separation unit is located at an upper part of the second regenerator;

the second regenerator gas collection chamber is located at a top of the second regenerator;

a gas outlet of the second regenerator gas-solid separation unit is connected to the second regenerator gas collection chamber; and a catalyst outlet of the second regenerator gas-solid separation unit is located at a lower part of the second regenerator.

~~11. The regeneration device according to claim 1, wherein the second regenerator comprises a second regenerator shell, a second regenerator distributor, a second regenerator gas-solid separation unit, and a second regenerator gas collection chamber;~~

~~the second regenerator distributor is located at the bottom of the second regenerator;~~

~~the second regenerator gas-solid separation unit is located at an upper part of the second regenerator;~~

~~the second regenerator gas collection chamber is located at a top of the second regenerator;~~

~~a gas outlet of the second regenerator gas-solid separation unit is connected to the second regenerator gas collection chamber; and a catalyst outlet of the second regenerator gas-solid separation unit is located at a lower part of the second regenerator.~~

~~12.~~ 8. A device for preparing low-carbon olefins from an oxygen-containing compound, comprising a fluidized bed reactor and a regeneration device,

wherein the regeneration device comprises the regeneration device according to claim 1; ~~any one of claims 1 to 11.~~ wherein the device comprises a spent catalyst inclined pipe, a fluidized bed reactor stripper, a spent catalyst delivery pipe, a first regenerated catalyst inclined pipe, and a first regenerated catalyst delivery pipe;

a spent catalyst zone, the spent catalyst inclined pipe, the fluidized bed reactor stripper, the

spent catalyst delivery pipe, and the first gas-solid separation unit of the first regenerator communicate with each other in sequence; and

the second activation zone, the first regenerated catalyst inclined pipe, the first regenerated catalyst delivery pipe, and a reaction zone of the fluidized bed reactor communicate with each other in sequence.

~~13. The device according to claim 12, wherein the device comprises a spent catalyst inclined pipe, a fluidized bed reactor stripper, a spent catalyst delivery pipe, a first regenerated catalyst inclined pipe, and a first regenerated catalyst delivery pipe;~~

~~a spent catalyst zone, the spent catalyst inclined pipe, the fluidized bed reactor stripper, the spent catalyst delivery pipe, and the first gas-solid separation unit of the first regenerator communicate with each other in sequence; and~~

~~the second activation zone, the first regenerated catalyst inclined pipe, the first regenerated catalyst delivery pipe, and a reaction zone of the fluidized bed reactor communicate with each other in sequence.~~

~~14.~~ 9. The device according to claim ~~12~~8, wherein the fluidized bed reactor comprises a lower shell, a delivery pipe, and an upper shell;

the lower shell encloses a reaction zone;

the delivery pipe is located above the reaction zone and communicates with the reaction zone;

the upper shell is arranged on a periphery of the delivery pipe;

the upper shell and the delivery pipe enclose a cavity; ~~and~~

the cavity is divided into a spent catalyst zone and a gas-solid separation zone from bottom to top~~.~~;

preferably, the reaction zone is a fast fluidized zone;

preferably, the spent catalyst zone is a bubbling fluidized zone;

the gas-solid separation zone is provided with a first gas-solid separation unit of the fluidized bed reactor;

an upper part of the delivery pipe is connected to an inlet of the first gas-solid separation unit of the fluidized bed reactor;

preferably, the fluidized bed reactor comprises a fluidized bed reactor distributor, a fluidized bed reactor cooler, a spent catalyst zone gas distributor, a fluidized bed reactor gas collection chamber, and a second gas-solid separation unit of the fluidized bed reactor;

the fluidized bed reactor distributor is located at a bottom of the reaction zone;

the fluidized bed reactor cooler is located in a lower part of the spent catalyst zone;

the spent catalyst zone gas distributor is located at a bottom of the spent catalyst zone;

gas outlets of the second gas-solid separation unit of the fluidized bed reactor and the first gas-solid separation unit of the fluidized bed reactor are connected to the fluidized bed reactor gas collection chamber;

the fluidized bed reactor gas collection chamber is provided with a product gas delivery pipe;

catalyst outlets of the first gas-solid separation unit of the fluidized bed reactor and the second gas-solid separation unit of the fluidized bed reactor are connected to the spent catalyst zone;

preferably, the reaction zone and the spent catalyst zone communicate with each other through a spent catalyst circulation pipe.

