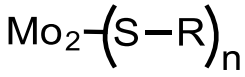
What is claimed is:

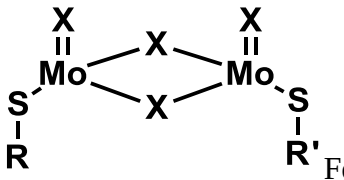
1. A method of inhibiting deposition of a foulant in process equipment for processing a hydrocarbon fluid in contact with the process equipment, comprising:

introducing into the process equipment or the hydrocarbon fluid in contact with the process equipment a fouling inhibitor composition comprising a sulfur-containing molybdenum complex having a general formula selected from Formula I, II, III, IV, V, or VI:



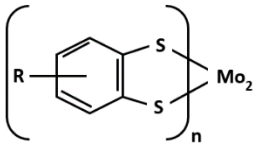
Formula I

wherein R of Formula I represents an oxygen, nitrogen or carbon-containing group; and n is 4-10;



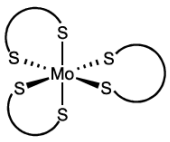
Formula II

wherein R and R' each represents a group selected from an alkyl group comprising one or more hydroxyl groups, an alkyl group, an alkenyl group, or an aryl group; and each X represents oxygen or sulfur and can be the same or different but where at least one X is sulfur;

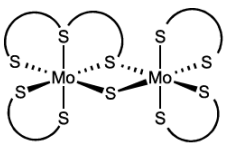


Formula III

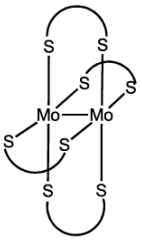
wherein R of Formula III represents an oxygen, nitrogen or carbon-containing group; and n is 2-6; or



Formula IV



Formula V



Formula VI

wherein the arcs in Formulae IV, V, and VI represent alkyl chains (linear, branched and cyclic) with or without saturation and optionally comprising a heteroatom; thiolate, sulfide, thiocarbamate, thiocarbonate, thioacid, aromatic ring with or without substituents, organic polysulfide, or inorganic polysulfide.

2. The method of claim 1, wherein the introducing is by injecting, spraying, or dripping the fouling inhibitor composition.

3. The method as in any preceding claim, wherein the introducing is carried out after or during a decoking or cleaning or during a warm up process.

4. The method as in any preceding claim, wherein the introducing is carried out during a hydrocarbon processing.

5. The method as in any preceding claim, wherein the introducing is carried out intermittently.

6. The method as in any preceding claim, wherein the introducing is carried out continuously.

7. The method as in any preceding claim, wherein the process equipment comprises iron or iron alloy.

8. The method as in claim 7, wherein the iron alloy comprises carbon steel, stainless steel, or a nickel-chromium-iron alloy.

9. The method as in any preceding claim, wherein the foulant comprises one or more of coke, sludge, a corrosion product, a polymer, and catalyst fines.

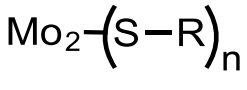
10. The method as in any preceding claim, wherein the sulfur-containing molybdenum complex is added to the hydrocarbon fluid from 1 ppm to 3000 ppm of the fluid volume.

11. The method as in any preceding claim, wherein the hydrocarbon fluid further comprises one or more, asphaltene inhibitors, paraffin inhibitors, scale inhibitors, emulsifiers, water clarifiers, dispersants, emulsion breakers, or any combination thereof.

12. The method as in any preceding claim, wherein the sulfur-containing molybdenum complex has the general formula III.

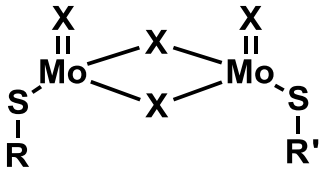
13. A method of passivating process equipment, comprising the step of:

contacting a metal surface of the process equipment with a composition comprising a sulfur-containing molybdenum complex selected from Formula I, II, III, IV, V, or VI:



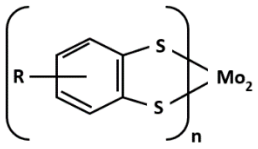
Formula I

wherein R of Formula I represents an oxygen, nitrogen or carbon-containing group; U and n is 4-10;



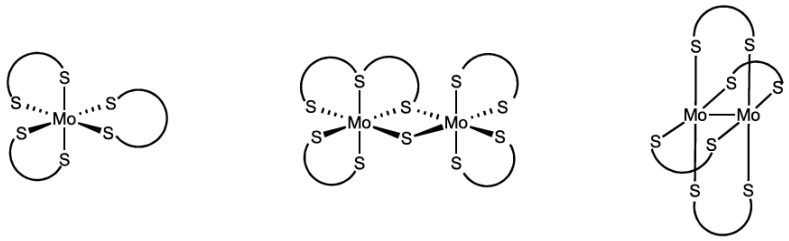
Formula II

wherein R and R' of Formula II each a group selected from an alkyl group comprising one or more hydroxyl groups, an alkyl group, an alkenyl group, an amide group, an amine group, and an aryl group; and each X represents oxygen or sulfur and can be the same or different but where at least one X in Formula II is sulfur;



Formula III

wherein R of Formula III represents an oxygen, nitrogen or carbon-containing group; and n is 2-6; or



Formula IV Formula V Formula VI

wherein the arcs in Formulae IV, V, and VI represent alkyl chains (linear, branched and cyclic) with or without saturation and optionally comprising a heteroatom; thiolate, sulfide, thiocarbamate, thiocarbonate, thioacid, aromatic ring with or without substituents, organic polysulfide, or inorganic polysulfide.

14. The method of claim 1, wherein R or R' of Formula II comprises 2 to 30 carbon atoms and one or more hydroxy groups.

15. The method of claim 1, wherein R or R' of Formula II comprises an alkyl group.

16. The method of claim 1, wherein R or R' of Formula II comprises an alkenyl group.

17. The method of claim 1, wherein R or R' of Formula II comprises an aryl group.

18. The method of claim 1, wherein R or R' comprises an aromatic ring with a substituent.

19. The method of claim 15, wherein the alkyl group of Formula II comprises 2 to 30 carbon atoms.

20. The method of claim 15, wherein the alkyl group of Formula II comprises 5 to 10 carbon atoms.

21. The method of claim 1, wherein the hydrocarbon fluid source comprises crude oil.

22. The method of claim 1, wherein the introducing step comprises introducing the fouling inhibitor composition into the hydrocarbon fluid source, wherein the composition comprises the phosphorus-free, sulfur-containing molybdenum complex and one or more other additives.

23. The method of claim 22, wherein the one or more other additives comprise an asphaltene inhibitor.

24. The method of claim 22, wherein the one or more other additives comprise a paraffin inhibitor.

25. The method of claim 22, wherein the one or more other additives comprise a dispersant.