CLAIMS

1. A naphtha-to-aromatics fluidized bed device, characterized in that the device comprises: a light hydrocarbon aromatization reactor; and a naphtha-to-aromatics reactor; wherein

the light hydrocarbon aromatization reactor includes at least one inlet for introducing a raw material and a high-temperature catalyst; and at least one outlet of the light hydrocarbon aromatization reactor is connected to the naphtha-to-aromatics reactor for delivering catalyst and generated light hydrocarbon aromatization product gas to the naphtha-to-aromatics reactor;

the naphtha-to-aromatics reactor is configured to introduce naphtha to react with a catalyst from the light hydrocarbon aromatization reactor to produce a product gas flow containing BTX.

2. The naphtha-to-aromatics fluidized bed device according to claim 1, characterized in that the naphtha-to-aromatics reactor is further provided with a product gas delivery pipe I for outputting the product gas flow containing BTX to a downstream section.

3. The naphtha-to-aromatics fluidized bed device according to claim 1, characterized in that the device further comprises a regenerator, and at least one inlet of the light hydrocarbon aromatization reactor is connected to the regenerator for obtaining a high-temperature regenerated catalyst generated by the regenerator.

4. The naphtha-to-aromatics fluidized bed device according to claim 1, characterized in that the light hydrocarbon aromatization reactor is divided from top to bottom into at least a gas-solid separation zone II and a light hydrocarbon aromatization reaction zone which are connected to form a bed reactor; the gas-solid separation zone II is provided with a gas-solid separation unit II and a gas collection chamber II, the gas outlet of the gas-solid separation unit II is connected to the gas collection chamber II, and a bed reactor distributor is provided in the inner lower part of the light hydrocarbon aromatization reaction zone for feeding a bed reactor feedstock.

5. The naphtha-to-aromatics fluidized bed device according to claim 4, characterized in that the gas collection chamber II is located at the inner top of the bed reactor.

6. The naphtha-to-aromatics fluidized bed device according to claim 4, characterized in that the bed reactor feedstock comprises C_4 and C_5 hydrocarbons;

the light hydrocarbon aromatization reactor further comprises a riser reactor in addition to the bed reactor, wherein the inlet end of the riser reactor is connect to the regenerator; the outlet end of the riser reactor extends into the lower section of the light hydrocarbon aromatization reaction zone, with the catalyst outlet of the gas-solid separation unit II located above it;

the inlet end of the riser reactor is further configured to introduce a catalyst and a riser reactor feedstock.

7. The naphtha-to-aromatics fluidized bed device according to claim 1, characterized in that the naphtha-to-aromatics reactor is divided from top to bottom into at least a gas-solid separation zone I and a naphtha-to-aromatics reaction zone which are connected; the gas-solid separation zone I is provided with a gas-solid separation unit I and a gas collection chamber I; the gas outlet of the gas-solid separation unit I is connect to the gas collection chamber I; the lower section of the naphtha-to-aromatics reaction zone is provided with a naphtha-to-aromatics reactor distributor for feeding naphtha feedstock.

8. The naphtha-to-aromatics fluidized bed device according to claim 7, characterized in that the gas-solid separation unit I employs at least one set of gas-solid cyclone separators, each set comprising a first-stage gas-solid cyclone separator and a second-stage gas-solid cyclone separator;

the gas collection chamber I is located at the inner top of the naphtha-to-aromatics reactor;

the gas collection chamber I is connected to the product gas delivery pipe I.

9. The naphtha-to-aromatics fluidized bed device according to claim 9, characterized in that

the gas-solid separation zone I is connected to the gas-solid separation zone II, and the naphtha-to-aromatics reaction zone of the naphtha-to-aromatics reactor is connected to the light hydrocarbon aromatization reaction zone;

the gas-solid separation zone I is connected to the gas collection chamber II through a product gas delivery pipe II;

a light hydrocarbon aromatization slide valve is provided on the pipeline connecting the naphtha-to-aromatics reaction zone of the naphtha-to-aromatics reactor and the light hydrocarbon aromatization reaction zone;

the outlet of the light hydrocarbon aromatization reaction zone is positioned higher than the inlet of the naphtha-to-aromatics reaction zone of the naphtha-to-aromatics reactor.

