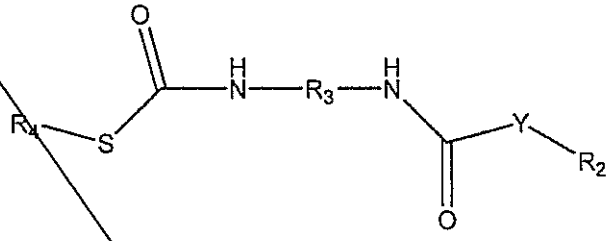
R_2 is a hydrocarbyl group containing 2 to 60, or 4 to 30, or 6 to 20 carbon atoms, or a heterocycle or substituted equivalents thereof, with the proviso that R_2 is free of a nitrogen-containing heterocycle,

or

wherein the ashless thiocarbamate compound having an optionally-substituted hydrocarbyl group on an S-atom and an optionally-substituted hydrocarbyl group on an N-atom is represented by the formula (4):



formula (4)

wherein

Y is >O, or >S, or > NH or >NR_5;

R_2 is a hydrocarbyl group containing 2 to 60, or 4 to 30, or 6 to 20 carbon atoms, or a heterocycle or substituted equivalents thereof, with the proviso that R_2 is free of a nitrogen-containing heterocycle;

R_3 is a hydrocarbylene group, or a heterocycle or substituted equivalents thereof;

R_4 is a hydrocarbyl group containing 2 to 60, or 4 to 30, or 6 to 20 carbon atoms, or a heterocycle or substituted equivalents thereof;

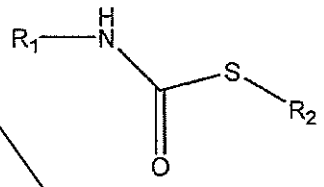
R_5 is a hydrocarbyl group containing 1 to 30, or 1 to 20, or 1 to 10, or 1 to 5 carbon atoms; and a pyrrole, a pyrrolidine, a pyrrolidinone, a pyridine, a piperidine, a pyrone, a pyrazole, a pyrazine, pyridazine, a 1,2-diazole, a 1,3-diazole, a 1,2,4-triazole, a benzotriazole, a quinoline, an indole, an imidazole, an oxazole, an oxazoline, a thiazole, a thiophene, an indolizine, a pyrimidine, a triazine, a furan, a tetrahydrofuran, a dihydrofuran, or mixtures thereof.

[0024] As used herein the expression "optionally-substituted hydrocarbyl" is intended to include hydrocarbyl groups that have substituents that are more polar than a hydrocarbon group. Examples of polar groups include esters, heterocycles, amides, imides, phosphates, sulphonates, sulphates, nitrates, nitriles, or ethers. The optionally-substituted hydrocarbylene group is defined substantially

The Claims defining the invention are as follows:

1. A lubricating composition comprising an oil of lubricating viscosity and 0.01 wt % to 5 wt % of an ashless thiocarbamate compound having an optionally-substituted hydrocarbyl group on an S-atom and an optionally-substituted hydrocarbyl group on an N-atom,

wherein the ashless thiocarbamate compound having an optionally-substituted hydrocarbyl group on an S-atom and an optionally-substituted hydrocarbyl group on an N-atom is represented by the formula (2):

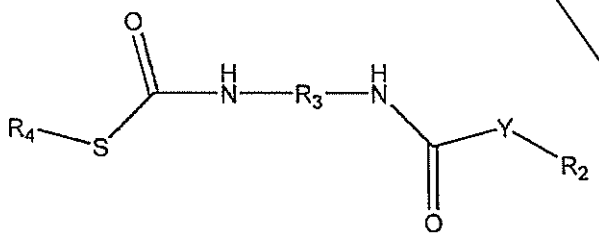


formula (2)

wherein R_1 is an optionally-substituted hydrocarbyl group containing 2 to 60 carbon atoms, or a heterocycle or substituted equivalents thereof; and

R_2 is a hydrocarbyl group containing 2 to 60 carbon atoms, or a heterocycle or substituted equivalents thereof, with the proviso that R_2 is free of a nitrogen-containing heterocycle, or

wherein the ashless thiocarbamate compound having an optionally-substituted hydrocarbyl group on an S-atom and an optionally-substituted hydrocarbyl group on an N-atom is represented by the formula (4):



formula (4)

wherein

Y is >O, or >S, or > NH or >NR_5;

