Claims

1. A method for producing a solvent oil from a reforming raffinate oil, comprising:

S2: subjecting a desulfurized and dehydrated reforming raffinate oil to a hydrogenation reaction to remove benzene and olefins under the catalysis of a hydrogenation catalyst, so as to obtain a reaction product;

S3: subjecting the reaction product obtained in S2 to gas-liquid separation;

S4: rectifying the separated liquid to distill off a C5 component, a C6 component, and a C7+ component, respectively;

S5: rectifying the C6 component to distill off cyclohexane, and a mixture of n-hexane and isohexane, respectively; and

S6: rectifying the mixture of n-hexane and isohexane to distill off isohexane and n-hexane, respectively, thereby completing the production of the solvent oil;

wherein the hydrogenation catalyst comprises a carrier, and a first active metal component and a second active metal component which are supported on the carrier, wherein the metal element of the first active metal component comprises nickel, and the content of the first active metal component in the catalyst is 40-70% by weight, and the content of the carrier in the catalyst is 20-59% by weight, with the balance being the second active metal component, based on 100% of the total weight of the catalyst.

2. The method according to claim 1, wherein in S2, the hydrogenation reaction to remove benzene and olefins is carried out under the following conditions: a temperature of 90-200°C, a reaction pressure of 1.0-3.0 MPa, a volume ratio of hydrogen to oil of 100-300 : 1, and a volume hourly space velocity of 1.0-3.0 h^{-1};

in S4, the rectification is carried out at a pressure of 0-0.2 MPa;

in S5, the rectification is carried out at a pressure of 0-0.1 MPa; and

in S6, the rectification is carried out at a pressure of 0-0.1 MPa.

3. The method according to claim 1, wherein the reaction product in S2 has a benzene content of ≤0.01% and a bromine index of ≤50 mg Br/100 g.

4. The method according to claim 1, wherein the rectification process in S4 is completed in a rectification column with a column top temperature of 30-50°C, and a column bottom temperature of 90-110°C;

wherein the rectification process in S5 is completed in a rectification column with a column top temperature of 55-75°C, and a column bottom temperature of 70-90°C;

wherein the rectification process in S6 is completed in a rectification column with a column top temperature of 50-70°C, and a column bottom temperature of 60-80°C.

5. The method according to claim 1, wherein in a reforming raffinate oil that has not been desulfurized and dehydrated, the sulfur content is 20 mg/kg or less, the benzene content is 3-5 v%, the olefin content is 1-3 v%, and the total content of n-hexane and isohexane is greater than 50 v%.

6. The method according to claim 1, wherein the dispersion of Ni metal in the hydrogenation catalyst is 10% or more;

the metal element of the second active metal component comprises one of or a combination of two or more of copper, lanthanum and magnesium; and

the carrier comprises one of aluminum oxide, silicon oxide, titanium oxide and cerium oxide, and/or a mixture of aluminum oxide and at least one of silicon oxide, titanium oxide and cerium oxide;

wherein the hydrogenation catalyst has a specific surface area of 200-500 m^2/g and a pore volume of 0.3-0.6 cm^3/g.

7. The method according to claim 1, wherein the hydrogenation catalyst is prepared by a process comprising:

bringing a slurry of a carrier precursor to a temperature for precipitation reaction, and adjusting the pH value of the slurry of the carrier precursor to an alkaline pH value, so as to obtain a first mixture system;

adding a precursor of the first active metal component, a precursor of the second active metal component, and a precipitant to the first mixture system in a parallel flow manner, and maintaining the pH of the system at an alkaline pH value to obtain a second mixture system; and

subjecting the second mixture system to an aging treatment, and roasting the product after aging to obtain the hydrogenation catalyst;

wherein the alkaline pH value is 8-11.

8. The method according to claim 10, wherein the precipitation reaction is carried out at a temperature of 40-90°C;

wherein the aging treatment is carried out at a temperature of 40-90°C;

wherein the roasting is carried out at a temperature of 300-600°C;

9. The method according to claim 7, wherein the precursor of the first active metal component is a compound of the metal element of the first active metal component;

the precursor of the second active metal component is a compound of the metal element of the second active metal component; and

the precipitant comprises an alkaline precipitant.

10. The method according to claim 7, wherein the precursor of the first active metal component comprises a metal salt of the metal element of the first active metal component;

wherein the precursor of the second active metal component comprises a metal salt of the metal element of the second active metal component;

wherein the precipitant comprises a soluble carbonate.

11. The method according to claim 1, wherein the method further comprises S1: desulfurizing and dehydrating a reforming raffinate oil to obtain a product with $S \leq 1$ mg/kg.

12. The method according to claim 11, wherein the desulfurization and dehydration process in S1 is carried out at a space velocity of 1-10 h^{-1};

wherein an adsorbent comprising a molecular sieve adsorbent is used for the desulfurization and dehydration in S1;

wherein the molecular sieve adsorbent comprises one of or a combination of two or more of a 3A molecular sieve, a 4A molecular sieve, a 5A molecular sieve, and a 13A molecular sieve;

wherein the molecular sieve adsorbent has a specific surface area of 400-700 m^2/g and a pore volume of 0.05-0.30 cm^3/g.

13. The method according to claim 1, wherein the method further comprises S7: converting the isohexane obtained in S6 into n-hexane by means of a normalization reaction;

wherein the normalization reaction in S7 is carried out under the following conditions: a reaction temperature of 200-400°C, a reaction pressure of 1.0-3.0 MPa, a volume ratio of hydrogen to oil of 100-300 : 1, and a volume hourly space velocity of 1.0-3.0 h^{-1};

wherein the isohexane in S7 has a purity of 90% or more.

14. The method according to claim 13, wherein the isohexane in S7 has a purity of 95% or more.

15. The method according to claim 15, wherein a catalyst for the normalization reaction comprises a molecular sieve catalyst, which comprises a third active metal component, a molecular sieve carrier and a non-molecular sieve carrier;

wherein the molecular sieve carrier comprises one of or a combination of two or more of MOR, MCM-41, ZSM-22, and SAPO-11;

wherein the metal element of the third active metal component comprises an element of group VIB and/or group VIII;

wherein the non-molecular sieve carrier comprises aluminum oxide.

16. The method according to claim 15, wherein the weight of the molecular sieve carrier accounts for 10-80% of the total weight of the catalyst, and the weight of the third active metal component accounts for 0.01-5% of the total weight of the catalyst, with the balance being a non-metal carrier, based on 100% of the total weight of the molecular sieve catalyst.

17. The method according to claim 16, wherein the weight of the third active metal component accounts for 0.1-0.5% of the total weight of the catalyst.

18. A system for producing a solvent oil from a reforming raffinate oil, which system is capable of implementing a method for producing a solvent oil from a reforming raffinate oil according to any one of claims 1-17.

19. The system according to claim 18, wherein the system for producing a solvent oil from a reforming raffinate oil comprises a desorption and desulfurization reactor, a hydrogenation reactor, a gas-liquid separator, a first rectification column, a second rectification column, and a third rectification column, which are connected in sequence.

20. The system according to claim 19, wherein the system for producing a solvent oil from a reforming raffinate oil further comprises a normalization reactor and a gas-liquid separator, wherein the inlet of the normalization reactor is connected to the outlet of the third rectification column, and the outlet of the normalization reactor is connected to the inlet of the gas-liquid separator.