10. The naphtha-to-aromatics fluidized bed device according to claim 3, characterized in that the regenerator is divided from top to bottom into at least a gas-solid separation zone III and a catalyst regeneration zone which are connected; the gas-solid separation zone III is provided with a regenerator gas-solid separation unit and a regenerator gas collection chamber; the gas outlet of the regenerator gas-solid separation unit is connected to the regenerator gas collection chamber; the regenerator gas collection chamber is provided with a flue gas delivery pipe; the lower section of the catalyst regeneration zone is provided with a regenerator distributor for introducing regeneration gas;

the catalyst regeneration zone is sequentially connected to the light hydrocarbon aromatization reactor through a regenerator stripper and a regenerated catalyst slide valve; the inlet pipe of the regenerator stripper extends into the regenerator shell, located above the regenerator distributor, and the catalyst outlet end of the regenerator gas-solid separation unit is located above the open end of the inlet pipe of the regenerator stripper;

the regenerator gas collection chamber is located at the inner top of the regenerator shell.

11. The naphtha-to-aromatics fluidized bed device according to claim 3, characterized in that at least one outlet of the naphtha-to-aromatics reactor is further connected to the inlet of the regenerator for delivering a spent catalyst generated in the naphtha-to-aromatics reactor to the regenerator, wherein the regenerator is configured to introduce a regeneration gas and convert the spent catalyst into a regenerated catalyst;

the naphtha-to-aromatics reaction zone of the naphtha-to-aromatics reactor is sequentially connected to the inlet of the regenerator through a reactor stripper, a spent catalyst slide valve and a spent catalyst delivery pipe; the inlet pipe of the reactor stripper extends into the naphtha-to-aromatics reactor shell, located above the naphtha-to-aromatics reactor distributor, and the catalyst outlet end of the gas-solid separation unit I is located above the open end of the inlet pipe of the reactor stripper;

the catalyst inlet of the regenerator is provided on the regenerator shell.

12. A method for producing aromatics from naphtha, characterized in that the method comprises: using the naphtha-to-aromatics fluidized bed device according to any one of claims 1-

11 to prepare aromatics;

the method comprises:

introducing the raw material and the high-temperature catalyst into the light hydrocarbon aromatization reactor to generate the light hydrocarbon aromatization product gas;

introducing naphtha and the catalyst and the light hydrocarbon aromatization product gas from the light hydrocarbon aromatization reactor into the naphtha-to-aromatics reactor to generate a product gas flow containing BTX;

the catalyst is a metal molecular sieve bifunctional catalyst;

the metal molecular sieve bifunctional catalyst employs a metal-modified HZSM-5 zeolite molecular sieve;

a metal used for a metal modification is at least one selected from the group consisting of La, Zn, Ga, Fe, Mo, and Cr;

the metal modification comprises: placing an HZSM-5 zeolite molecular sieve in a metal salt solution, and carrying out an impregnation, a drying and a calcination to obtain the metal-modified HZSM-5 zeolite molecular sieve.

13. The method for producing aromatics from naphtha according to claim 12, characterized in that the components of the light hydrocarbon aromatization product gas comprise: BTX, light olefins and H_2;

in addition to BTX, the product gas flow containing BTX further comprises: light olefins, hydrogen, light alkanes, combustible gas, heavy aromatics and unconverted naphtha.

14. The method for producing aromatics from naphtha according to claim 12, characterized in that introducing the raw material and the high-temperature catalyst into the light hydrocarbon aromatization reactor to generate light hydrocarbon aromatization product gas specifically comprises:

feeding the bed reactor feedstock into the light hydrocarbon aromatization reaction zone through the bed reactor distributor, contacting with the catalyst introduced into the bed reactor to generate light hydrocarbon aromatization product gas;

the bed reactor feedstock comprises C_4 and C_5 hydrocarbons or

the bed reactor feedstock comprises C_3, C_4 and C_5 hydrocarbons;

the C_4 and C_5 hydrocarbons are derived from C_4 and C_5 hydrocarbons separated from the product gas flow;

the C_3, C_4 and C_5 hydrocarbons are derived from C_3, C_4 and C_5 hydrocarbons separated from the product gas flow;

the process conditions for the light hydrocarbon aromatization reaction zone are: gas superficial velocity of 0.5-2.0 m/s, reaction temperature of 550-665°C, reaction pressure of 100-500 kPa, bed density of 150-700 kg/m^3.