R_2 is a hydrocarbyl group containing 2 to 60 carbon atoms, or a heterocycle or substituted equivalents thereof, with the proviso that R_2 is free of a nitrogen-containing heterocycle;

R_3 is a hydrocarbylene group, or a heterocycle or substituted equivalents thereof;

R_4 is a hydrocarbyl group containing 2 to 60 carbon atoms, or a heterocycle or substituted equivalents thereof;

R_5 is a hydrocarbyl group containing 1 to 30 carbon atoms; and the heterocycle is a pyrrole, a pyrrolidine, a pyrrolidinone, a pyridine, a piperidine, a pyrone, a pyrazole, a pyrazine, pyridazine, a 1,2-diazole, a 1,3-diazole, a 1,2,4-triazole, a benzotriazole, a quinoline, an indole, an imidazole, an oxazole, an oxazoline, a thiazole, a thiophene, an indolizine, a pyrimidine, a triazine, a furan, a tetrahydrofuran, a dihydrofuran, or mixtures thereof.

2. The lubricating composition of Claim 1, wherein R_1 is an optionally-substituted hydrocarbyl group containing 4 to 30 carbon atoms, or a heterocycle or substituted equivalents thereof; and/or R_2 is a hydrocarbyl group containing 4 to 30 carbon atoms, or a heterocycle or substituted equivalents thereof; and/or R_4 is a hydrocarbyl group containing 4 to 30 carbon atoms, or a heterocycle or substituted equivalents thereof; and/or R_5 is a hydrocarbyl group containing 1 to 20 carbon atoms.

3. The lubricating composition of Claim 1, wherein R_1 is an optionally-substituted hydrocarbyl group containing 6 to 20 carbon atoms, or a heterocycle or substituted equivalents thereof; and/or R_2 is a hydrocarbyl group containing 6 to 20 carbon atoms, or a heterocycle or substituted equivalents thereof; and/or R_4 is a hydrocarbyl group containing 6 to 20 carbon atoms, or a heterocycle or substituted equivalents thereof; and/or R_5 is a hydrocarbyl group containing 1 to 10 carbon atoms.

4. The lubricating composition of Claim 1, wherein R_5 is a hydrocarbyl group containing 1 to 5 carbon atoms.

5. The lubricating composition of Claim 1, wherein Y is >O or >S.

6. The lubricating composition of Claim 1, wherein R_3 is a hydrocarbylene group containing 1 to 16 carbon atoms.

7. The lubricating composition of Claim 1, wherein R_3 is a hydrocarbylene group containing 6 carbon atoms.

8. The lubricating composition of Claim 1, wherein the ashless thiocarbamate compound having an optionally-substituted hydrocarbyl group on an S-atom and an optionally-substituted hydrocarbyl group on an N-atom comprises one or more linear hydrocarbyl groups.

9. The lubricating composition of any one of Claims 1 to 8, wherein the ashless thiocarbamate compound having an optionally-substituted hydrocarbyl group on an S-atom and an optionally-substituted hydrocarbyl group on an N-atom comprises one linear hydrocarbyl group and one branched hydrocarbyl group.

10. The lubricating composition of any one of Claims 1 to 9, wherein the ashless thiocarbamate compound having an optionally-substituted hydrocarbyl group on an S-atom and an optionally-substituted hydrocarbyl group on an N-atom comprises one or more cyclic hydrocarbyl groups.

11. The lubricating composition of any one of Claims 1 to 9, wherein the ashless thiocarbamate compound having an optionally-substituted hydrocarbyl group on an S-atom and an optionally-substituted hydrocarbyl group on an N-atom comprises one cyclic hydrocarbyl group and one linear hydrocarbyl group.

12. The lubricating composition of any one of Claims 1 to 9 and 11, wherein the ashless thiocarbamate compound having an optionally-substituted hydrocarbyl group on an S-atom and an optionally-substituted hydrocarbyl group on an N-atom comprises one heterocyclic hydrocarbyl group and one linear hydrocarbyl group.

13. The lubricating composition of any one of Claims 1 to 12, wherein the ashless thiocarbamate compound having an optionally-substituted hydrocarbyl group on an S-atom and an optionally-substituted hydrocarbyl group on an N-atom is halogen free.