~~15. The device according to claim 14, wherein the reaction zone is a fast fluidized zone.~~

~~16. The device according to claim 14, wherein the spent catalyst zone is a bubbling fluidized zone.~~

~~17. The device according to claim 14, wherein~~

the gas-solid separation zone is provided with a first gas-solid separation unit of the fluidized bed reactor; and

an upper part of the delivery pipe is connected to an inlet of the first gas-solid separation unit of the fluidized bed reactor.

18. The device according to claim 14, wherein the fluidized bed reactor comprises a fluidized bed reactor distributor, a fluidized bed reactor cooler, a spent catalyst zone gas distributor, a fluidized bed reactor gas collection chamber, and a second gas-solid separation unit of the fluidized bed reactor;

the fluidized bed reactor distributor is located at a bottom of the reaction zone;

the fluidized bed reactor cooler is located in a lower part of the spent catalyst zone;

the spent catalyst zone gas distributor is located at a bottom of the spent catalyst zone;

gas outlets of the second gas-solid separation unit of the fluidized bed reactor and the first gas-solid separation unit of the fluidized bed reactor are connected to the fluidized bed reactor gas collection chamber;

the fluidized bed reactor gas collection chamber is provided with a product gas delivery pipe; and

catalyst outlets of the first gas-solid separation unit of the fluidized bed reactor and the second gas-solid separation unit of the fluidized bed reactor are connected to the spent catalyst zone.

19. The device according to claim 14, wherein the reaction zone and the spent catalyst zone communicate with each other through a spent catalyst circulation pipe.

~~20. A method for activating a catalyst to prepare low-carbon olefins from an oxygen-containing compound, wherein the method uses the regeneration device according to any one of claims 1 to 11.~~

~~21. The method according to claim 20, wherein the method comprises:~~

~~feeding a first activation zone raw material and a spent catalyst into the first activation zone, wherein the spent catalyst chemically reacts with the first activation zone raw material while flowing circularly along the first activation zone subzones to generate a catalyst A;~~

~~feeding a part A1 of the catalyst A and a second regenerator raw material into the second regenerator, and allowing a chemical reaction to generate a catalyst A3; and~~

~~feeding a remaining part A2 of the catalyst A, the catalyst A3, and a second activation zone raw material into the second activation zone, and allowing a chemical reaction to generate a regenerated catalyst;~~

~~wherein a coke composition in the catalyst A comprises oxygen-containing hydrocarbon species and oxygen-free hydrocarbon species.~~

~~22. The method according to claim 21, wherein the first activation zone raw material comprises oxygen and water vapor;~~

~~a mass fraction of the oxygen is 0 wt% to 10 wt%; and~~

~~a mass fraction of the water vapor is 90 wt% to 100 wt%.~~

~~23. The method according to claim 21, wherein the second activation zone raw material is at least one selected from the group consisting of water vapor and a hydrocarbon mixture; and~~

~~the hydrocarbon mixture comprises methane, ethane, propane, and C_4-C_6 hydrocarbon compounds, and the C_4-C_6 hydrocarbon compounds comprise butene, butane, pentene, pentane, hexene, and hexane.~~

~~24. The method according to claim 21, wherein the second regenerator raw material comprises air.~~

~~25.The method according to claim 21, wherein a coke content in the catalyst A3 is 0 wt% to 0.5 wt%.~~

~~26. The method according to claim 21, wherein a coke content in the spent catalyst is 9 wt%~~

~~to 13 wt%.~~

~~27. The method according to claim 21, wherein a coke content in the spent catalyst is 10 wt% to 12 wt%.~~

~~28. The method according to claim 21, wherein a coke content in the regenerated catalyst is 5 wt% to 11 wt; and~~

~~a quartile deviation of a coke content distribution in the regenerated catalyst is less than or equal to 1.5 wt%.~~