15. The method for producing aromatics from naphtha according to claim 14, characterized in that the method further comprises: removing the catalyst entrained in the light hydrocarbon aromatization product gas in the gas-solid separation zone II of the light hydrocarbon aromatization reactor;

the catalyst in the light hydrocarbon aromatization reaction zone enters the naphtha-to-aromatics reactor through the light hydrocarbon aromatization slide valve;

removing catalyst entrained in the light hydrocarbon aromatization product gas in the gas-solid separation zone II specifically comprises:

the light hydrocarbon aromatization product gas enters the gas-solid separation unit II to remove the catalyst entrained in it, then enters the gas collection chamber II, and is delivered to the gas-solid separation zone I of the naphtha-to-aromatics reactor through the product gas delivery pipe II;

introducing naphtha into the naphtha-to-aromatics reaction zone of the naphtha-to-aromatics reactor through the naphtha-to-aromatics reactor distributor, contacting with the catalyst from the light hydrocarbon aromatization reactor to generate a product gas flow containing BTX, while the catalyst becomes coked and converts into the spent catalyst;

the method further comprises: removing the spent catalyst entrained in the product gas flow containing BTX in the gas-solid separation zone I of the naphtha-to-aromatics reactor and delivering to downstream section;

the naphtha is at least one selected from the group consisting of coal direct liquefaction naphtha, coal indirect liquefaction naphtha, straight-run naphtha and hydrocracked naphtha;

the naphtha further comprises unconverted naphtha separated from the product gas flow, wherein the main components of the unconverted naphtha are linear aliphatic hydrocarbons, branched aliphatic hydrocarbons and naphthenes of C_4-C_{12};

the process conditions for the naphtha-to-aromatics reaction zone are: gas superficial velocity of 0.5-2.0 m/s, reaction temperature of 500-650°C, reaction pressure of 100-500 kPa, bed density of 150-700 kg/m^3;

the method further comprises: introducing the regeneration gas and the spent catalyst into the regenerator to obtain the high-temperature regenerated catalyst, which is delivered to the light

hydrocarbon aromatization reactor;

the regeneration gas is introduced into the regeneration zone of the regenerator through the regenerator distributor;

the regeneration gas is at least one selected from the group consisting of oxygen, air and oxygen-enriched air;

the carbon content in the spent catalyst is in a range from 1.0 wt% to 3.0 wt%;

the carbon content in the regenerated catalyst is ≤0.5 wt%;

the process conditions for the regeneration zone of the regenerator are: gas superficial velocity of 0.5-2.0 m/s, regeneration temperature of 600-750°C, regeneration pressure of 100-500 kPa, bed density of 150-700 kg/m^3;

the coke on the spent catalyst reacts with the regeneration gas to generate a flue gas; the flue gas enters the gas-solid separation zone III to remove the regenerated catalyst entrained in it;

the flue gas entering the gas-solid separation zone III to remove the regenerated catalyst entrained in it specifically comprises: the flue gas first enters the regenerator gas-solid separation unit to remove the regenerated catalyst entrained in it, then flows through the regenerator gas collection chamber and flue gas delivery pipe to enter downstream section;

the regenerated catalyst enters the light hydrocarbon aromatization reactor through the regenerator stripper and the regenerated catalyst slide valve;

the method further comprises: feeding the riser reactor feedstock into the inlet end of the riser reactor of the light hydrocarbon aromatization reactor; the regenerated catalyst flows through the regenerator stripper and regenerated catalyst slide valve into the riser reactor, where the riser

reactor feedstock is converted into a BTX-containing flow under the action of the regenerated catalyst, which then enters the lower section of the light hydrocarbon aromatization reaction zone in the bed reactor through the outlet end of the riser reactor;

the method further comprises: introducing the catalyst into the inlet end of the riser reactor of the light hydrocarbon aromatization reactor, which enters the bed reactor through the riser reactor;

the riser reactor feedstock comprises water vapor and light alkanes separated from the product gas flow;

the water vapor content in the riser reactor feedstock is in a range from 0 wt% to 80 wt%;

the process conditions for the riser reactor are: gas superficial velocity of 3.0-10.0 m/s, temperature of 580-700°C, pressure of 100-500 kPa, bed density of 50-150 kg/m^3;

the components of the BTX-containing flow comprise: BTX, light olefins and H_2;

the method further comprises:

the spent catalyst in the naphtha-to-aromatics reaction zone of the naphtha-to-aromatics reactor is introduced into the reactor stripper, stripped, and then flows through the spent catalyst slide valve and the spent catalyst delivery pipe into a downstream section;

the downstream section is the regenerator.