14. The lubricating composition of any one of Claims 1 to 13, wherein the ashless thiocarbamate compound having an optionally-substituted hydrocarbyl group on an S-atom and an optionally-substituted hydrocarbyl group on an N-atom is present at 0.05 wt % to 2.5 wt %.

15. The lubricating composition of any one of Claims 1 to 13, wherein the ashless thiocarbamate compound having an optionally-substituted hydrocarbyl group on an S-atom and an optionally-substituted hydrocarbyl group on an N-atom is present at 0.1 wt % to 2 wt %.

16. The lubricating composition of any one of Claims 1 to 13, wherein the ashless thiocarbamate compound having an optionally-substituted hydrocarbyl group on an S-atom and an optionally-substituted hydrocarbyl group on an N-atom is present at 0.25 wt % to 1.5 wt %.

17. The lubricating composition of any one of Claims 1 to 13, wherein the ashless thiocarbamate compound having an optionally-substituted hydrocarbyl group on an S-atom and an optionally-substituted hydrocarbyl group on an N-atom is present at 0.5 wt % to 1 wt %.

18. The lubricating composition of any one of Claims 1 to 17, wherein the ashless thiocarbamate compound having an optionally-substituted hydrocarbyl group on an S-atom and an optionally-substituted hydrocarbyl group on an N-atom is present at 0.25 wt % to 1 wt % of the lubricating composition.

19. The lubricating composition of any one of Claims 1 to 18, wherein the lubricating composition is characterised as having (i) a sulphur content of 0.5 wt % or less, (ii) a phosphorus content of 0.1 wt % or less, and (iii) a sulphated ash content of 0.5 wt % to 1.5 wt % or less.

20. The lubricating composition of any one of Claims 1 to 19, wherein the composition is free of fatty esters having a carbon chain of 10 to 22 carbon atoms.

21. The lubricating composition of Claim 20, wherein the composition is free of glycerol monooleate.

22. The lubricating composition of any one of Claims 1 to 21, further comprising a phosphorus-containing antiwear agent.

23. The lubricating composition of Claim 22, further comprising zinc dialkyldithiophosphate.

24. The lubricating composition of any one of Claims 1 to 23, further comprising a molybdenum compound selected from the group consisting of molybdenum

dialkyldithiophosphates, molybdenum dithiocarbamates, amine salts of molybdenum compounds, and mixtures thereof.

25. The lubricating composition of any one of Claims 1 to 24, further comprising an overbased detergent, wherein the overbased detergent is present at 1 wt % to 10 wt %.

26. The lubricating composition of Claim 25, wherein the overbased detergent is present at 3 wt % to 8 wt %.

27. The lubricating composition of Claim 25 or Claim 26, wherein the overbased detergent is selected from the group consisting of phenates, sulphur containing phenates, sulphonates, salixarates, salicylates, and mixtures thereof.

28. The lubricating composition of any one of Claims 1 to 27, further comprising a succinimide dispersant, wherein the succinimide dispersant is present at 2.5 wt % to 6 wt %.

29. The lubricating composition of any one of Claims 1 to 28, wherein the lubricating composition has a TBN in the range of 3 to 15 mg KOH/g.

30. The lubricating composition of Claim 29, wherein the lubricating composition has a TBN in the range of 4 to 12 mg KOH/g.

31. The lubricating composition of Claim 30, wherein the lubricating composition has a TBN in the range of 6 to 10 mg KOH/g.

32. A method of lubricating an internal combustion engine comprising supplying to the internal combustion engine a lubricating composition of any one of Claims 1 to 31.

33. The method of Claim 32, wherein the internal combustion engine is lubricated with a lubricating composition of any one of Claims 1 to 31, and wherein the engine has a steel surface on a cylinder bore, a cylinder block, or a piston ring.

34. The method of Claim 33, wherein the internal combustion engine is a heavy duty diesel internal combustion engine.

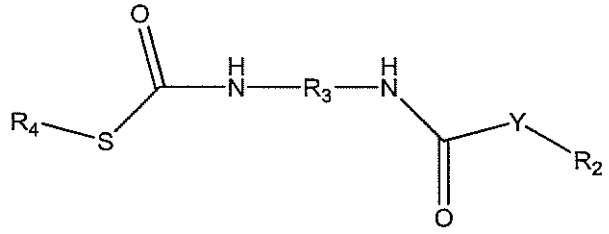
35. An ashless thiocarbamate compound having an optionally-substituted hydrocarbyl group on an S-atom and an optionally-substituted hydrocarbyl group on an N-atom of any one of Claims 1 to 31 for use in reducing lead corrosion in an internal combustion engine.

