PCT/EP2010/062283 **January 23, 2012**

Albemarle Europe SPRL

THAT WHICH IS CLAIMED IS:

1. A process for forming a solution composition, which process comprises bringing together, in an aqueous medium,

i) at least one phosphorus compound;

ii) at least one Group VI metal compound; and

iii) at least one Group VIII metal compound,

such that a solution composition having a) a phosphorus concentration in the range of from about 0. 40 to about 1.7 mol/l and a P:Group VI molar ratio of from about 1:6 to about 1:12 and a Group VI metal concentration in the range of about 6.9 mol/L to about 9.7 mol/L; b) a Group VI metal concentration of more than 6.9 mol/L, a phosphorus concentration in the range of from about 1.1 to about 3.3 mol/l and a P:Group VI molar ratio of from about 1:3 to about 1:6; or c) a Group VI metal concentration of more than 6.9 mol/L, a phosphorus concentration in the range of from about 2.2 to about 6 mol/l and a P:Group VI molar ratio of from about 1:1 to about 1:3 is formed.

2. A process as in Claim 1, wherein said solution composition has a Group VI metal concentration in the range of about 6.9 mol/L to about 9.7 mol/L.

3. A process as in Claim 1, wherein said phosphorus compound is a water soluble, acidic phosphorus compound.

4. A process as in Claim 1, wherein said phosphorus compound is orthophosphoric acid.

5. A process as in Claim 1, wherein i) said at least one Group VI metal compound is an oxide or an oxo-acid; ii) said at least one Group VIII metal compound is an a carbonate, hydroxide, or hydroxy-carbonate; or iii) i) and ii).

Clean copy

6. A process as in Claim 1, wherein a organic additive is included in forming said solution composition, which additive has at least two hydroxyl groups and no acidic carboxylic groups, and/or wherein an organic acid is included, which organic acid has at least one acid group and at least one functional group selected from a hydroxyl group and an acid group.

7. A process as in Claim 6 wherein said organic additive is diethylene glycol, triethylene glycol, tetraethylene glycol, or polyethylene glycol.

8. A process as in any of Claims 1-7 wherein said solution composition has a Group VIII metal concentration in the range of about 1.12 mol/L to about 4.85 mol/L.

9. A process as in any of Claims 1-7 wherein said at least one Group VI metal compound is a) a molybdenum compound, b) a tungsten compound, or c) combinations of a) and b) and/or wherein said at least one Group VIII compound is d) a nickel compound, e) a cobalt compound, or f) combination of d) and e).

10. A process as in any of Claims 1-7 wherein said process further comprises removing at least a portion of said aqueous medium from said solution composition.

11. A process for forming a solution composition, which process comprises bringing together, in an aqueous medium,

i) at least one phosphorus compound;
ii) at least one Group VI metal compound; and
iii) at least one Group VIII metal compound,

thereby forming an aqueous solution composition comprising an aqueous medium, and components i)-iii), and removing at least a portion of the aqueous medium from said first solution such that a solution having a phosphorus concentration in the range of from about 0.5 to about 6.00 mol/l, a P:Group VI molar ratio of from about 1:1 to about 1:12 and a Group VI metal concentration of more than about 6.9 mol/L is formed.

12. A solution composition formed as in Claim 11, which composition comprises a Group VI metal, a Group VIII metal, and phosphorus, where the composition has a phosphorus concentration in the range of from about 0.5 to about 6.0mol/l and a P:Group VI molar ratio of from about 1:1 to about 1:12 and a Group VI metal concentration of more than about 6.9 mol/L.

13. A solution composition comprising an aqueous medium, at least one Group VI metal compound, at least one Group VIII metal compound, and at least one phosphorus compound, where the composition has a) a phosphorus concentration in the range of from about 0.4 to about 1.7mol/l and a P:Group VI molar ratio of from about 1:6 to about 1:12 and a Group VI metal concentration of more than about 6.9 mol/L; b) a Group VI metal concentration of more than 6.9 mol/L, a phosphorus concentration in the range of from about 1.1 to about 3.3 mol/l and a P:Group VI molar ratio of from about 1:3 to about 1:6; or c) a Group VI metal concentration of more than 6.9 mol/L, a phosphorus concentration in the range of from about 2.2 to about 6 mol/l and a P:Group VI molar ratio of from about 1:1 to about 1:3.

14. A solution composition as in Claim 13 wherein said solution composition has a Group VI metal concentration in the range of about 6.9 mol/L to about 9.7 mol/L.

