King et al., U.S. Pat. No. 4,263,152; King et al., U.S. Pat. No. 4,261,843; and King et al., U.S. Pat. No. 4,259,195 teach molybdenum compounds used as anti-oxidant and anti-wear additives comprising an acidic molybdenum compound and a basic nitrogen compound which acts as a dispersant.

DeVries et al., U.S. Pat. No. 4,259,194 discloses a sulfur containing additive comprising the reaction product of ammonium tetrathiomolybdate and a basic nitrogen compound for use as an anti-oxidant, anti-wear agent, and friction modifier.

Nemo, U.S. Pat. No. 4,705,643 teaches the preparation of carboxylic acid amides as detergent additives in lubricating oils.

Udding et al., U.S. Pat. No. 5,468,891 describes antifriction additives for lubricating oils comprising a molybdenum-containing complex prepared by reacting an alkaline earth metal salt of a carboxylic acid, an amine and a source of cationic molybdenum, wherein the ratio of the number of equivalents of acid groups to the number of moles of molybdenum (eq:mol) is in the range from 1:10 to 10:1, and the ratio of the number of equivalents of acid groups to the number of moles of amine (eq:mol) is in the range from 20:1 to 1:10.

Ruhe, Jr. et al., U.S. Pat. No. 6,962,896 describes antioxidant additives for lubricating oils comprising low color molybdenum compounds and polyamide dispersants including molybdenum oxysulfide polyamides.

Gatto et al., U.S. Pat No. 6,174,842 discloses a lubricating oil composition comprising a lubricating oil, an oil-soluble molybdenum compound substantially free of reactive sulfur, an oil-soluble diarylamine and a calcium phenate as an anti-wear and anti-oxidant additive.

SUMMARY OF THE ~~INVENTION~~DISCLOSURE

An embodiment of the present ~~invention~~ disclosure is directed to

an oil soluble additive composition prepared by a process comprising:

(1) reacting a molybdenum component;

(2) an amide wherein said amide comprises the reaction product of a carboxylic acid component and a polyamine component, wherein the charge mole ratio of the carboxylic acid component to the polyamine component is about 2:1 to 1:1;

(3) a sulfur source wherein the ratio of sulfur to molybdenum is about 2:1; and

(4) a post-treating agent.

An embodiment of the present disclosure is directed to an oil soluble friction modifier additive composition prepared by a process comprising reacting:

(1) a molybdenum component, wherein the molybdenum component is a molybdenum oxide, sulfide, or oxysulfide of formula MoOxSy wherein $x \geq 0$, $y \geq 0$, and $12 \geq (x+y) \geq 2$;

(2) an amide wherein said amide comprises the reaction product of [[a]] an aliphatic carboxylic acid component having from 10 to 30 carbon atoms and a polyamine component selected from tetraethylenepentamine (TEPA), diethylenetriamine (DETA), ethylenediamine (EDA), or mixtures thereof, wherein the charge mole ratio of the aliphatic carboxylic acid component to the polyamine component is 2:1 to 1:1, ; and

(3) a sulfur source wherein the mole ratio of sulfur to molybdenum is 2:1; and thereafter reacting the reaction product of (1), (2) and (3) with

(4) a post-treating agent, wherein the post-treating agent is a cyclic carbonate.

An embodiment of the present ~~invention~~ disclosure is directed to a lubricating oil composition comprising:

a. an oil of lubricating viscosity and

b. the reaction product of

i. a molybdenum component;

ii. an amide wherein said amide comprises the reaction product of a carboxylic acid component and a polyamine component, wherein the charge mole ratio of the carboxylic acid component to the polyamine component is about 2:1 to 1:1;

iii. a sulfur source wherein the ratio of sulfur to molybdenum is about 2:1; and

iv. a post-treating agent.

An embodiment of the present disclosure is directed to a lubricating oil composition comprising:

a. an oil of lubricating viscosity and

b. an oil soluble friction modifier additive composition, wherein the oil soluble friction modifier additive composition is a post-treated reaction product obtained from the reaction of a cyclic carbonate post-treating agent with a product of the reaction of:

i. a molybdenum component, wherein the molybdenum component is a molybdenum oxide, sulfide, or oxysulfide of formula MoOxSy wherein $x \geq 0$, $y \geq 0$, and $12 \geq (x+y) \geq 2$;

ii. an amide wherein said amide comprises the reaction product of an aliphatic carboxylic acid component having from 10 to 30 carbon atoms and a polyamine component selected from tetraethylenepentamine (TEPA), diethylenetriamine (DETA), ethylenediamine (EDA), or mixtures thereof, wherein the charge mole ratio of the aliphatic carboxylic acid component to the polyamine component is about 2:1 to 1:1; and

iii. a sulfur source wherein the mole ratio of sulfur to molybdenum is 2:1.