36. The ashless thiocarbamate compound of Claim 35 wherein the internal combustion engine is a heavy duty diesel internal combustion engine.

R_2 is a hydrocarbyl group containing 2 to 60, or 4 to 30, or 6 to 20 carbon atoms, or a heterocycle or substituted equivalents thereof, with the proviso that R_2 is free of a nitrogen-containing heterocycle,

or

wherein the ashless thiocarbamate compound having an optionally-substituted hydrocarbyl group on an S-atom and an optionally-substituted hydrocarbyl group on an N-atom is represented by the formula (4):



formula (4)

wherein

Y is >O, or >S, or > NH or $>NR_5$;

R_2 is a hydrocarbyl group containing 2 to 60, or 4 to 30, or 6 to 20 carbon atoms, or a heterocycle or substituted equivalents thereof, with the proviso that R_2 is free of a nitrogen-containing heterocycle;

R_3 is a hydrocarbylene group, or a heterocycle or substituted equivalents thereof;

R_4 is a hydrocarbyl group containing 2 to 60, or 4 to 30, or 6 to 20 carbon atoms, or a heterocycle or substituted equivalents thereof;

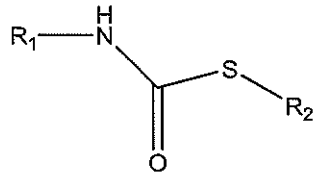
R_5 is a hydrocarbyl group containing 1 to 30, or 1 to 20, or 1 to 10, or 1 to 5 carbon atoms; and a pyridine, a 1,2,4-triazole, a benzotriazole, a tetrahydrofuran, or mixtures thereof.

[0024] As used herein the expression "optionally-substituted hydrocarbyl" is intended to include hydrocarbyl groups that have substituents that are more polar than a hydrocarbon group. Examples of polar groups include esters, heterocycles, amides, imides, phosphates, sulphonates, sulphates, nitrates, nitriles, or ethers. The optionally-substituted hydrocarbylene group is defined substantially

The Claims defining the invention are as follows:

1. A lubricating composition comprising an oil of lubricating viscosity and 0.01 wt % to 5 wt % of an ashless thiocarbamate compound having a hydrocarbyl group having substituents that are more polar than a hydrocarbon group on an S-atom and a hydrocarbyl group having substituents that are more polar than a hydrocarbon group on an N-atom,

wherein the ashless thiocarbamate compound having a hydrocarbyl group having substituents that are more polar than a hydrocarbon group on an S-atom and a hydrocarbyl group having substituents that are more polar than a hydrocarbon group on an N-atom is represented by the formula (2):

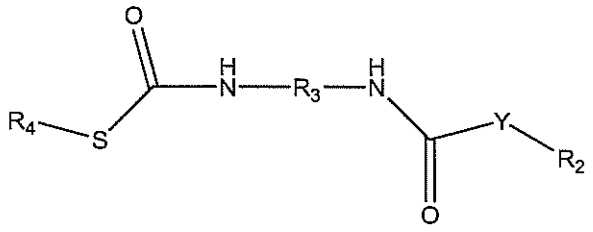


formula (2)

wherein R_1 is an a hydrocarbyl group having substituents that are more polar than a hydrocarbon group containing 2 to 60 carbon atoms, or a heterocycle or substituted equivalents thereof; and

R_2 is a hydrocarbyl group containing 2 to 60 carbon atoms, or a heterocycle or substituted equivalents thereof, with the proviso that R_2 is free of a nitrogen-containing heterocycle, or

wherein the ashless thiocarbamate compound having an a hydrocarbyl group having substituents that are more polar than a hydrocarbon group on an S-atom and an a hydrocarbyl group having substituents that are more polar than a hydrocarbon group on an N-atom is represented by the formula (4):



formula (4)

wherein

Y is >O, or >S, or > NH or >NR_5;

R_2 is a hydrocarbyl group containing 2 to 60 carbon atoms, or a heterocycle or substituted equivalents thereof, with the proviso that R_2 is free of a nitrogen-containing heterocycle;

R_3 is a hydrocarbylene group, or a heterocycle or substituted equivalents thereof;

R_4 is a hydrocarbyl group containing 2 to 60 carbon atoms, or a heterocycle or substituted equivalents thereof;

R_5 is a hydrocarbyl group containing 1 to 30 carbon atoms; and the heterocycle is a pyridine, a 1,2,4-triazole, a benzotriazole, a tetrahydrofuran, or mixtures thereof.

