CLAIMS

1. A device for producing aromatics from naphtha, wherein the device for producing aromatics from naphtha comprises a naphtha to aromatics reactor, a regenerator, and a light hydrocarbon aromatization reactor;

the naphtha to aromatics reactor is connected to the regenerator via a spent catalyst delivery pipe I; the regenerator is connected to the naphtha to aromatics reactor via a regenerated catalyst delivery pipe;

the light hydrocarbon aromatization reactor includes a riser reactor, and the riser reactor is connected to a bed reactor; and

the regenerator is connected to the riser reactor via a regenerated catalyst slide valve II; the bed reactor is connected to the regenerator via a spent catalyst delivery pipe II.

2. The device for producing aromatics from naphtha according to claim 1, wherein a gas-solid separation zone is provided on the upper part of the naphtha to aromatics reactor; a product gas delivery pipe I is provided in the gas-solid separation zone; and

a naphtha to aromatics reaction zone is provided at the bottom of the naphtha to aromatics reactor; the regenerated catalyst delivery pipe inputs a catalyst into the naphtha to aromatics reaction zone; a naphtha to aromatics reactor distributor for introducing a naphtha raw material is provided at the bottom of the naphtha aromatics reaction zone.

3. The device for producing aromatics from naphtha according to claim 2, wherein a gas-solid separation unit I and a gas collection chamber I are provided in the naphtha to aromatics reactor; the gas collection chamber I is located at the top of the gas-solid separation zone; a gas outlet of the gas-solid separation unit I is connected to the gas collection chamber I, and the gas collection chamber I is connected to the product gas delivery pipe I.

4. The device for producing aromatics from naphtha according to claim 2, wherein a stripper I is provided beneath the naphtha to aromatics reaction zone; the naphtha to aromatics

reaction zone is connected to the spent catalyst delivery pipe I via the stripper I.

5. The device for producing aromatics from naphtha according to claim 4, wherein the stripper I is connected to the spent catalyst delivery pipe I via the spent catalyst slide valve I.

6. The device for producing aromatics from naphtha according to claim 3, wherein the gas-solid separation unit I adopts one or more groups of gas-solid cyclone separators, and each group of gas-solid cyclone separators includes a first-stage gas-solid cyclone separator and a second-stage gas-solid cyclone separator.

7. The device for producing aromatics from naphtha according to claim 1, wherein a regenerator gas-solid separation zone is provided on upper part of the regenerator; a flue gas delivery pipe is provided in the regenerator gas-solid separation zone;

a regeneration zone is provided at the lower part of the regenerator; the regenerated catalyst delivery pipe I and the regenerated catalyst delivery pipe II are used to feed the spent catalyst into the regeneration zone; a regenerator distributor for introducing a regeneration gas is provided at lower part of the regenerator;

the regenerated catalyst delivery pipe delivers a regenerated catalyst in the regeneration zone to the naphtha to aromatics reactor; the regenerated catalyst slide valve II delivers the regenerated catalyst to the riser reactor.

8. The device for producing aromatics from naphtha according to claim 7, wherein a regenerator gas-solid separation unit and a regenerator gas collection chamber are provided in the regenerator shell; the regenerator gas collection chamber is located at the top of the regenerator gas-solid separation zone; a gas outlet of the regenerator gas-solid separation unit is connected to the regenerator gas collection chamber; the regenerator gas collection chamber is connected to the flue gas delivery pipe.

9. The device for producing aromatics from naphtha according to claim 7, wherein a

regenerator stripper is provided beneath the regeneration zone; the regeneration zone is connected to the regenerated catalyst slide valve I and the regenerated catalyst slide valve II via the regenerator stripper;

the regenerated catalyst slide valve I is connected to the naphtha to aromatics reactor via the regenerated catalyst delivery pipe; the regenerated catalyst slide valve II is connected to the riser reactor;

wherein the regenerator gas-solid separation unit adopts one or more groups of gas-solid cyclone separators, and each group of gas-solid cyclone separators includes a first-stage gas-solid cyclone separator and a second-stage gas-solid cyclone separator.

10. The device for producing aromatics from naphtha according to claim 7, wherein a bed reactor gas-solid separation zone is provided on upper part of the bed reactor; a product gas delivery pipe II is provided in the bed reactor gas-solid separation zone;

a light hydrocarbon aromatization reaction zone is provided at the lower part of the bed reactor; a bed reactor distributor is provided at the lower part of the light hydrocarbon aromatization reaction zone; the bed reactor distributor is used to feed a bed reactor feedstock; upper end of the riser reactor penetrates bottom of the bed reactor and is inserted into the bed reactor along axial direction;

the regenerated catalyst slide valve II delivers a regenerated catalyst to a feed inlet end of the riser reactor;

wherein a gas-solid separation unit II and a gas collection chamber II are provided in the bed reactor gas-solid separation zone; a gas outlet of the gas-solid separation unit II is connected to the gas collection chamber II; a catalyst outlet of the gas-solid separation unit II is located in the light hydrocarbon aromatization reaction zone; the gas collection chamber II is connected to a product gas delivery pipe II located outside the bed reactor.

