to provide an increase in antiwear properties of the lubricant composition greater than an increase in antiwear properties of the lubricant composition devoid of the hydrocarbon soluble titanium compound, wherein the compound is essentially devoid of sulfur and phosphorus atoms. The '418 application further discloses that the hydrocarbon soluble titanium compound is a reaction product of a titanium alkoxide and an about C_6 to about C_{25} carboxylic acid. All of the examples disclosed in the '418 application disclose a hydrocarbon soluble titanium compound in combination with a zinc dithiophosphate.

[0009] Therefore, as demand for further decrease of the phosphorus content and a limit on the sulfur content of lubricating oils is very high, this reduction cannot be satisfied by the present measures in practice and still meet the severe antiwear and oxidation-corrosion inhibiting properties required of today's engine oils. Accordingly, it would be desirable to develop lubricating oil compositions having relatively low levels or free of any phosphorus content while also having relatively low levels of sulfur and sulfated ash but which still provide the needed wear protection now provided by lubricating oils containing a zinc dialkyldithiophosphate. It would also be desirable to develop lubricating oil compositions which are free of any zinc dialkyldithiophosphate.

SUMMARY OF THE DISCLOSURE~~INVENTION~~

[0010] In accordance with one embodiment of the present disclosure~~invention~~, a lubricating oil composition is provided which comprises (a) a major amount of an oil of lubricating viscosity; (b) one or more non-halogen-containing oil-soluble titanium complexes comprising at least one ligand comprising an anion of a carboxylic acid; (c) one or more dispersants; and (d) one or more detergents, wherein the lubricating oil composition is free of any zinc dialkyldithiophosphate.

[0011] In accordance with a second embodiment of the present disclosure~~invention~~, a method of reducing wear of metal parts in an internal combustion engine is provided comprising operating the engine with a lubricating oil composition comprising (a) a major amount of an oil of lubricating viscosity; (b) one or more non-halogen-containing oil-soluble titanium complexes comprising at least one ligand comprising an anion of a carboxylic acid; (c) one or more dispersants; and (d) one or more detergents, wherein the lubricating oil composition is free of any zinc dialkyldithiophosphate.

[0012] In accordance with a third embodiment of the present disclosure~~invention~~, there is provided an internal combustion engine lubricated with a lubricating oil composition comprising (a) a major amount of an oil of lubricating viscosity; (b) one or more non-

halogen-containing oil-soluble titanium complexes comprising at least one ligand comprising an anion of a carboxylic acid; (c) one or more dispersants; and (d) one or more detergents, wherein the lubricating oil composition is free of any zinc dialkyldithiophosphate.

[0013] By employing the one or more non-halogen-containing oil-soluble titanium complexes comprising at least one ligand comprising an anion of a carboxylic acid disclosed herein in a lubricating oil composition of the present disclosure~~invention~~ in the absence of any zinc dialkyldithiophosphate, it has unexpectedly been discovered that the lubricating oil composition advantageously possesses improved or relatively comparable wear reducing properties as compared to a corresponding lubricating oil composition in which the non-halogen-containing oil-soluble titanium complexes comprising at least one ligand comprising an anion of a monocarboxylic acid disclosed herein in the lubricating oil composition is replaced with a zinc dialkyl dithiophosphate compound or a different titanium complex. In addition, the wear reducing properties can be achieved with the lubricating oil compositions of the present disclosure~~invention~~ while also employing relatively low levels or free of any phosphorus content as well as relatively low levels of sulfur and sulfated ash.

[0013a] In one aspect, there is provided a lubricating oil composition comprising (a) a major amount of an oil of lubricating viscosity; (b) 1600 ppm to 3000 ppm as titanium metal, based on the total weight of the lubricating oil composition, of one or more non-halogen-containing oil-soluble titanium complexes comprising at least one ligand comprising an anion of a carboxylic acid; (c) one or more dispersants; and (d) at least two metal-containing detergents including a first metal-containing detergent concentrate which is an overbased alkaline earth metal sulfonate or phenate detergent concentrate or mixture thereof having an BN of 100 to 450 and a second metal-containing detergent concentrate which is an overbased alkaline earth metal sulfonate or phenate detergent concentrate or mixture thereof having a BN of 10 to 50, wherein the lubricating oil composition is free of any zinc dialkyldithiophosphate; and has a sulfated ash content of no more than 1.0 wt. % as determined by ASTM D874; and a phosphorus content less than 0.01 wt. %.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0014] Definitions

[0015] The term "Total Base Number" or "TBN" refers to the equivalent number of milligrams of KOH needed to neutralize 1 gram of a product. Therefore, a high TBN reflects strongly overbased products and, as a result, a higher base reserve for neutralizing acids. The TBN of a product can be determined by ASTM Standard No. D2896 or equivalent procedure.

Lubricants with higher TBN have a greater alkalinity reserve than low TBN lubricants, i.e., they can neutralize a greater quantity of acidic species.

[0016] All concentrations of materials disclosed in this application, unless otherwise specified, are on an "actives" basis; that is, the concentrations reported do not include, e.g., diluent or unreacted starting materials or intermediates.

[0017] The present invention is directed to a lubricating oil composition containing at least (a) a major amount of an oil of lubricating viscosity; (b) one or more non-halogen-containing oil-soluble titanium complexes comprising at least one ligand comprising an anion of a carboxylic acid; (c) one or more dispersants; and (d) one or more detergents, wherein the lubricating oil composition is free of any zinc dialkyldithiophosphate. In one embodiment, a lubricating oil composition of the present invention contains at least (a) a major amount of an oil of lubricating viscosity; (b) one or more non-halogen-containing oil-soluble titanium