~~29. The method according to claim 21, wherein in the regenerated catalyst, coke species comprise polymethylbenzene and polymethylnaphthalene;~~

~~a total mass of the polymethylbenzene and the polymethylnaphthalene accounts for greater than or equal to 60 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 30 wt% of the total mass of coke; and~~

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

~~30. The method according to claim 21, wherein a mass flow rate of a catalyst entering the first regenerator from the second regenerator is 1 wt% to 20 wt% of a mass flow rate of a catalyst entering the fluidized bed reactor from the first regenerator.~~

~~31. The method according to claim 21, wherein the spent catalyst comprises a SAPO-34 molecular sieve.~~

~~32. The method according to claim 21, wherein process operating conditions of the first activation zone of the first regenerator are as follows: apparent gas linear velocity: 0.1 m/s to 0.5 m/s; temperature: 650°C to 750°C; pressure: 100 kPa to 500 kPa; and bed density: 400 kg/m^3 to 700 kg/m^3.~~

~~33. The method according to claim 21, wherein process operating conditions of the second activation zone of the first regenerator are as follows: apparent gas linear velocity: 0.1 m/s to 0.5 m/s; temperature: 550°C to 700°C; pressure: 100 kPa to 500 kPa; and bed density: 400 kg/m^3 to 700 kg/m^3.~~

~~34.The method according to claim 21, wherein process operating conditions of the second~~

~~regenerator are as follows: apparent gas linear velocity: 0.5 m/s to 2.0 m/s; temperature: 650°C to 750°C; pressure: 100 kPa to 500 kPa; and bed density: 150 kg/m^3 to 700 kg/m^3.~~

~~35.~~ 10. A method for preparing low-carbon olefins from an oxygen-containing compound using the device according to claim 8; ~~any one of claims 12 to 19.~~

the method for preparing low-carbon olefins from the oxygen-containing compound comprises a method for activating a catalyst to prepare the low-carbon olefins from the oxygen-containing compound, wherein the method for activating the catalyst to prepare the low-carbon olefins from the oxygen-containing compound uses the regeneration device;

wherein the method for activating the catalyst to prepare the low-carbon olefins from the oxygen-containing compound comprises:

feeding a first activation zone raw material and a spent catalyst into the first activation zone, wherein the spent catalyst chemically reacts with the first activation zone raw material while flowing circularly along the first activation zone subzones to generate a catalyst A;

feeding a part A1 of the catalyst A and a second regenerator raw material into the second regenerator, and allowing a chemical reaction to generate a catalyst A3;

feeding a remaining part A2 of the catalyst A, the catalyst A3, and a second activation zone raw material into the second activation zone, and allowing a chemical reaction to generate a regenerated catalyst;

wherein a coke composition in the catalyst A comprises oxygen-containing hydrocarbon species and oxygen-free hydrocarbon species;

wherein the method comprises:

feeding a raw material with the oxygen-containing compound and a regenerated catalyst into the reaction zone, and allowing a reaction to obtain a stream A with low-carbon olefins and a spent catalyst;

subjecting the stream A to gas-solid separation, and delivering the spent catalyst to the spent catalyst zone; and

returning a part of the spent catalyst in the spent catalyst zone to a fluidized bed reaction zone, and allowing a remaining part of the spent catalyst to enter the first regenerator.

~~36. The method according to claim 35, wherein the method comprises:~~

~~feeding a raw material with the oxygen-containing compound and a regenerated catalyst into the reaction zone, and allowing a reaction to obtain a stream A with low-carbon olefins and a spent catalyst;~~

~~subjecting the stream A to gas-solid separation, and delivering the spent catalyst to the spent catalyst zone; and~~

~~returning a part of the spent catalyst in the spent catalyst zone to a fluidized bed reaction zone, and allowing a remaining part of the spent catalyst to enter the first regenerator.~~

11. The method according to claim 10, wherein the first activation zone raw material comprises oxygen and water vapor;

a mass fraction of the oxygen is 0 wt% to 10 wt%;

a mass fraction of the water vapor is 90 wt% to 100 wt%;

preferably, the second activation zone raw material is at least one selected from the group consisting of water vapor and a hydrocarbon mixture;

the hydrocarbon mixture comprises methane, ethane, propane, and C4-C6 hydrocarbon compounds, and the C4-C6 hydrocarbon compounds comprise butene, butane, pentene, pentane, hexene, and hexane;

preferably, the second regenerator raw material comprises air.