15. A solution composition as in Claim 13 wherein said composition has a) a Group VIII metal concentration in the range of about 1.12 mol/L to about 4.85 mol/L.

16. A solution composition as in Claim 15 further comprising a organic additive, which additive has at least two hydroxyl groups and no acidic carboxylic groups, and/or wherein an organic acid is included, which organic acid has at least one acid group and at least one functional group selected from a hydroxyl group and an acid group.

17. A solution composition as in Claim 16 wherein said organic additive is diethylene glycol, triethylene glycol, tetraethylene glycol, or polyethylene glycol, and/or wherein said organic acid is citric acid.

18. A solution composition as in any of Claims 13-17 wherein said Group VI metal is molybdenum and/or tungsten, and/or wherein said Group VIII metal is nickel and/or cobalt.

19. A solution composition as in any of Claims 13-17 wherein said Group VI metal is molybdenum, and/or wherein said Group VIII metal is cobalt and/or nickel.

20. A solution composition as in any of claims 13-16 wherein said composition comprises a) 18 wt% to about 26 wt% of said aqueous medium, based on the total weight of the composition; b) 16 wt% to about 19 wt% of said aqueous medium, based on the total weight of the composition; or c) less than 17wt% of said aqueous medium, based on the total weight of the composition.

21. A solution composition as in claim 20 wherein said aqueous medium is water.

22. A process for forming a catalyst, which process comprises

I) bringing together a carrier or a substrate and an impregnation solution comprising a solution composition, wherein said solution composition comprises an aqueous medium, at least one Group VI metal, at least one Group VIII metal, and at least one phosphorus compound, wherein the solution composition is characterized by a) a phosphorus concentration in the range of from about 0. 40 to about 1.7 mol/l and a P:Group VI molar ratio of from about 1:6 to about 1:12 and a Group VI metal concentration of more than about 6.9 mol/L; b) a Group VI metal concentration of more than 6.9 mol/L, a phosphorus concentration in the range of from about 1.1 to about 3.3 mol/l and a P:Group VI molar ratio of from about 1:3 to about 1:6; c) a Group VI metal concentration of more than 6.9 mol/L, a phosphorus concentration in the range of from about 2.2 to about 6 mol/l and a P:Group VI molar ratio of from about 1:1 to about 1:3; or d) a phosphorus concentration in the range of from about 0.5 to about 6.00 mol/l and a P:Group VI molar ratio of from about 1:1 to about 1:12 and a Group VI metal concentration of more than about 6.9 mol/L; and

II) drying the intermediate product,

to form a catalyst.

23. A process as in Claim 22, wherein said solution composition has a Group VI metal concentration in the range of about 6.9 mol/L to about 9.7 mol/L.

24. A process as in Claim 22 further comprising sulfiding the catalyst.

25. A process as in Claim 22 wherein said carrier or substrate is silica, alumina, silica-alumina, alumina with silica-alumina dispersed therein, alumina-coated silica, or silica-coated alumina, cordierite, ceramic, glass, metal, clays, magnesia, zirconia, boria, or titania.

26. A process as in Claim 22 wherein at least one organic additive, which additive has at least two hydroxyl groups and no acidic carboxylic groups, is present in the impregnation solution, and/or wherein at least one organic acid having at least one acid group and at least one functional group selected from a hydroxyl group and an acid group is present in the impregnation solution.

27. A process as in Claim 26 wherein said additive is diethylene glycol, triethylene glycol, tetraethylene glycol, or polyethylene glycol, and/or wherein said organic acid is citric acid.

28. A process as in Claim 22 wherein said process comprises a single impregnation step.

29. A process as in any of Claims 22-28 wherein said solution composition comprises a) 18 wt% to about 26 wt% of said aqueous medium, based on the total weight of the solution composition; b) 16 wt% to about 19 wt% of said aqueous medium, based on the total weight of the solution composition; or c) less than 17wt% of said aqueous medium, based on the total weight of the solution composition.

30. A catalyst composition formed as in any of Claims 22-28.

31. The catalyst according to claim 30 wherein said catalyst comprises said substrate or carrier and wherein said carrier or substrate is a) impregnated with said at least one Group VI metal, at least one Group VIII metal, and said phosphorus; b) said Group VI metal, Group VIII metal, and phosphorus are present as a membrane on said carrier or substrate; or c) said Group VI metal, Group VIII metal, and phosphorus are present as a coating on said carrier or substrate.

32. A method for hydrotreating, hydrodenitrogenation, and/or hydrodesulfurization, which method comprises contacting a hydrocarbon feed and a catalyst of any of Claims 30 or 31.