An embodiment of the present ~~invention~~ disclosure is directed to a process for preparing an oil soluble additive composition which comprises reacting:

a. a molybdenum component;

b. an amide wherein said amide comprises the reaction product of a carboxylic acid component and a polyamine component, wherein the charge mole ratio of the carboxylic acid component to the polyamine component is about 2:1 to 1:1;

c. a sulfur source wherein the ratio of sulfur to molybdenum is about 2:1; and

d. a post-treating agent.

An embodiment of the present disclosure is directed to a process for preparing an oil soluble friction modifier additive composition which comprises reacting:

a. a molybdenum component, wherein the molybdenum component is a molybdenum oxide, sulfide, or oxysulfide of formula MoOxSy wherein $x \geq 0$, $y \geq 0$, and $12 \geq (x+y) \geq 2$;

b. an amide wherein said amide comprises the reaction product of [[a]] an aliphatic carboxylic acid component having from 10 to 30 carbon atoms and a polyamine component selected from tetraethylenepentamine (TEPA), diethylenetriamine (DETA), ethylenediamine (EDA), or mixtures thereof,

wherein the charge mole ratio of the aliphatic carboxylic acid component to the polyamine component is 2:1 to 1:1;

c. a sulfur source wherein the mole ratio of sulfur to molybdenum is 2:1; and thereafter reacting the product of (a), (b) and (c) with

d. a post-treating agent, wherein the post-treating agent is a cyclic carbonate.

An embodiment of the present ~~invention~~ disclosure is directed to an oil soluble additive composition comprising the reaction product of:

a. a molybdenum component;

b. an amide wherein said amide comprises the reaction product of a carboxylic acid component and a polyamine component, wherein the charge mole ratio of the carboxylic acid component to the polyamine component is about 2:1 to 1:1;

c. a sulfur source wherein the ratio of sulfur to molybdenum is about 2:1; and

d. a post-treating agent.

An embodiment of the present disclosure is directed to an oil soluble friction modifier additive composition comprising a post-treated reaction product obtained from the reaction of a cyclic carbonate post-treating agent with a product of the reaction of:

a. a molybdenum component, wherein the molybdenum component is a molybdenum oxide, sulfide, or oxysulfide of formula MoOxSy wherein $x \geq 0$, $y \geq 0$, and $12 \geq (x+y) \geq 2$;

b. an amide wherein said amide comprises the reaction product of [[a]] an aliphatic carboxylic acid component having from 10 to 30 carbon atoms and a polyamine component selected from tetraethylenepentamine (TEPA), diethylenetriamine (DETA), ethylenediamine (EDA), or mixtures thereof, wherein the charge mole ratio of the aliphatic carboxylic acid component to the polyamine component is about 2:1 to 1:1; and

c. a sulfur source wherein the mole ratio of sulfur to molybdenum is 2:1.

WHAT IS CLAIMED IS:

1. An oil soluble additive composition prepared by a process comprising:
   (1) reacting a molybdenum component;
   (2) an amide wherein said amide comprises the reaction product of a carboxylic acid component and a polyamine component, wherein the charge mole ratio of the carboxylic acid component to the polyamine component is about 2:1 to 1:1;
   (3) a sulfur source wherein the ratio of sulfur to molybdenum is about 2:1; and
   (4) a post-treating agent.

2. The oil soluble additive composition of claim 1, wherein the molybdenum component is a molybdenum oxide.

3. The oil soluble additive composition of claim 1, wherein the molybdenum component is a molybdenum oxysulfide.

4. The oil soluble additive composition of claim 1, wherein the molybdenum component is a molybdenum sulfide.

5. The oil soluble additive composition of claim 1, wherein the amide contains at least one basic nitrogen.

6. The oil soluble additive composition of claim 1, wherein the carboxylic acid component is a carboxylic acid, carboxylic acid salt, carboxylic acid anhydride, carboxylic acid ester, or mixtures thereof.

7. The oil soluble additive composition of claim 1, wherein the carboxylic acid component is a fatty acid.

8. The oil soluble additive composition of claim 1, wherein the carboxylic acid component is isostearic acid, stearic acid, or mixtures thereof.