12. The method according to claim 10, wherein a coke content in the catalyst A3 is 0 wt% to 0.5 wt%;

preferably, a coke content in the spent catalyst is 9 wt% to 13 wt%.

preferably, a coke content in the spent catalyst is 10 wt% to 12 wt%.

preferably, a coke content in the regenerated catalyst is 5 wt% to 11 wt;

a quartile deviation of a coke content distribution in the regenerated catalyst is less than or equal to 1.5 wt%;

preferably, in the regenerated catalyst, coke species comprise polymethylbenzene and polymethylnaphthalene;

a total mass of the polymethylbenzene and the polymethylnaphthalene accounts for greater than or equal to 60 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 30 wt% of the total mass of coke; and

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

13. The method according to claim 10, wherein a mass flow rate of a catalyst entering the first regenerator from the second regenerator is 1 wt% to 20 wt% of a mass flow rate of a catalyst entering the fluidized bed reactor from the first regenerator.

14. The method according to claim 10, wherein the spent catalyst comprises a SAPO-34 molecular sieve.

15. The method according to claim 10, wherein process operating conditions of the first activation zone of the first regenerator are as follows: apparent gas linear velocity: 0.1 m/s to 0.5 m/s; temperature: 650°C to 750°C; pressure: 100 kPa to 500 kPa; and bed density: 400 kg/m3 to 700 kg/m3;

preferably, process operating conditions of the second activation zone of the first regenerator are as follows: apparent gas linear velocity: 0.1 m/s to 0.5 m/s; temperature: 550°C to 700°C; pressure: 100 kPa to 500 kPa; and bed density: 400 kg/m3 to 700 kg/m3.

16. The method according to claim 21, wherein process operating conditions of the second regenerator are as follows: apparent gas linear velocity: 0.5 m/s to 2.0 m/s; temperature: 650°C to 750°C; pressure: 100 kPa to 500 kPa; and bed density: 150 kg/m3 to 700 kg/m3.

~~37.~~17. The method according to claim 10~~36~~, wherein the spent catalyst zone fluidizing gas is at least one selected from the group consisting of nitrogen and water vapor~~.~~;

preferably, the raw material with the oxygen-containing compound is at least one selected from the group consisting of methanol and dimethyl ether (DME).

~~38. The method according to claim 36, wherein the raw material with the oxygen-containing compound is at least one selected from the group consisting of methanol and dimethyl ether (DME).~~

~~39.~~18.The method according to claim ~~36~~10, wherein a ratio of a mass flow rate of the regenerated catalyst to a feed amount of the oxygen-containing compound is 0.3 to 1.0 ton of catalyst/ton of methanol;~~.~~

preferably, a ratio of a mass flow rate of the regenerated catalyst to a feed amount of the oxygen-containing compound is 0.5 to 1.0 ton of catalyst/ton of methanol.

~~40.The method according to claim 36, wherein a ratio of a mass flow rate of the regenerated catalyst to a feed amount of the oxygen-containing compound is 0.5 to 1.0 ton of catalyst/ton of methanol.~~

~~41.~~ 19. The method according to claim ~~36~~10, wherein process operating conditions of the reaction zone of the fluidized bed reactor are as follows: apparent gas linear velocity: 0.5 m/s to 7.0 m/s; reaction temperature: 350°C to 550°C; reaction pressure: 100 kPa to 500 kPa; and bed density: 100 kg/m^3 to 500 kg/m^3.

~~42.~~ 20. The method according to claim ~~36~~10, wherein process operating conditions of the spent catalyst zone of the fluidized bed reactor are as follows: apparent gas linear velocity: 0.1 m/s to 1.0 m/s; reaction temperature: 350°C to 550°C; reaction pressure: 100 kPa to 500 kPa; and bed

density: 200 kg/m^3 to 800 kg/m^3.