THAT WHICH IS CLAIMED IS:

1. A process for forming a solution composition, which process comprises bringing together, in an aqueous medium,

i) at least one phosphorus compound;

ii) at least one Group VI metal compound; and

iii) at least one Group VIII metal compound,

such that a solution composition having a) a phosphorus concentration in the range of from about 0. 40 to about 1.7 mol/l and a P:Group VI molar ratio of from about 1:6 to about 1:12 and a Group VI metal concentration in the range of about 6.9 mol/L to about 9.7 mol/L; b) a Group VI metal concentration of more than 6.9 mol/L, a phosphorus concentration in the range of from about 1.1 to about 3.3 mol/l and a P:Group VI molar ratio of from about 1:3 to about 1:6; or c) a Group VI metal concentration of more than 6.9 mol/L, a phosphorus concentration in the range of from about 2.2 to about 6 mol/l and a P:Group VI molar ratio of from about 1:1 to about 1:3 is formed.

2. A process as in Claim 1, wherein said solution composition has a Group VI metal concentration in the range of about 6.9 mol/L to about 9.7 mol/L.

3. A process as in Claim 1, wherein said phosphorus compound is a water soluble, acidic phosphorus compound.

4. A process as in Claim 1, wherein said phosphorus compound is orthophosphoric acid.

5. A process as in Claim 1, wherein i) said at least one Group VI metal compound is an oxide or an oxo-acid; ii) said at least one Group VIII metal compound is an a carbonate, hydroxide, or hydroxy-carbonate; or iii) i) and ii).

6. A process as in Claim 1, wherein a organic additive is included in forming said solution composition, which additive has at least two hydroxyl groups and no acidic carboxylic groups, and/or wherein an organic acid is included, which organic acid has at least one acid group and at least one functional group selected from a hydroxyl group and an acid group.

7. A process as in Claim 6 wherein said organic additive is diethylene glycol, triethylene glycol, tetraethylene glycol, or polyethylene glycol.

8. A process as in any of Claims 1-7 wherein said solution composition has a Group VIII metal concentration in the range of about 1.12 mol/L to about 4.85 mol/L.

9. A process as in any of Claims 1-7 wherein said at least one Group VI metal compound is a) a molybdenum compound, b) a tungsten compound, or c) combinations of a) and b) and/or wherein said at least one Group VIII compound is d) a nickel compound, e) a cobalt compound, or f) combination of d) and e).

10. A process as in any of Claims 1-7 wherein said process further comprises removing at least a portion of said aqueous medium from said solution composition.

11. A process for forming a solution composition, which process comprises bringing together, in an aqueous medium,

i) at least one phosphorus compound;

ii) at least one Group VI metal compound; and

iii) at least one Group VIII metal compound,

thereby forming an aqueous solution composition comprising an aqueous medium, and components i)-iii), and removing at least a portion of the aqueous medium from said first solution such that a solution having a phosphorus concentration in the range of from about 0.5 to about 6.00 mol/1, a P:Group VI molar ratio of from about 1:1 to about 1:12 and a Group VI metal concentration of more than about 6.9 mol/L is formed.

12. A solution composition formed as in Claim 11, which composition comprises a Group VI metal, a Group VIII metal, and phosphorus, where the composition has a phosphorus concentration in the range of from about 0.5 to about 6.0mol/l and a P:Group VI molar ratio of from about 1:1 to about 1:12 and a Group VI metal concentration of more than about 6.9 mol/L.

13. A solution composition comprising an aqueous medium, at least one Group VI metal compound, at least one Group VIII metal compound, and at least one phosphorus compound, where the composition has a) a phosphorus concentration in the range of from about 0.4 to about 1.7mol/l and a P:Group VI molar ratio of from about 1:6 to about 1:12 and a Group VI metal concentration of more than about 6.9 mol/L; b) a Group VI metal concentration of more than 6.9 mol/L, a phosphorus concentration in the range of from about 1.1 to about 3.3 mol/l and a P:Group VI molar ratio of from about 1:3 to about 1:6; or c) a Group VI metal concentration of more than 6.9 mol/L, a phosphorus concentration in the range of from about 2.2 to about 6 mol/l and a P:Group VI molar ratio of from about 1:1 to about 1:3.

14. A solution composition as in Claim 13 wherein said solution composition has a Group VI metal concentration in the range of about 6.9 mol/L to about 9.7 mol/L.

15. A solution composition as in Claim 13 wherein said composition has a) a Group VIII metal concentration in the range of about 1.12 mol/L to about 4.85 mol/L.

