CLAIMS

1. A process for producing paraffins from a petroleum-based composition comprising long chain aromatics, the process comprising:

mixing a supercritical water stream with a pressurized, heated petroleum-based composition to create a combined feed stream,

wherein the pressurized, heated petroleum-based composition is at a pressure greater than the critical pressure of water and at a temperature greater than 75°C,

introducing the combined feed stream to a first reactor through an inlet port of the first reactor, where the first reactor operates at a first temperature greater than the critical temperature of water and a first pressure greater than the critical pressure of water;

cracking at least a portion of the long chain aromatics in the first reactor to form a first reactor product, where the first reactor product comprises water, paraffins, short chain aromatics, olefins, and unconverted long chain aromatics;

introducing the first reactor product to a second reactor through an upper inlet port of the second reactor, the second reactor operating at a second temperature less than the first temperature but greater than the critical temperature of water and a second pressure greater than the critical pressure of water,

wherein the second reactor is a downflow reactor comprising the upper inlet port, a lower outlet port, and a middle outlet port disposed between the upper inlet port and the lower outlet port;

wherein the second reactor has a volume less than or equal to a volume of the first reactor;

wherein a middle outlet product is passed out of the second reactor though the middle outlet port, the middle outlet product comprising paraffins and short chain aromatics; and

wherein a lower outlet product is passed out of the second reactor through the lower outlet port, the lower outlet product comprising multi-ring aromatics and oligomerized olefins;

cooling the middle outlet product to a temperature less than 200°C;

reducing the pressure of the cooled middle outlet product to form a cooled, depressurized middle stream with a pressure from 0.05 MPa to 2.2 MPa;

separating the cooled, depressurized middle stream into a gas-phase stream and a liquid-phase stream, where the liquid-phase stream comprises water, short chain aromatics, and paraffins;

separating the liquid-phase stream into a water-containing stream and an oil-containing stream, where the oil-containing stream comprises paraffins and short chain aromatics; and

separating the oil-containing stream into a stream comprising the paraffins and a stream comprising the short chain aromatics.

2. The process of claim 1, wherein the separating of the oil-containing stream is performed in an extraction unit.

3. The process of claim 2, wherein the extraction unit is a solvent extraction unit.

4. The process of claim 2, wherein the separating of the oil-containing stream further comprises a distillation unit upstream of the extraction unit.

5. The process of claim 1, wherein the first reactor and the second reactor are absent a catalyst and an external supply of hydrogen gas.

6. The process of claim 1, wherein a ratio of the volume of the first reactor to the volume of the second reactor is 0.1:1 to 1:1 at standard ambient temperature and pressure.

7. The process of claim 1, further comprising delivering the lower outlet product to a mechanical mixer.

8. The process of claim 1, wherein the multi-ring aromatics include asphaltenes.

9. The process of claim 1, further comprising injecting plug remover solution into the lower outlet port.

10. The process of claim 9, wherein the plug remover solution comprises toluene.

11. The process of claim 1, wherein the lower outlet port is not continuously opened.

12. The process of claim 1, wherein the middle outlet product includes less than 1 weight percent of olefins.

13. The process of claim 1, wherein the petroleum-based composition comprises atmospheric residue, vacuum gas oil, or vacuum residue.

14. The process of claim 1, wherein a ratio of a flow rate of the supercritical water stream and a flow rate of the pressurized, heated petroleum-based composition is 5:1 to 1:1 at standard ambient temperature and pressure.

15. The process of claim 1, wherein the first reactor, the second reactor, or both include agitating or stirring devices.