CLAIMS

1. A process, comprising:

providing a first hydrocarbon-containing composition comprising, per gram of the first hydrocarbon-containing composition, at least 0.05 grams of hydrocarbons having a boiling point in the range from 25°C up to 204°C, at least 0.1 gram of hydrocarbons having a boiling point in the range from 204°C up to 260°C, at least 0.25 gram of hydrocarbons having a boiling point in the range from 260°C up to 343°C, at least 0.3 gram of hydrocarbons having a boiling point in the range from 343°C to 538°C, at most 0.03 gram of hydrocarbons having a boiling point of greater than 538°C, where the boiling point ranges of the first hydrocarbon-containing composition are as determined by ASTM Method D5307, and from 0.001 to 0.05 gram of sulfur on an atomic basis as determined by ASTM Method D4294, wherein at least 40 wt.% of the sulfur, on an atomic sulfur basis as determined by ASTM Method D4294, is contained in hydrocarbon compounds having a boiling point of less than 343°C as determined by ASTM Method D5307, and at least 40 wt. % of the sulfur contained in hydrocarbon compounds having a boiling point of less than 343°C in the first hydrocarbon-containing composition is contained in benzothiophenic compounds as determined by GC-GC sulfur chemiluminescence;

apart from the mixing zone, contacting the first hydrocarbon-containing composition with hydrogen and a catalyst comprising a Column 6 metal of the Periodic Table or a compound thereof at a temperature of from 260°C to 425°C and a pressure of from 3.4 MPa to 27.5 MPa to produce a product stream comprising a second hydrocarbon-containing composition;

separating the second hydrocarbon-containing composition into fractions wherein one fraction is comprised of hydrocarbons having a boiling point of from 343°C to 538°C as determined in accordance with ASTM Method D5307; and

contacting the fraction comprised of hydrocarbons having a boiling point of from 343°C to 538°C with a fluidizable cracking catalyst at a temperature of at least 500°C.

2. The process of claim 1 wherein the first hydrocarbon-containing composition contains at most 0.5 wppm of vanadium, at most 0.5 wppm of nickel, and at most 0.3 wppm of iron.

3. The process of claim 1 or claim 2 wherein the catalyst comprising a Column 6 metal further comprises a support material selected from alumina, silica, titania, zirconia, or mixtures thereof.

4. The process of claim 1 wherein the catalyst comprising a Column 6 metal further comprises a Column 7-10 metal or a compound thereof.

5. The process of claim 1 or any of claims 2-3 wherein the first hydrocarbon-containing composition is contacted with hydrogen and the catalyst comprising a Column 6 metal of the Periodic Table or a compound thereof at a temperature of from 260°C to 425°C and a pressure of from 3.4 MPa to less than 10.3 MPa to produce a product stream comprising the second hydrocarbon-containing composition.

6. The process of claim 1 or any of claims 2-5 wherein the fluidizable cracking catalyst comprises a zeolite, and has a bulk density of from 0.7 g/cm^3 to 1.1 g/cm^3, a particle size distribution of from 10 μm to 150 μm, and an average particle size of from 60 μm to 100 μm.

7. The process of claim 1 or any of claims 2-6 wherein the fluidizable cracking catalyst is provided for contact with the fraction comprised of hydrocarbons having a boiling point of at least 343°C at a temperature of from 700°C to 850°C.

8. The process of claim 1 of any of claims 2-7 wherein the fraction comprised of hydrocarbons having a boiling point of at least 343°C is provided for contact with the fluidizable cracking catalyst at a temperature of from 315°C to 430°C.

9. The process of claim 1 or any of claims 2-8 wherein the fluidizable cracking catalyst is regenerated and heated by combusting coke deposited on the fluidizable cracking catalyst, then providing the regenerated fluidizable cracking catalyst for

contact with the fraction comprised of hydrocarbons having a boiling point of at least 343°C.

10. The process of claim 1 or any of claims 2-9 wherein the fluidizable cracking catalyst and the fraction comprised of hydrocarbons having a boiling point of at least 343°C are contacted at a weight ratio of from 1 to 15 kg catalyst to 1 kg of the fraction comprised of hydrocarbons having a boiling point of at least 343°C.

11. The process of claim 1 or any of claims 2-10 wherein contacting the fraction comprised of hydrocarbons having a boiling point of at least 343°C with a fluidizable cracking catalyst at a temperature of at least 500°C produces a hydrocarbon mixture comprised of a gasoline fraction comprising at most 500 wppm sulfur and a light cycle oil fraction comprising at most 0.75 wt.% sulfur.

CLAIMS

1. A process, comprising:

providing a hydrocarbon-containing feedstock to a mixing zone, where the hydrocarbon-containing feedstock is selected to contain at least 20 wt.% hydrocarbons having a boiling point of greater than 538°C as determined in accordance with ASTM Method D5307;

providing a metal-containing catalyst comprising a Lewis base to the mixing zone; wherein any metal-containing catalyst provided to the mixing zone has an acidity as measured by ammonia chemisorption of at most 200 μmol ammonia desorbed from the catalyst per gram of catalyst;

continuously or intermittently providing hydrogen to the mixing zone;

blending the hydrogen, hydrocarbon-containing feedstock, and the metal-containing catalyst in the mixing zone at a temperature of from 375°C to 500°C and at a pressure of from 6.9 MPa to less than 27.5 MPa to produce:

a) a vapor comprised of hydrocarbons that are vaporizable at the temperature and the pressure within the mixing zone; and

b) a hydrocarbon-depleted feed residuum comprising hydrocarbons that are liquid at the temperature and pressure within the mixing zone;

continuously or intermittently separating at least a portion of the vapor from the mixing zone while retaining in the mixing zone at least a portion of the hydrocarbon-depleted feed residuum comprising hydrocarbons that are liquid at the temperature and pressure within the mixing zone, wherein the vapor separated from the mixing zone comprises a first hydrocarbon-containing product containing one or more hydrocarbon compounds that are liquid at STP;