16. A solution composition as in Claim 15 further comprising a organic additive, which additive has at least two hydroxyl groups and no acidic carboxylic groups, and/or wherein an organic acid is included, which organic acid has at least one acid group and at least one functional group selected from a hydroxyl group and an acid group.

17. A solution composition as in Claim 16 wherein said organic additive is diethylene glycol, triethylene glycol, tetraethylene glycol, or polyethylene glycol, and/or wherein said organic acid is citric acid.

18. A solution composition as in any of Claims 13-17 wherein said Group VI metal is molybdenum and/or tungsten, and/or wherein said Group VIII metal is nickel and/or cobalt.

19. A solution composition as in any of Claims 13-17 wherein said Group VI metal is molybdenum, and/or wherein said Group VIII metal is cobalt and/or nickel.

20. A solution composition as in any of claims 13-16 wherein said composition comprises a) 18 wt% to about 26 wt% of said aqueous medium, based on the total weight of the composition; b) 16 wt% to about 19 wt% of said aqueous medium, based on the total weight of the composition; or c) less than 17wt% of said aqueous medium, based on the total weight of the composition.

21. A solution composition as in claim 20 wherein said aqueous medium is water.

22. A process for forming a catalyst, which process comprises

I) bringing together a carrier or a substrate and an impregnation solution comprising a solution composition, wherein said solution composition comprises an aqueous medium, at least one Group VI metal, at least one Group VIII metal, and at least one phosphorus compound, wherein the solution composition is characterized by a) a phosphorus concentration in the range of from about 0. 40 to about 1.7 mol/l and a P:Group VI molar ratio of from about 1:6 to about 1:12 and a Group VI metal concentration of more than about 6.9 mol/L; b) a Group VI metal concentration of more than 6.9 mol/L, a phosphorus concentration in the range of from about 1.1 to about 3.3 mol/l and a P:Group VI molar ratio of from about 1:3 to about 1:6; c) a Group VI metal concentration of more than 6.9 mol/L, a phosphorus concentration in the range of from about 2.2 to about 6 mol/l and a P:Group VI molar ratio of from about 1:1 to about 1:3; or d) a phosphorus concentration in the range of from about 0.5 to about 6.00 mol/l and a P:Group VI molar ratio of from about 1:1 to about 1:12 and a Group VI metal concentration of more than about 6.9 mol/L; and

II) drying the intermediate product,

to form a catalyst.

23. A process as in Claim 22, wherein said solution composition has a Group VI metal concentration in the range of about 6.9 mol/L to about 9.7 mol/L.

24. A process as in Claim 22 further comprising sulfiding the catalyst.

25. A process as in Claim 22 wherein said carrier or substrate is silica, alumina, silica-alumina, alumina with silica-alumina dispersed therein, alumina-coated silica, or silica-coated alumina, cordierite, ceramic, glass, metal, clays, magnesia, zirconia, boria, or titania.

26. A process as in Claim 22 wherein at least one organic additive, which additive has at least two hydroxyl groups and no acidic carboxylic groups, is present in the impregnation solution, and/or wherein at least one organic acid having at least one acid group and at least one functional group selected from a hydroxyl group and an acid group is present in the impregnation solution.

27. A process as in Claim 26 wherein said additive is diethylene glycol, triethylene glycol, tetraethylene glycol, or polyethylene glycol, and/or wherein said organic acid is citric acid.

28. A process as in Claim 22 wherein said process comprises a single impregnation step.

29. A process as in any of Claims 22-28 wherein said solution composition comprises a) 18 wt% to about 26 wt% of said aqueous medium, based on the total weight of the solution composition; b) 16 wt% to about 19 wt% of said aqueous medium, based on the total weight of the solution composition; or c) less than 17wt% of said aqueous medium, based on the total weight of the solution composition.

30. A catalyst composition formed as in any of Claims 22-28.

31. The catalyst according to claim 30 wherein said catalyst comprises said substrate or carrier and wherein said carrier or substrate is a) impregnated with said at least one Group VI metal, at least one Group VIII metal, and said phosphorus; b) said Group VI metal, Group VIII metal, and phosphorus are present as a membrane on said carrier or substrate; or c) said Group VI metal, Group VIII metal, and phosphorus are present as a coating on said carrier or substrate.

32. A method for hydrotreating, hydrodenitrogenation, and/or hydrodesulfurization, which method comprises contacting a hydrocarbon feed and a catalyst of any of Claims 30 or 31.