CLAIMS

1. A method to selectively remove metal compounds and sulfur from a petroleum feedstock, the method comprising the steps of:

feeding a pre-heated water stream and a pre-heated petroleum feedstock to a mixing zone, wherein the pre-heated water stream is at a temperature above the critical temperature of water and at a pressure above the critical pressure of water, wherein the pre-heated petroleum feedstock is at a temperature of less than 150° C. and at a pressure above the critical pressure of water;

mixing the pre-heated water stream and the pre-heated petroleum feedstock to form a mixed stream;

introducing the mixed stream to a first supercritical water reactor to produce an upgraded stream, the first supercritical water reactor at a pressure above the critical pressure of water and at a temperature above the critical temperature of water, the first supercritical water reactor in the absence of externally provided hydrogen;

mixing carbon with a make-up water stream in a carbon dispersal zone to produce a carbon dispersed water stream, wherein the carbon comprises a carbon material, wherein the carbon is present in a range of between 0.05 wt % of petroleum feedstock and 1.0 wt % of petroleum feedstock, wherein the carbon dispersed water stream is at a temperature above the critical temperature of water and a pressure above the critical pressure of water, wherein the carbon dispersal zone is in the absence of a fixed bed, such that the carbon is dispersed in the carbon dispersed water stream;

combining the upgraded stream and the carbon dispersed water stream in a make-up mixing zone to produce a diluted carbon dispersed stream, wherein the carbon dispersed water stream is above the critical temperature of water and above the critical pressure of water, wherein the carbon dispersed water stream increases a volumetric flow rate ratio of water to oil in the diluted carbon dispersed stream as compared to the upgraded stream, wherein the carbon is dispersed in the diluted carbon dispersed stream, wherein the carbon is operable to trap metals present in the upgraded stream; and

introducing the diluted carbon dispersed stream to a second supercritical water reactor to produce a carbon dispersed product effluent stream, wherein the second supercritical water reactor is at a pressure lower than the pressure in the first supercritical water reactor, wherein a temperature in the second supercritical water reactor is at least the same as the temperature

in the first supercritical water reactor, wherein the second supercritical water reactor is configured to allow conversion reactions to occur.

2. The method of claim 1, further comprising the steps of:

introducing the carbon dispersed product effluent stream to a filter cooling device to produce a cooled carbon dispersed effluent, wherein the cooled carbon dispersed effluent is at a temperature below 225° C.;

introducing the cooled carbon dispersed effluent to a filtering element to produce a used carbon and a filtered stream, wherein the filtering element is configured to separate the carbon from the cooled carbon dispersed effluent; and

introducing the filtered stream to a cooling device to produce a cooled stream.

3. The method of claim 2, further comprising the steps of:

feeding the cooled stream to a pressure let-down device to produce a depressurized stream;

separating the depressurized stream in a separator unit a gas-phase product, a water-phase product and a liquid petroleum product; and

separating the liquid petroleum product in a hydrocarbon separator to produce a light oil product and a residue product.

4. The method of claim 1, wherein the carbon material is selected from the group consisting of carbon black, activated carbon, and combinations of the same.

5. The method of claim 4, wherein the carbon material comprises carbon particles.

6. The method of claim 5, wherein the carbon particles have a particle diameter of less than 10 micrometers.

7. The method of claim 5, wherein the carbon particles have a carbon content of at least 80 wt %.

8. The method of claim 1, wherein the petroleum feedstock is a petroleum-based hydrocarbon selected from the group consisting of whole range crude oil, reduced crude oil, fuel oil, refinery streams, residues from refinery streams, cracked product streams from crude

oil refinery, streams from steam crackers, atmospheric residue streams, vacuum residue streams, coal-derived hydrocarbons, and biomass-derived hydrocarbons.

9. The method of claim 1, wherein a ratio of a volumetric flow rate of petroleum feedstock to water entering the first supercritical water reactor is between 1:10 and 1:0.1.