2. The lubricating composition of Claim 1, wherein R_1 is an a hydrocarbyl group having substituents that are more polar than a hydrocarbon group containing 4 to 30 carbon atoms, or a heterocycle or substituted equivalents thereof; and/or R_2 is a hydrocarbyl group containing 4 to 30 carbon atoms, or a heterocycle or substituted equivalents thereof; and/or R_4 is a hydrocarbyl group containing 4 to 30 carbon atoms, or a heterocycle or substituted equivalents thereof; and/or R_5 is a hydrocarbyl group containing 1 to 20 carbon atoms.

3. The lubricating composition of Claim 1, wherein R_1 is an a hydrocarbyl group having substituents that are more polar than a hydrocarbon group containing 6 to 20 carbon atoms, or a heterocycle or substituted equivalents thereof; and/or R_2 is a hydrocarbyl group containing 6 to 20 carbon atoms, or a heterocycle or substituted equivalents thereof; and/or R_4 is a hydrocarbyl group containing 6 to 20 carbon atoms, or a heterocycle or substituted equivalents thereof; and/or R_5 is a hydrocarbyl group containing 1 to 10 carbon atoms.

4. The lubricating composition of any one of Claims 1 to 3, wherein R_5 is a hydrocarbyl group containing 1 to 5 carbon atoms.

5. The lubricating composition of any one of Claims 1 to 4, wherein Y is >O or >S.

6. The lubricating composition of any one of Claims 1 to 5, wherein R_3 is a hydrocarbylene group containing 1 to 16 carbon atoms.

7. The lubricating composition of any one of Claims 1 to 6, wherein R_3 is a hydrocarbylene group containing 6 carbon atoms.

8. The lubricating composition of any one of Claims 1 to 7, wherein the ashless thiocarbamate compound having an a hydrocarbyl group having substituents that are more polar than a hydrocarbon group on an S-atom and an a hydrocarbyl group having substituents that are more polar than a hydrocarbon group on an N-atom comprises one or more linear hydrocarbyl groups.

9. The lubricating composition of any one of Claims 1 to 7, wherein the ashless thiocarbamate compound having an a hydrocarbyl group having substituents that are more polar than a hydrocarbon group on an S-atom and an a hydrocarbyl group having substituents that are more polar than a hydrocarbon group on an N-atom comprises one linear hydrocarbyl group and one branched hydrocarbyl group.

10. The lubricating composition of any one of Claims 1 to 7, wherein the ashless thiocarbamate compound having an a hydrocarbyl group having substituents that are more polar than a hydrocarbon group on an S-atom and an a hydrocarbyl group having substituents that are more polar than a hydrocarbon group on an N-atom comprises one or more cyclic hydrocarbyl groups.

11. The lubricating composition of any one of Claims 1 to 7, wherein the ashless thiocarbamate compound having an a hydrocarbyl group having substituents that are more polar than a hydrocarbon group on an S-atom and an a hydrocarbyl group having substituents that are more polar than a hydrocarbon group on an N-atom comprises one cyclic hydrocarbyl group and one linear hydrocarbyl group.

12. The lubricating composition of any one of Claims 1 to 7, wherein the ashless thiocarbamate compound having an a hydrocarbyl group having substituents that are

more polar than a hydrocarbon group on an S-atom and an a hydrocarbyl group having substituents that are more polar than a hydrocarbon group on an N-atom comprises one heterocyclic hydrocarbyl group and one linear hydrocarbyl group.

13. The lubricating composition of any one of Claims 1 to 12, wherein the ashless thiocarbamate compound having an a hydrocarbyl group having substituents that are more polar than a hydrocarbon group on an S-atom and an a hydrocarbyl group having substituents that are more polar than a hydrocarbon group on an N-atom is halogen free.

14. The lubricating composition of any one of Claims 1 to 13, wherein the ashless thiocarbamate compound having an a hydrocarbyl group having substituents that are more polar than a hydrocarbon group on an S-atom and an a hydrocarbyl group having substituents that are more polar than a hydrocarbon group on an N-atom is present at 0.05 wt % to 2.5 wt %.

