Claims

1. A process for producing aromatics from a hydrocarbon source in the presence of supercritical water, the process comprising the steps of:

mixing a pressurized, pre-heated water stream with a pressurized, pre-heated petroleum feedstock to create a combined stream,

wherein the pressurized, pre-heated water stream and the pressurized, pre-heated petroleum feedstock are at a pressure above a critical pressure of water,

wherein the pressurized, pre-heated water stream is heated to a temperature above a critical temperature of water,

wherein the pressurized, pre-heated petroleum feedstock is heated to a temperature between 10°C. and 300°C.;

feeding the combined stream to a supercritical water reactor to produce a modified stream comprising water, aromatics and other hydrocarbons, wherein the supercritical water reactor is operated in an absence of an external supply of hydrogen gas and wherein the supercritical water reactor is operated in an absence of catalyst;

cooling the modified stream in a reactor cooler to create a cooled stream, wherein the cooled stream is cooled to a temperature below 200°C.;

depressurizing the cooled stream in a pressure reducer to create a depressurized stream, the depressurized stream comprising water, aromatics, gases, and other hydrocarbons, wherein a pressure of the depressurized stream is between 0.05 MPa and 2.2 MPa;

separating the depressurized stream in a vapor-liquid separator to create a vapor stream and a liquid stream, the vapor stream comprising an amount of water and aromatics comprising benzene, toluene, and xylene, wherein the amount of water being a portion of the water present in the depressurized stream;

condensing the vapor stream in a condenser to create a condensed stream;

separating the condensed stream in a lights separator into a water recovery stream and a light product recovery stream, wherein the light product recovery stream contains the aromatics;

extracting the aromatics in an extraction unit from the light product recovery stream to create an aromatic extract stream comprising benzene, toluene, and xylene, and a light product stream;

depressurizing the liquid stream in a heavy pressure reducer to create a depressurized liquid stream, wherein a pressure of the depressurized liquid stream is below 1 MPa;

separating the depressurized liquid stream in a heavy separator into an upgraded product stream and a bottoms water stream, wherein the upgraded product stream comprises upgraded hydrocarbons relative to the pressurized, pre-heated petroleum feedstock; and

recycling part of the upgraded product stream to the pressurized, pre-heated petroleum feedstock as a product recycle.

2. The process of claim 1, wherein the product recycle is split in a 1:1 ratio with a product stream.

3. The process of claim 1, wherein the supercritical water reactor is a two-stage reactor, the two-stage reactor comprising a first stage and a second stage, wherein a ratio of a residence time of the first stage to a residence time of the second stage is between 1.2:1 and 20:1.

4. The process of claim 3, wherein a temperature difference between the first stage and the second stage of the two-stage reactor is between 5°C. and 100°C.

5. The process of claim 3, wherein the first stage of the two-stage reactor is an upflow reactor and wherein the second stage of the two-stage reactor is a downflow reactor.

6. The process of claim 1, wherein the modified stream has a higher content of aromatics and a lower content of impurities as compared to the pressurized, pre-heated petroleum feedstock.

7. The process of claim 1, wherein the amount of water in the vapor stream is greater than 90 wt % of the water present in the depressurized stream.

8. A process for producing aromatics from a hydrocarbon source in the presence of supercritical water, the process comprising the steps of:

mixing a pressurized, pre-heated water stream with a pressurized, pre-heated petroleum feedstock to create a combined stream,

wherein the pressurized, pre-heated water stream and the pressurized, pre-heated petroleum feedstock are at a pressure above a critical pressure of water,

wherein the pressurized, pre-heated water stream is heated to a temperature above a critical temperature of water,

wherein the pressurized, pre-heated petroleum feedstock is heated to a temperature between 10°C. and 300°C.;

feeding the combined stream to a supercritical water reactor to produce a modified stream comprising water, aromatics and upgraded hydrocarbons, wherein the supercritical water reactor is operated in an absence of an external supply of hydrogen gas and wherein the supercritical water reactor is operated in an absence of catalyst;

cooling the modified stream in a reactor cooler to create a cooled stream, wherein the cooled stream is cooled to a temperature below 200°C.;

depressurizing the cooled stream in a pressure reducer to create a depressurized stream, the depressurized stream comprising water, aromatics comprising benzene, toluene, and xylene, and upgraded hydrocarbons, wherein a pressure of the depressurized stream is between 0.3 MPa and 2.2 MPa;

separating the depressurized stream in a vapor-liquid separator to generate a vapor stream and a liquid stream, wherein the liquid stream comprises the water, the aromatics, and the upgraded hydrocarbons;

separating the liquid stream in a heavy separator to produce a petroleum recovery stream comprising the aromatics and upgraded hydrocarbons, and a water recovery stream;

separating the petroleum recovery stream in a distillation column to produce a light product recovery stream and an upgraded product stream,

wherein the light product recovery stream comprises the aromatics, and

wherein the upgraded product stream comprises the upgraded hydrocarbons, the upgraded product stream having a higher API gravity, lower sulfur content, and lower metal content compared to the pressurized, pre-heated petroleum feedstock;

extracting the light product recovery stream in an extraction unit to produce a light product stream and an aromatic extract stream comprising benzene, toluene, and xylene;

mixing the light product stream with the upgraded product stream to create a mixed product stream; and

recycling part of the mixed product stream to the pressurized, pre-heated petroleum feedstock as a product recycle.

9. The process of claim 8, wherein the product recycle is split in a 1:1 ratio with a product stream.

10. The process of claim 8, wherein the supercritical water reactor is a two-stage reactor, the two-stage reactor comprising a first stage and a second stage, wherein a ratio of a residence time of the first stage to a residence time of the second stage is between 1.2:1 and 20:1.

11. The process of claim 10, wherein a temperature difference between the first stage and the second stage of the two-stage reactor is between 5°C. and 100°C.

12. The process of claim 10, wherein the first stage of the two-stage reactor is an upflow reactor and wherein the second stage of the two-stage reactor is a downflow reactor.

13. The process of claim 8, wherein the modified stream has a higher content of the aromatics and a lower content of impurities as compared to the pressurized, pre-heated petroleum feedstock.