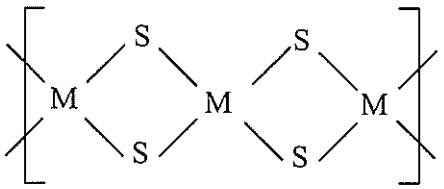
apart from the mixing zone, contacting the first hydrocarbon-containing product with hydrogen and a catalyst comprising a Column 6 metal of the Periodic Table or a compound thereof at a temperature of from 260°C to 425°C and a pressure of from 3.4 MPa to 27.5 MPa to produce a product stream comprising a second hydrocarbon-containing product;

separating the second hydrocarbon-containing product into fractions wherein one fraction is comprised of hydrocarbons having a boiling point of from 343°C to 538°C as determined in accordance with ASTM Method D5307; and

contacting the fraction comprised of hydrocarbons having a boiling point of from 343°C to 538°C with a fluidizable cracking catalyst at a temperature of at least 500°C.

2. The method of claim 1 wherein any metal-containing catalyst provided to the mixing zone has an acidity as measured by ammonia chemisorption of at most 100 μmol ammonia desorbed from the catalyst per gram of catalyst.

3. The process of claim 1 wherein a metal-containing catalyst provided to the mixing zone is comprised of a material comprised of a first metal and a second metal where the first metal comprises a metal selected from the group consisting of Cu, Ni, Co, Fe, Ag, Mn, Zn, Sn, Ru, La, Ce, Pr, Sm, Eu, Yb, Lu, Dy, Pb, Sb, and Bi, where the second metal comprises a metal selected from the group consisting of Mo, W, Sn, and Sb, where the second metal is not the same as the first metal, wherein at least a portion of the material comprised of the first metal and the second metal has a structure according to formula (I)



(I)

where M is either the first metal or the second metal, and at least one M is the first metal and at least one M is the second metal.

4. The process of claim 1 wherein hydrogen sulfide is provided to the mixing zone at a mole ratio of hydrogen sulfide to hydrogen of at least 1:10.

5. The process of claim 1 wherein the temperature in the mixing zone is selected and controlled to be from 450°C to 500°C.

6. The process of claim 1 wherein the combined volume of the hydrocarbon-depleted feed residuum, the metal-containing catalyst, and the hydrocarbon-containing feedstock in the mixing zone defines a mixture volume in the mixing zone, and the hydrocarbon-containing feedstock is

provided to the mixing zone at a rate selected to be at least 400 kg/hr m3 of the mixture volume in the mixing zone.

7. The process of claim 6 wherein the mixing zone is located in reactor; the reactor has a reactor volume; the combined volume of the hydrocarbon-containing feedstock and the metal-containing catalyst initially provided to the mixing zone defines an initial mixture volume, where the initial mixture volume is from 5% to 97% of the reactor volume; and where the mixture volume of the metal-containing catalyst in the mixing zone, the hydrocarbon-depleted feed residuum, and the hydrocarbon-containing feed is maintained at a level of at least 10% of the initial mixture volume.

8. The process of claim 1 wherein the first hydrocarbon-containing product contains at most 0.5 wppm of vanadium, at most 0.5 wppm of nickel, and at most 0.3 wppm of iron.

9. The process of claim 1 wherein the catalyst comprising a Column 6 metal further comprises a support material selected from alumina, silica, titania, zirconia, or mixtures thereof.

10. The process of claim 1 wherein the catalyst comprising a Column 6 metal further comprises a Column 7-10 metal or a compound thereof.

11. The process of claim 1 wherein the first hydrocarbon-containing product is contacted with hydrogen and the catalyst comprising a Column 6 metal of the Periodic Table or a compound thereof at a temperature of from 260°C to 425°C and a pressure of from 3.4 MPa to less than 10.3 MPa to produce a product stream comprising a second hydrocarbon-containing product.

12. The process of claim 1 wherein the fluidizable cracking catalyst comprises a zeolite, and has a bulk density of from 0.7 g/cm3 to 1.1 g/cm3, a particle size distribution of from 10 μm to 150 μm, and an average particle size of from 60 μm to 100 μm.

13. The process of claim 1 wherein the fluidizable cracking catalyst is provided for contact with the fraction comprised of hydrocarbons having a boiling point of at least 343°C at a temperature of from 700°C to 850°C.

14. The process of claim 1 wherein the fraction comprised of hydrocarbons having a boiling point of at least 343°C is provided for contact with the fluidizable cracking catalyst at a temperature of from 315°C to 430°C.

15. The process of claim 1 wherein the fluidizable cracking catalyst is regenerated and heated by combusting coke deposited on the fluidizable cracking catalyst, then providing the regenerated fluidizable cracking catalyst for contact with the fraction comprised of hydrocarbons having a boiling point of at least 343°C.

16. The process of claim 1 wherein the fluidizable cracking catalyst and the fraction comprised of hydrocarbons having a boiling point of at least 343°C are contacted at a weight ratio of from 1 to 15 kg catalyst to 1 kg of the fraction comprised of hydrocarbons having a boiling point of at least 343°C.

17. The process of claim 1 wherein contacting the fraction comprised of hydrocarbons having a boiling point of at least 343°C with a fluidizable cracking catalyst at a temperature of at least 500°C produces a hydrocarbon mixture comprised of a gasoline fraction comprising at most 500 wppm sulfur and a light cycle oil fraction comprising at most 0.75 wt.% sulfur.