## Claims

What is claimed:

1. A catalytic cracking process comprising the following steps:

i) spraying a heavy feedstock oil into a first riser reactor via a first nozzle, and subjecting it to a first catalytic cracking reaction therein to obtain a catalytic cracking reaction product;

ii) separating the catalytic cracking reaction product to obtain a catalytic cracking gasoline and a catalytic cracking light cycle oil;

iii) splitting the catalytic cracking gasoline obtained in step ii) and optionally a catalytic cracking gasoline from an external source to obtain a light gasoline fraction, a medium gasoline fraction and a heavy gasoline fraction;

iv) subjecting the catalytic cracking light cycle oil obtained in step ii) and optionally a catalytic cracking light cycle oil from an external source to a hydrotreatment to obtain a hydrogenated light cycle oil;

v) mixing a portion of the light gasoline fraction obtained in step iii) with at least a portion of the hydrogenated light cycle oil obtained in step iv) to obtain a mixed fraction;

vi) spraying the mixed fraction obtained in step v) into the first riser reactor or a second riser reactor via a second nozzle, and subjecting it to a second catalytic cracking reaction therein; and

vii) spraying a portion of the medium gasoline fraction obtained in step iii) into the first or second riser reactor via a third nozzle, and subjecting it to a third catalytic cracking reaction therein.

2. The process according to claim 1, wherein in steps i), vi) and vii), the heavy feedstock oil, the mixed fraction and the medium gasoline fraction are sprayed into the first riser reactor via the first nozzle, the second nozzle and the third nozzle, respectively, to conduct corresponding catalytic cracking reactions;

preferably along the height direction of the first riser reactor, the first nozzle is disposed above the second and third nozzles, and more preferably the second nozzle is disposed above the third nozzle.

3. The process according to claim 1, wherein in step i), the heavy feedstock oil is sprayed into the first riser reactor via the first nozzle to conduct the first catalytic cracking reaction; and in step vi) and step vii), the mixed fraction and the medium gasoline fraction are sprayed into the second riser reactor via the second nozzle and the third nozzle, respectively, to conduct corresponding catalytic cracking reactions, preferably along the height direction of the second riser reactor, the second nozzle is disposed above the third nozzle.

4. The process according to claim 2, wherein the reaction time in the riser reactor section between the second nozzle and the first nozzle is between 0.01 and 3 seconds, preferably between 0.05 and 2 seconds.

5. The process according to claim 2 or claim 4, wherein the reaction conditions in the first riser reactor are as follows: a reaction temperature ranging from 480 °C to 650 °C, preferably from 490 °C to 550 °C; a weight ratio of catalytic cracking catalyst to the heavy feedstock oil ranging from 2 to 100, preferably from 4 to 50; an reaction time of the heavy feedstock oil ranging from 1 to 10 seconds, preferably from 2 to 8 seconds; a reaction pressure ranging from 0.15 to 0.4 MPa; a weight ratio of steam to the heavy feedstock oil ranging from 0.01 to 0.5, preferably from 0.02 to 0.2, and a micro-activity (MAT) of catalytic cracking catalyst of not less than 55, preferably not less than 60.

6. The process according to claim 3, wherein:

reaction conditions in the first riser reactor are as follows: a reaction temperature ranging from 480 °C to 650 °C, preferably from 490 °C to 600 °C, a

catalyst-to-oil ratio ranging from 2 to 100, preferably from 4 to 50, a reaction time ranging from 1 to 10 seconds, preferably from 2 to 8 seconds, a reaction pressure ranging from 0.15 to 0.4 MPa, and a weight ratio of steam to the heavy feedstock oil ranging from 0.01 to 0.5, preferably from 0.02 to 0.2, a micro-activity (MAT) of catalytic cracking catalyst of not less than 55, preferably not less than 60; and

reaction conditions in the second riser reactor are as follows: a reaction temperature ranging from 400 °C to 650 °C, preferably from 420 °C to 550 °C, a catalyst-to-oil ratio ranging from 5 to 100, preferably from 8 to 80, a reaction time ranging from 0.01 to 10 seconds, preferably from 0.05 to 5 seconds, a reaction pressure ranging from 0.15 to 0.4 MPa, a weight ratio of steam to the total amount of feedstock fed to the second riser reactor ranging from 0.01 to 0.5, preferably from 0.02 to 0.2, and a micro-activity (MAT) of catalytic cracking catalyst of not less than 55, preferably not less than 60.