9. The oil soluble additive composition of claim 1, wherein the charge mole ratio of the carboxylic acid component to the polyamine component is about 1.7:1 to 1:1.

10. The oil soluble additive composition of claim 1, wherein the polyamine is a polyalkylenepolyamine of the general formula

$$H_2N(\text{-}R\text{-}NH)_n\text{-}H$$

and wherein R is an alkylene group of 2-3 carbon atoms and n is an integer of from 1 to 11.

11. The oil soluble composition of claim 1, wherein the polyamine is tetraethylenepentamine (TEPA), diethylenetriamine (DETA), ethylenediamine (EDA), or mixtures thereof.

12. The oil soluble additive composition of claim 1, wherein the mole ratio of molybdenum to sulfur is about 1:0 to 1:8.

13. The oil soluble additive composition of claim 1, wherein the molybdenum component is a molybdenum sulfide or oxysulfide and the mole ratio of molybdenum to sulfur is about 1:1 to 1:4.

14. The oil soluble additive composition of claim 1, wherein the molybdenum component is sulfurized.

15. The oil soluble additive composition of claim 1 wherein the post-treating agent is a cyclic carbonate.

16. The oil soluble additive composition of claim 15 wherein the cyclic carbonate is ethylene carbonate or glycerine carbonate.

17. A lubricating oil composition comprising:

c. an oil of lubricating viscosity and

d. the reaction product of

i. a molybdenum component;

ii. an amide wherein said amide comprises the reaction product of a carboxylic acid component and a polyamine component, wherein the charge mole ratio

of the carboxylic acid component to the polyamine component is about 2:1 to 1:1;

iii. a sulfur source wherein the ratio of sulfur to molybdenum is about 2:1; and

iv. a post-treating agent.

18. The lubricating oil composition of claim 17, wherein the molybdenum content of the lubricating oil composition is between about 50 ppm and 5000 ppm.

19. The lubricating oil composition of claim 17, wherein the oil soluble additive composition content is between 0.05 to 15% by weight.

20. The lubricating oil composition of claim 17, wherein the charge mole ratio of the carboxylic acid component to the polyamine component is about 1.7:1 to 1:1.

21. The oil soluble additive composition of claim 17 wherein the post-treating agent is a cyclic carbonate.

22. The lubricating oil composition of claim 21 wherein the cyclic carbonate is ethylene carbonate or glycerine carbonate.

23. A process for preparing an oil soluble additive composition which comprises reacting:

a. a molybdenum component;

b. an amide wherein said amide comprises the reaction product of a carboxylic acid component and a polyamine component, wherein the charge mole ratio of the carboxylic acid component to the polyamine component is about 2:1 to 1:1;

c. a sulfur source wherein the ratio of sulfur to molybdenum is about 2:1; and

d. a post-treating agent.

24. The process of claim 23, wherein the molybdenum-containing reaction product is sulfurized in an amount sufficient to provide 0.01 to 12 atoms of sulfur per atom of molybdenum.

25. The process of claim 23, wherein said reaction of said molybdenum component and said amide is in the presence of a polar promoter.

26. The process of claim 25, wherein the polar promoter is selected from the group consisting of 1,3-propanediol, 1,4-butanediol, diethylene glycol, butyl cellosolve, propylene glycol, 1,4-butyleneglycol, methyl carbitol, ethanolamine, ammonium hydroxide, alkyl ammonium hydroxide, metal hydroxide, N-methyl-diethanol-amine, dimethyl formamide, N-methyl acetamide, dimethyl acetamide, methanol, ethylene glycol, dimethyl sulfoxide, hexamethyl phosphoramide, tetrahydrofuran, water, inorganic acid, and mixtures thereof.

27. The process of claim 26, wherein the polar promoter is water.

28. The process of claim 24, wherein the sulfurization is carried out with a sulfur source selected from sulfur, hydrogen sulfide, phosphorus pentasulfide, R2Sx where R is hydrocarbyl, and x is at least 2, inorganic sulfides or inorganic polysulfides, thioacetamide, thiourea, mercaptans of the formula RSH where R is hydrocarbyl, or a sulfur-containing antioxidant.

29. The process of claim 23, wherein the molybdenum component is selected from the group consisting of molybdic acid, ammonium molybdate, sodium molybdate, potassium molybdate, metal molybdates, MoOCl4, MoO2Br2, Mo2O3Cl6, molybdenum trioxide, and mixtures thereof.

