CLAIMS

1. A method for removing a polar molecule contaminant from a liquid hydrocarbon stream comprising:

(a) providing a hydrocarbon stream containing a polar molecule contaminant;

(b) dispersing a magnetic nanoparticle compound that includes a material that is attracted to a magnetic field and has a surface capable of adsorbing polar molecules and a surface energy of at least 10 mJ/m^2 into the refinery stream, and adsorbing the polar molecule contaminant onto the nanoparticle compound at a temperature up to the magnetic phase transition temperature of the nanoparticle compound to form a nanoparticle compound-polar molecule complex; and

(c) applying a magnetic field to the stream from a magnetic field source containing the nanoparticle compound-polar molecule complex to attract or repel the nanoparticles towards or away from the magnetic source separate the complex from the refinery stream by attraction or repulsion of the complex .

2. The method of claim 1, wherein the polar molecule contaminant is selected from sulfur-containing compounds, nitrogen-containing compounds, porphyrin, asphaltene, naphthenic acid, mercury and carbon dioxide.

3. The method of claim 1, wherein the nanoparticle compound has a surface energy of at least about 70 mJ/m^2.

4. The method of claim 1, wherein the nanoparticle compound has a surface area of from about 5 to 500 m^2/g as measured by nitrogen BET.

5. The method of claim 5, wherein the nanoparticle compound has a surface area of from about 10 to 300 m^2/g as measured by nitrogen BET.

6. The method of claim 1, wherein the material that is attracted to a magnetic field is selected from iron, nickel, cobalt and magnetite.

7. The method of claim 1, wherein the nanoparticle compound is introduced to the hydrocarbon stream to form a concentration of nanoparticle compound between about 0.1 weight % and 15 weight %.

8. The method of claim 1, further including a step of regenerating the nanoparticle compound following the separation step to remove the polar molecule contaminant adsorbed onto the nanoparticle compound.

9. The method of claim 8, wherein the step of regenerating the nanoparticle compound includes heating the nanoparticle compound-polar molecule complex at a temperature of at least about 250°C and below the magnetic phase transition temperature of the nanoparticle compound.

10. The method of claim 16, wherein the nanoparticle compound comprises magnetite, and the magnetic phase transition temperature is 585°C.

CLAIMS:

1. A method for removing a polar molecule contaminant from a liquid hydrocarbon stream in a hydrocarbon refining process comprising:

(a) providing a liquid hydrocarbon stream containing a polar molecule contaminant;

(b) introducing a magnetic nanoparticle compound having a surface energy of at least about 20 mJ/m^2 into the stream at a temperature up to the magnetic phase transition temperature of the nanoparticle compound and adsorbing the polar molecule contaminant onto the nanoparticle compound to form a nanoparticle compound-polar molecule complex; and

(c) applying a magnetic field to the nanoparticle compound-polar molecule complex to separate the complex from the liquid hydrocarbon stream.

2. The method of claim 1, wherein the polar molecule contaminant is selected from sulfur-containing compounds, nitrogen-containing compounds, porphyrin, asphaltene, naphthenic acid, mercury and carbon dioxide.

3. The method of claim 1, wherein the nanoparticle compound has a surface energy of at least about 70 mJ/m^2.

4. The method of claim 1, wherein the nanoparticle compound has a surface area of from about 5 to 500 m^2/g as measured by nitrogen BET.

5. The method of claim 4, wherein the nanoparticle compound has a surface area of from about 10 to 300 m^2/g as measured by nitrogen BET.

6. The method of claim 1, wherein the nanoparticle compound is selected from iron, nickel, cobalt and magnetite.

7. The method of claim 1, further including maintaining a temperature of the

liquid hydrocarbon stream following introduction of the nanoparticle compound at a similar temperature as prior to the introduction of the nanoparticle compound.

8. The method of claim 1, wherein the nanoparticle compound comprises magnetite, and the magnetic phase transition temperature is about 585°C.

9. The method of claim 1, wherein the nanoparticle compound is introduced to the liquid hydrocarbon stream to form a concentration of nanoparticle compound between about 0.1 weight % and 15 weight %.

10. The method of claim 1, further including a step of regenerating the nanoparticle compound following the separation step to remove the polar molecule contaminant adsorbed onto the nanoparticle compound.

11. The method of claim 10, wherein the step of regenerating the nanoparticle compound includes heating the nanoparticle compound-polar molecule complex at a temperature above about 250°C.

12. The method of claim 11, wherein the step of regenerating the nanoparticle compound includes heating the nanoparticle compound-polar molecule complex at a temperature above about 250°C and below the magnetic phase transition temperature of the nanoparticle compound.

13. The method of claim 12, wherein the nanoparticle compound comprises magnetite, and the magnetic phase transition temperature is about 585°C.

14. The method of claim 10, wherein the step of regenerating the nanoparticle compound includes immersing the nanoparticle compound-polar molecule complex in water.

15. The method of claim 1, further including heating the nanoparticle compound prior to introducing the nanoparticle compound into the liquid hydrocarbon stream to increase the nanoparticle compound's capacity to remove polar molecule contaminants from

the liquid hydrocarbon stream.

16. The method of claim 15, wherein the nanoparticle compound is heated at a temperature of at least about 250°C.

17. The method of claim 15, wherein the nanoparticle compound is heated at a temperature of at least about 350°C.

18. The method of claim 15, wherein the nanoparticle compound is heated at a temperature above about 250°C and below the magnetic phase transition temperature of the nanoparticle compound.

19. The method of claim 18, wherein the nanoparticle compound comprises magnetite and the magnetic phase transition temperature is about 585°C.