11. The device for producing aromatics from naphtha according to claim 10, wherein the

light hydrocarbon aromatization reaction zone is connected to a stripper II, and the bed reactor is connected to the spent catalyst delivery pipe II via the stripper II;

wherein the stripper II is connected to the spent catalyst delivery pipe II via the spent catalyst slide valve II;

wherein the gas-solid separation unit II is a gas-solid cyclone separator; and the catalyst outlet of the gas-solid separation unit II is located above outlet end of the riser reactor.

12. A method for preparing aromatics from naphtha, using the device according to any one of claims 1 to 11; a catalyst is a metal molecular sieve bifunctional catalyst;

feeding a raw material containing naphtha into the naphtha to aromatics reactor; feeding a riser reactor feedstock into the riser reactor; feeding the bed reactor feedstock containing C_3, C_4 and C_5 hydrocarbons into the bed reactor; feeding a regeneration gas to the regenerator;

the naphtha to aromatics reactor and the bed reactor output a product gas, and a spent catalyst is input into the regenerator via the spent catalyst delivery pipe I and the spent catalyst delivery pipe II; after the spent catalyst reacts with the regeneration gas in the regenerator to be regenerated, it is fed into the naphtha to aromatics reactor and the riser reactor; the regenerator discharges a flue gas.

13. The method for producing aromatics from naphtha according to claim 12, wherein the catalyst is 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.

14. The method according to claim 12, wherein 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;

wherein the raw material containing naphtha further comprises unconverted naphtha separated from the product gas flow; the unconverted naphtha contains linear aliphatic hydrocarbons, branched aliphatic hydrocarbons, and naphthenes of C_4–C_{12};

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

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

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

wherein the light alkanes in the riser reactor feedstock are separated from the product gas flow;

wherein the bed reactor feedstock comprises at least one selected from the group consisting of C_3, C_4, and C_5 hydrocarbons; the C_3, C_4, and C_5 hydrocarbons are separated from the product gas flow.

15. The method according to claim 16, wherein the method comprises: introducing naphtha into the naphtha to aromatics reaction zone of the naphtha to aromatics reactor via the distributor of naphtha to aromatics reactor, where it contacts with a catalyst from the regenerator to generate a product gas flow containing BTX, light olefins, hydrogen, light alkanes, combustible gas,

heavy aromatics, and unconverted naphtha, while the catalyst becomes coked and converts to the spent catalyst;

feeding the regeneration gas into the regeneration zone of the regenerator via the reactor distributor, where it contacts with the spent catalyst from the naphtha to aromatics reactor and the spent catalyst from the light hydrocarbon aromatization reactor, reacting with coke on the spent catalyst to generate flue gas and the spent catalyst converts to the regenerate the catalyst;

feeding the riser reactor feedstock into the feed inlet end of the riser reactor, which contacts with the regenerated catalyst from the regenerator, converting under catalytic action into a flow containing BTX, light olefins, and H_2, which then enters the lower part of the light hydrocarbon aromatization reaction zone in the bed reactor via the outlet end of the riser reactor;

feeding the bed reactor feedstock into the light hydrocarbon aromatization reaction zone via the reactor distributor, where it contacts with a catalyst from the riser reactor to generate light hydrocarbon aromatization product gas flow containing BTX, light olefins, and H_2, while the catalyst becomes coked and converts to the spent catalyst.

wherein the reaction conditions in the naphtha to aromatics reaction zone are: gas superficial velocity in a range from 0.5 m/s to 2.0 m/s, reaction temperature in a range from 500°C to 650°C, reaction pressure in a range from 100 kPa to 500 kPa, bed density in a range from 150 kg/m³ to 700 kg/m³;

wherein the regeneration conditions in the regeneration zone are: gas superficial velocity in a range from 0.5–2.0 m/s, regeneration temperature in a range from 600°C to 750°C, regeneration pressure in a range from 100 KPa to 500 kPa, bed density in a range from 150 kg/m³ to 700 kg/m³;

wherein the process conditions for the riser reactor are: gas superficial velocity in a range from 3.0 m/s to 10.0 m/s, temperature in a range from 580 to 700°C, pressure in a range from 100 to 500 kPa, bed density in a range from 50 kg/m³ to 150 kg/m³;

wherein the process conditions for the light hydrocarbon aromatization zone are: gas superficial velocity in a range from 0.5 m/s to 2.0 m/s, reaction temperature in a range from 550°C to 665°C, reaction pressure in a range from 100 kPa to 500 kPa, bed density in a range from 150 kg/m³ to 700 kg/m³.