15. The lubricating composition of any one of Claims 1 to 14, wherein the ashless thiocarbamate compound having an a hydrocarbyl group having substituents that are more polar than a hydrocarbon group on an S-atom and an a hydrocarbyl group having substituents that are more polar than a hydrocarbon group on an N-atom is present at 0.1 wt % to 2 wt %.

16. The lubricating composition of any one of Claims 1 to 15, wherein the ashless thiocarbamate compound having an a hydrocarbyl group having substituents that are more polar than a hydrocarbon group on an S-atom and an a hydrocarbyl group having substituents that are more polar than a hydrocarbon group on an N-atom is present at 0.25 wt % to 1.5 wt %.

17. The lubricating composition of any one of Claims 1 to 16, wherein the ashless thiocarbamate compound having an a hydrocarbyl group having substituents that are more polar than a hydrocarbon group on an S-atom and an a hydrocarbyl group having substituents that are more polar than a hydrocarbon group on an N-atom is present at 0.5 wt % to 1 wt %.

18. The lubricating composition of any one of Claims 1 to 16, wherein the ashless thiocarbamate compound having an a hydrocarbyl group having substituents that are

more polar than a hydrocarbon group on an S-atom and an a hydrocarbyl group having substituents that are more polar than a hydrocarbon group on an N-atom is present at 0.25 wt % to 1 wt % of the lubricating composition.

19. The lubricating composition of any one of Claims 1 to 18, wherein the lubricating composition is characterised as having (i) a sulphur content of 0.5 wt % or less, (ii) a phosphorus content of 0.1 wt % or less, and (iii) a sulphated ash content of 0.5 wt % to 1.5 wt % or less.

20. The lubricating composition of any one of Claims 1 to 19, wherein the composition is free of fatty esters having a carbon chain of 10 to 22 carbon atoms.

21. The lubricating composition of Claim 20, wherein the composition is free of glycerol monooleate.

22. The lubricating composition of any one of Claims 1 to 21, further comprising a phosphorus-containing antiwear agent.

23. The lubricating composition of Claim 22, further comprising zinc dialkyldithiophosphate.

24. The lubricating composition of any one of Claims 1 to 23, further comprising a molybdenum compound selected from the group consisting of molybdenum dialkyldithiophosphates, molybdenum dithiocarbamates, amine salts of molybdenum compounds, and mixtures thereof.

25. The lubricating composition of any one of Claims 1 to 24, further comprising an overbased detergent, wherein the overbased detergent is present at 1 wt % to 10 wt %.

26. The lubricating composition of Claim 25, wherein the overbased detergent is present at 3 wt % to 8 wt %.

27. The lubricating composition of Claim 25 or Claim 26, wherein the overbased detergent is selected from the group consisting of phenates, sulphur containing phenates, sulphonates, salixarates, salicylates, and mixtures thereof.

28. The lubricating composition of any one of Claims 1 to 27, further comprising a succinimide dispersant, wherein the succinimide dispersant is present at 2.5 wt % to 6 wt %.

29. The lubricating composition of any one of Claims 1 to 28, wherein the lubricating composition has a TBN in the range of 3 to 15 mg KOH/g.

30. The lubricating composition of Claim 29, wherein the lubricating composition has a TBN in the range of 4 to 12 mg KOH/g.

31. The lubricating composition of Claim 30, wherein the lubricating composition has a TBN in the range of 6 to 10 mg KOH/g.

32. A method of lubricating an internal combustion engine comprising supplying to the internal combustion engine a lubricating composition of any one of Claims 1 to 31.

33. The method of Claim 32, wherein the internal combustion engine is lubricated with a lubricating composition of any one of Claims 1 to 31, and wherein the engine has a steel surface on a cylinder bore, a cylinder block, or a piston ring.

34. The method of Claim 33, wherein the internal combustion engine is a heavy duty diesel internal combustion engine.

35. An ashless thiocarbamate compound having an a hydrocarbyl group having substituents that are more polar than a hydrocarbon group on an S-atom and an a hydrocarbyl group having substituents that are more polar than a hydrocarbon group on an N-atom of any one of Claims 1 to 31 for use in reducing lead corrosion in an internal combustion engine.

36. The ashless thiocarbamate compound of Claim 35 wherein the internal combustion engine is a heavy duty diesel internal combustion engine.