30. The process of claim 29, wherein the molybdenum component is molybdenum trioxide.

31. The process of claim 23, wherein the carboxylic acid component comprises a fatty acid.

32. The process of claim 23, wherein the carboxylic acid component comprises isostearic acid, stearic acid, or mixtures thereof.

33. The process of claim 23, wherein the polyamine component comprises a polyalkylenepolyamine represented by the general formula

$$H_2N(\text{-}R\text{-}NH)_n\text{-}H$$

and wherein R is an alkylene group of 2-3 carbon atoms and n is an integer of from 1 to 11.

34. The process of claim 23, wherein the polyamine component is tetraethylenepentamine (TEPA), diethylenetriamine (DETA), ethylenediamine (EDA), or mixtures thereof.

35. The oil soluble additive composition of claim 23, wherein the post-treating agent is a cyclic carbonate.

36. The process of claim 23, wherein the cyclic carbonate is ethylene carbonate or glycerine carbonate.

37. An oil soluble additive composition comprising the reaction product of:

a. a molybdenum component;

b. an amide wherein said amide comprises the reaction product of a carboxylic acid component and a polyamine component, wherein the charge mole ratio of the carboxylic acid component to the polyamine component is about 2:1 to 1:1;

c. a sulfur source wherein the ratio of sulfur to molybdenum is about 2:1; and

d. a post-treating agent.

Claims

1. An oil soluble friction modifier additive composition prepared by a process comprising reacting:

(1) a molybdenum component, wherein the molybdenum component is a molybdenum oxide, sulfide, or oxysulfide of formula MoO_xS_y wherein $x \geq 0$, $y \geq 0$, and $12 \geq (x+y) \geq 2$;

(2) an amide wherein said amide comprises the reaction product of an aliphatic carboxylic acid component having from 10 to 30 carbon atoms and a polyamine component selected from tetraethylenepentamine (TEPA), diethylenetriamine (DETA), ethylenediamine (EDA), or mixtures thereof, wherein the charge mole ratio of the aliphatic carboxylic acid component to the polyamine component is 2:1 to 1:1, ; and

(3) a sulfur source wherein the mole ratio of sulfur to molybdenum is 2:1; and thereafter reacting the reaction product of (1), (2) and (3) with

(4) a post-treating agent, wherein the post-treating agent is a cyclic carbonate.

2. The oil soluble friction modifier additive composition of claim 1, wherein the molybdenum component is a molybdenum oxide.

3. The oil soluble friction modifier additive composition of claim 1, wherein the molybdenum component is a molybdenum oxysulfide.

4. The oil soluble friction modifier additive composition of claim 1, wherein the molybdenum component is a molybdenum sulfide.

5. The oil soluble friction modifier additive composition of claim 1, wherein the amide contains at least one basic nitrogen.

6. The oil soluble friction modifier additive composition of claim 1, wherein the aliphatic carboxylic acid component is a carboxylic acid, carboxylic acid salt, carboxylic acid anhydride, carboxylic acid ester, or mixtures thereof.

7. The oil soluble friction modifier additive composition of claim 1, wherein the aliphatic carboxylic acid component is isostearic acid, stearic acid, or mixtures thereof.

8. The oil soluble friction modifier additive composition of claim 1, wherein the charge mole ratio of the aliphatic carboxylic acid component to the polyamine component is 1.7:1 to 1:1.

9. The oil soluble friction modifier additive composition of claim 1, wherein the molybdenum component is sulfurized.

10. The oil soluble friction modifier additive composition of claim 1 wherein the cyclic carbonate is ethylene carbonate or glycerine carbonate.

11. A lubricating oil composition comprising:

a. an oil of lubricating viscosity and

b. an oil soluble friction modifier additive composition, wherein the oil soluble friction modifier additive composition is a post-treated reaction product obtained from the reaction of a cyclic carbonate post-treating agent with a product of the reaction of:

i. a molybdenum component, wherein the molybdenum component is a molybdenum oxide, sulfide, or oxysulfide of formula MoO_xS_y wherein $x \geq 0$, $y \geq 0$, and $12 \geq (x+y) \geq 2$;

ii. an amide wherein said amide comprises the reaction product of an aliphatic carboxylic acid component having from 10 to 30 carbon atoms and a polyamine component selected from tetraethylenepentamine (TEPA), diethylenetriamine (DETA), ethylenediamine (EDA), or mixtures thereof, wherein the charge mole ratio of the aliphatic carboxylic acid component to the polyamine component is 2:1 to 1:1; and

iii. a sulfur source wherein the mole ratio of sulfur to molybdenum is 2:1.