7. The process according to any one of claims 2 to 6, wherein the reaction time in the riser reactor section between the third nozzle and the second nozzle is in a range from 0.01 to 2 seconds, preferably from 0.05 to 1 second.

8. The process according to any one of claims 1 to 7, wherein the cut point between the light gasoline fraction and the medium gasoline fraction is between 60 and 80 °C, and the cut point between the medium gasoline fraction and the heavy gasoline fraction is between 120 °C and 130 °C.

9. The process according to any one of claims 1 to 8, wherein the medium gasoline fraction subjected to the third catalytic cracking reaction in step vii) has a distillation range within a range from 90 °C to 130 °C.

10. The process according to any one of claims 1 to 9, wherein 2% to 90% by weight, preferably 10% to 80% by weight, of the medium gasoline fraction is subjected to the third catalytic cracking reaction in step vii).

11. The process according to any one of claims 1 to 10, wherein in step v), 2% to 90% by weight, preferably 10 to 70% by weight, of the light gasoline fraction is mixed with 10% to 100% by weight, preferably 30% to 100% by weight, of the hydrogenated light cycle oil to obtain the mixed fraction.

12. The process according to any one of claims 1 to 11, wherein the hydrogenation step iv) is carried out in the presence of a hydrogenation catalyst comprising a support and an active component supported thereon, the active component is selected from the group consisting of a Group VIB metal, a Group VIII non-noble metal, and combinations thereof, the Group VIB metal is preferably molybdenum and/or tungsten, the Group VIII non-noble metal is preferably nickel and/or cobalt, the active component is preferably nickel-tungsten, nickel-tungsten-cobalt, nickel-molybdenum or cobalt-molybdenum, and the support is selected from the group consisting of alumina, silica, amorphous silica-alumina, and combinations thereof; preferably, the hydrogenation catalyst comprises from 70% to 85% by weight of the support and from 15% to 30% by weight of the active component.

13. The process according to any one of claims 1 to 12, wherein the hydrogenation step iv) is carried out under the following conditions: a reaction temperature ranging from 330 °C to 450 °C, preferably from 340 °C to 380 °C, a hydrogen partial pressure ranging from 6 to 25 MPa, preferably from 10 to 22 MPa, a volume space velocity ranging from 0.1 to 20 $h^{-1}$, preferably from 0.1 to 3.0 $h^{-1}$, and a hydrogen-to-oil volume ratio ranging from 1000 to 2000 $Nm^3/m^3$, preferably from 350 to 2000 $Nm^3/m^3$.

14. The process according to any one of claims 1 to 13, wherein the hydrogenation step iv) is carried out to an extent that the resultant hydrogenated light cycle oil has a bicyclic aromatics content of no more than 20% by weight, preferably no more than 10% by weight, more preferably no more than 8% by weight, a hydrogen content of no less than 11% by weight, preferably no less than 14% by weight, and an initial boiling point of greater than 165 °C, preferably greater than 175 °C.

15. The process according to any one of claims 1 to 14, wherein the first and second riser reactors are independently an equal-diameter riser reactor with or without a fluidized bed reactor, or a variable-diameter riser reactor with or without a fluidized bed reactor.

16. The process according to any one of claims 1 to 15, wherein the catalytic cracking reactions of steps i), vi) and vii) are carried out in the presence of a catalytic cracking catalyst, and the catalytic cracking catalysts used in steps i), vi) and vii) each independently comprises, on a dry basis, 10% to 50% by weight of a zeolite, 5% to 90% by weight of an inorganic oxide and 0% to 70% by weight of a clay, based on the weight of the catalytic cracking catalyst; the zeolite is selected from the group consisting of a Y zeolite with or without a rare earth element, an HY zeolite with or without a rare earth element, a USY zeolite with or without a rare earth element, a Beta zeolite with or without a rare earth element, and combinations thereof; the inorganic oxide is selected from the group consisting of silica, alumina, and combinations thereof; and the clay is selected from kaolin and/or halloysite.