CLAIMS

What is claimed is:

1. A method for hydrothermally processing biomass, comprising:

contacting a biomass feed with water in the presence of a dissolved metal catalyst and a reducing gas under effective hydrothermal processing conditions to produce a multi-phase product; and

separating the multi-phase product to produce at least a gas phase portion, a liquid hydrocarbon product, an aqueous portion, and a solids portion.

2. The method of claim 1, wherein the dissolved metal catalyst is a metal salt.

3. The method of claim 1, wherein the dissolved metal catalyst is a metal salt containing Co, Mo, Cr, Mn, or a combination thereof.

4. The method of claim 1, wherein the dissolved metal catalyst is a biocompatible material.

5. The method of claim 4, wherein the metal comprises Fe, Mn, Zn, Mo, Cu, or a combination thereof.

6. The method of claim 1, wherein the metal is Co, Mo, or a combination thereof.

7. The method of claim 1, wherein the effective hydrothermal processing conditions include a temperature from about 150°C to about 500°C and a pressure from about 4.5 barg (about 450 kPag) to about 300 barg (about 30 MPag).

8. The method of claim 1, wherein the effective hydrothermal processing conditions include a partial pressure of reducing gas of at least about 2 bar (about 0.2 MPa), wherein the reducing gas is hydrogen.

~~9. The method of claim 1, wherein contacting the algae based feed with water~~ under effective hydrothermal processing conditions substantially does not result in a phase change for the water.

10. The method of claim 1, wherein the metal catalyst is dissolved in the water.

11. The method of claim 1, wherein the weight ratio of water to algae is from about 3:1 to about 5:1.

12. The method of claim 1, wherein the catalyst particles are present in an amount from about 0.1 wt% to about 5 wt%, based on a weight of the algae.

13. The method of claim 1, further comprising separating the hydrocarbon liquid product to produce a fraction having at least 90 wt% of its boiling range between about 193°C and about 360°C.

14. A method for hydrothermally processing biomass, comprising:

introducing a biomass feed, a solution containing a metal catalyst precursor, and a sulfiding agent into a reaction zone;

contacting the biomass feed, metal catalyst precursor, and sulfiding agent with water in the presence of a reducing gas under effective hydrothermal processing conditions to convert the metal catalyst precursor into a sulfided metal catalyst and to produce a multi-phase product; and

separating the multi-phase product to produce at least a gas phase portion, a liquid hydrocarbon product, an aqueous portion, and a solids portion.

15. The method of claim 14, wherein the sulfiding agent is hydrogen sulfide.

16. The method of claim 14, wherein the metal catalyst precursor is a metal salt ~~containing Co, Mo, or a combination thereof.~~

~~17. The method of claim 14, wherein the sulfided metal catalyst forms part of the~~ solids portion, the sulfided metal catalyst being separated from the solids portion by filtration.

18. A method for hydrothermally processing biomass, comprising:

introducing a biomass feed and an aqueous recycle stream into a reaction zone, the aqueous recycle stream containing at least one metal catalyst;

contacting the biomass feed with the aqueous recycle stream, including the at least one metal catalyst, in the reaction zone under effective hydrothermal processing conditions to produce a multi-phase product; and

separating a liquid hydrocarbon product from the multi-phase product.

19. The method of claim 18, further comprising introducing an additional portion of the metal catalyst into the reaction zone.

20. The method of claim 18, wherein the biomass feed and aqueous recycle stream ~~are combined prior to being introduced into the reaction zone.~~

CLAIMS:

1. A method for hydrothermally processing biomass, comprising:

contacting an algae based biomass feed with water in the presence of a dissolved metal catalyst and a reducing gas under effective hydrothermal processing conditions to produce a multi-phase product; and

separating the multi-phase product to produce at least a gas phase portion, a liquid hydrocarbon product, an aqueous portion, and a solids portion.

2. The method of claim 1, wherein the dissolved metal catalyst is a metal salt.

3. The method of claim 1, wherein the dissolved metal catalyst is a metal salt containing Co, Mo, Cr, Mn, or a combination thereof.

4. The method of claim 1, wherein the dissolved metal catalyst is a biocompatible material.

5. The method of claim 4, wherein the metal comprises Fe, Mn, Zn, Mo, Cu, or a combination thereof.

6. The method of claim 1, wherein the metal is Co, Mo, or a combination thereof.

7. The method of claim 1, wherein the effective hydrothermal processing conditions include a temperature from about 150°C to about 500°C and a pressure from about 4.5 barg (about 450 kPag) to about 300 barg (about 30 MPag).

8. The method of claim 1, wherein the effective hydrothermal processing conditions include a partial pressure of reducing gas of at least about 2 bar (about 0.2 MPa), wherein the reducing gas is hydrogen.

9. The method of claim 1, wherein contacting the algae based feed with water under effective hydrothermal processing conditions substantially does not result in a phase change for the water.

10. The method of claim 1, wherein the metal catalyst is dissolved in the water.

11. The method of claim 1, wherein the weight ratio of water to algae is from about 3:1 to about 5:1.

12. The method of claim 1, wherein the dissolved metal catalyst is present in an amount from about 0.1 wt% to about 5 wt%, based on a weight of the algae.

13. The method of claim 1, further comprising separating the hydrocarbon liquid product to produce a fraction having at least 90 wt% of its boiling range between about 193°C and about 360°C.

14. A method for hydrothermally processing biomass, comprising:

introducing an algae based a biomass feed, a solution containing a metal catalyst precursor, and a sulfiding agent into a reaction zone;

contacting the algae based biomass feed, metal catalyst precursor, and sulfiding agent with water in the presence of a reducing gas under effective hydrothermal processing conditions to convert the metal catalyst precursor into a sulfided metal catalyst and to produce a multi-phase product; and

separating the multi-phase product to produce at least a gas phase portion, a liquid hydrocarbon product, an aqueous portion, and a solids portion.

15. The method of claim 14, wherein the sulfiding agent is hydrogen sulfide.

16. The method of claim 14, wherein the metal catalyst precursor is a metal salt containing Co, Mo, or a combination thereof.

17. The method of claim 14, wherein the sulfided metal catalyst forms part of the solids portion, the sulfided metal catalyst being separated from the solids portion by filtration.

18. A method for hydrothermally processing biomass, comprising:

introducing an algae based a biomass feed and an aqueous recycle stream into a reaction zone, the aqueous recycle stream containing at least one metal catalyst;

contacting the algae based biomass feed with the aqueous recycle stream, including the at least one metal catalyst, in the reaction zone under effective hydrothermal processing conditions to produce a multi-phase product; and

separating a liquid hydrocarbon product from the multi-phase product.

19. The method of claim 18, further comprising introducing an additional portion of the metal catalyst into the reaction zone.

20. The method of claim 18, wherein the algae based biomass feed and aqueous recycle stream are combined prior to being introduced into the reaction zone.