12. The lubricating oil composition of claim 11, wherein the molybdenum content of the lubricating oil composition is between 50 ppm and 5000 ppm, based on the total weight of the lubricating oil composition.

13. The lubricating oil composition of claim 11, wherein the oil soluble friction modifier additive composition content is between 0.05 to 15% by weight.

14. The lubricating oil composition of claim 11, wherein the charge mole ratio of the aliphatic carboxylic acid component to the polyamine component is 1.7:1 to 1:1.

15. The lubricating oil composition of claim 11 wherein the cyclic carbonate is ethylene carbonate or glycerine carbonate.

16. A process for preparing an oil soluble friction modifier additive composition which comprises reacting:

a. a molybdenum component, wherein the molybdenum component is a molybdenum oxide, sulfide, or oxysulfide of formula MoO_xS_y wherein $x \geq 0$, $y \geq 0$, and $12 \geq (x+y) \geq 2$;

b. an amide wherein said amide comprises the reaction product of an aliphatic carboxylic acid component having from 10 to 30 carbon atoms and a polyamine component selected from tetraethylenepentamine (TEPA), diethylenetriamine (DETA), ethylenediamine (EDA), or mixtures thereof, wherein the charge mole ratio of the aliphatic carboxylic acid component to the polyamine component is 2:1 to 1:1;

c. a sulfur source wherein the mole ratio of sulfur to molybdenum is 2:1; and thereafter reacting the product of (a), (b) and (c) with

d. a post-treating agent, wherein the post-treating agent is a cyclic carbonate.

17. The process of claim 16, wherein the molybdenum-containing reaction product is sulfurized in an amount sufficient to provide 0.01 to 12 atoms of sulfur per atom of molybdenum.

18. The process of claim 16, wherein said reaction of said molybdenum component and said amide is in the presence of a polar promoter.

19. The process of claim 18, wherein the polar promoter is selected from the group consisting of 1,3-propanediol, 1,4-butanediol, diethylene glycol, butyl cellosolve, propylene glycol, 1,4-butyleneglycol, methyl carbitol, ethanolamine, ammonium hydroxide, alkyl ammonium hydroxide, metal hydroxide, N-methyl-diethanol-amine, dimethyl formamide, N-methyl acetamide, dimethyl acetamide, methanol,

ethylene glycol, dimethyl sulfoxide, hexamethyl phosphoramide, tetrahydrofuran, water, inorganic acid, and mixtures thereof.

20. The process of claim 19, wherein the polar promoter is water.

21. The process of claim 17, wherein the sulfurization is carried out with a sulfur source selected from sulfur, hydrogen sulfide, phosphorus pentasulfide, R_2S_x where $\underline{R_2}$ is hydrocarbyl, and x is at least 2, inorganic sulfides or inorganic polysulfides, thioacetamide, thiourea, mercaptans of the formula RSH where R is hydrocarbyl, or a sulfur-containing antioxidant.

22. The process of claim 16, wherein the molybdenum component is selected from the group consisting of molybdic acid, ammonium molybdate, sodium molybdate, potassium molybdate, alkali or alkaline earth metal molybdates, $MoOCl_4$, MoO_2Br_2, $Mo_2O_3Cl_6$, molybdenum trioxide, and mixtures thereof.

23. The process of claim 22, wherein the molybdenum component is molybdenum trioxide.

24. The process of claim 16, wherein the aliphatic carboxylic acid component comprises isostearic acid, stearic acid, or mixtures thereof.

25. The process of claim 16, wherein the cyclic carbonate is ethylene carbonate or glycerine carbonate.

26. An oil soluble friction modifier additive composition comprising a post-treated reaction product obtained from the reaction of a cyclic carbonate post-treating agent with a product of the reaction of:

a. a molybdenum component, wherein the molybdenum component is a molybdenum oxide, sulfide, or oxysulfide of formula MoO_xS_y wherein $x \geq 0$, $y \geq 0$, and $12 \geq (x+y) \geq 2$;

b. an amide wherein said amide comprises the reaction product of an aliphatic carboxylic acid component having from 10 to 30 carbon atoms and a polyamine component selected from tetraethylenepentamine (TEPA), diethylenetriamine (DETA), ethylenediamine (EDA), or mixtures thereof, wherein the charge mole ratio of the aliphatic carboxylic acid component to the polyamine component is 2:1 to 1:1; and

c. a sulfur source wherein the mole ratio of sulfur to molybdenum is 2:1.