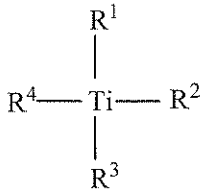
"OEMs") require passage of a number of performance tests, including a copper corrosion test.

**[0009]** Therefore, it would be desirable to develop lubricating oil compositions which exhibit improved copper corrosion performance.

## SUMMARY OF THE ~~INVENTION~~DISCLOSURE

**[0010]** In accordance with one embodiment of the present ~~invention~~disclosure, there is provided a method for improving copper corrosion performance of a lubricating oil composition comprising (a) a major amount of a base oil of lubricating viscosity; and (b) one or more dispersants containing one or more basic nitrogen atoms, the method comprising adding to the lubricating oil composition an effective amount of one or more copper corrosion performance improving agents comprising one or more oil-soluble titanium compounds.

**[0011]** In accordance with a second embodiment of the present ~~invention~~disclosure, there is provided a method for improving copper corrosion performance of a lubricating oil composition comprising (a) a major amount of a base oil of lubricating viscosity; and (b) one or more dispersants containing one or more basic nitrogen atoms, the method comprising adding to the lubricating oil composition an effective amount of one or more copper corrosion performance improving agents of the general formula:

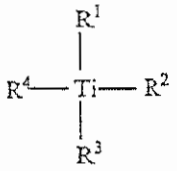


wherein $R^1$, $R^2$, $R^3$ and $R^4$ are independently a hydrocarbyloxy-containing group.

**[0012]** In accordance with a third embodiment of the present ~~invention~~disclosure, there is provided a method for improving copper corrosion performance of a lubricating oil composition in an internal combustion engine which comprises operating the engine with a lubricating oil composition comprising (a) a major amount of a base oil of lubricating viscosity; (b) one or more dispersants containing one or more basic nitrogen atoms; and (c) an effective amount of one or more copper corrosion performance improving agents comprising one or more oil-soluble titanium compounds

**[0013]** The method of the present ~~invention~~disclosure advantageously improves the copper corrosion performance of a lubricating oil composition comprising (a) a major amount of a base oil of lubricating viscosity; and (b) one or more dispersants containing one or more basic nitrogen atoms, by adding to the lubricating oil composition an effective amount of one or more copper corrosion performance improving agents comprising one or more oil-soluble titanium compounds.

**[0013a]** In one aspect, there is provided the use of one or more oil-soluble titanium compounds in a lubricating oil composition comprising (a) a major amount of a base oil of lubricating viscosity; and (b) one or more dispersants containing one or more basic nitrogen atoms, for improving copper corrosion performance of the lubricating oil composition in an internal combustion engine, wherein the one or more oil-soluble titanium compounds are used in an amount from 0.01 wt% to 5 wt% based on the total weight of the lubricating oil composition, and further wherein the one or more oil-soluble titanium compounds are represented by the general formula:



wherein $R^1$, $R^2$, $R^3$ and $R^4$ are independently a hydrocarbyloxy-containing group.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

**[0014]** The present invention is directed to a method for improving copper corrosion performance of a lubricating oil composition comprising (a) a major amount of a base oil of lubricating viscosity; and (b) one or more dispersants containing one or more basic nitrogen atoms. In general, the method involves at least adding to the lubricating oil composition an effective amount of one or more copper corrosion performance improving agents comprising one or more oil-soluble titanium compounds.

**[0015]** Generally, the one or more oil-soluble titanium compounds are represented by the general formula:

WHAT IS CLAIMED IS:

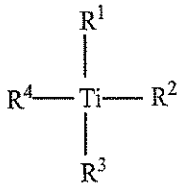
1. A method for improving copper corrosion performance of a lubricating oil composition comprising (a) a major amount of a base oil of lubricating viscosity, and (b) one or more dispersants containing one or more basic nitrogen atoms, the method comprising adding to the lubricating oil composition an effective amount of one or more copper corrosion performance improving agents comprising one or more oil-soluble titanium compounds.

2. The method according to Claim 1, wherein the base oil of lubricating viscosity is selected from the group consisting of a Group I base oil, Group II base oil, Group III base oil, Group IV base oil, Group V base oil, and mixtures thereof.

3. The method according to Claim 1 or Claim 2, wherein the one or more dispersants are selected from the group consisting of a succinimide, carboxylic acid amide, hydrocarbyl monoamine, hydrocarbyl polyamine, Mannich base, phosphonamide, thiophosphonamide and phosphoramide, thiazole, triazole, a copolymer which contain a carboxylate ester with one or more additional polar functions, a borate post-treated succinimide, an ethylene carbonate post-treated succinimide, and mixtures thereof.

4. The method according to Claims 1-3, wherein the one or more dispersants is an alkenyl succinimide.

5. The method according to Claims 1-4, wherein the one or more oil-soluble titanium compounds are represented by the general formula:



wherein $R^1$, $R^2$, $R^3$ and $R^4$ are independently a hydrocarbyloxy-containing group.

6. The method according to Claim 5, wherein each $R^1$, $R^2$, $R^3$ and $R^4$ is independently a $C_1$ to $C_{20}$ alkoxy group.

7. The method according to Claim 5, wherein at least two of $R^1$, $R^2$, $R^3$ and $R^4$ of the oil-soluble titanium compound are the same $C_1$ to $C_{20}$ alkoxy group.

8. The method according to Claim 5, wherein at least three of $R^1$, $R^2$, $R^3$ and $R^4$ of the oil-soluble titanium compound are the same $C_1$ to $C_{20}$ alkoxy group.

9. The method according to Claim 5, wherein each of $R^1$, $R^2$, $R^3$ and $R^4$ of the oil-soluble titanium compound is the same $C_1$ to $C_{20}$ alkoxy group.

10. The method according to Claims 1-9, wherein the lubricating oil composition comprises:

about 0.05 to about 15 wt. % of the one or more dispersants; and

about 0.01 to about 5 wt. % of the one or more copper corrosion performance improving agents, based on the total weight of the lubricating oil composition.

11. The method according to Claims 1-10, wherein the lubricating oil composition further comprises one or more lubricating oil additives selected from the group consisting of an antioxidant, detergent, rust inhibitor, dehazing agent, demulsifying agent, metal deactivating agent, friction modifier, antiwear agent, pour point depressant, antifoaming agent, co-solvent, package compatibiliser, corrosion-inhibitor, dye, extreme pressure agent, and mixtures thereof.

12. The method according to Claims 1-11, wherein the lubricating oil composition is a crankcase lubricating oil composition for an internal combustion engine.

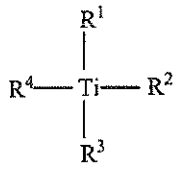
13. The method according to Claims 1-11, wherein the lubricating oil composition is a crankcase lubricating oil composition for a compression-ignited diesel engine.

14. The method according to Claims 1-11, wherein the lubricating oil composition is a crankcase lubricating oil composition for an internal combustion heavy duty diesel engine.

15. The use of one or more oil-soluble titanium compounds in a lubricating oil composition comprising (a) a major amount of a base oil of lubricating viscosity; and (b) one or more dispersants containing one or more basic nitrogen atoms, for the purpose of improving copper corrosion performance of the lubricating oil composition in an internal combustion engine.

WHAT IS CLAIMED IS:

1. The use of one or more oil-soluble titanium compounds in a lubricating oil composition comprising (a) a major amount of a base oil of lubricating viscosity; and (b) one or more dispersants containing one or more basic nitrogen atoms, for improving copper corrosion performance of the lubricating oil composition in an internal combustion engine, wherein the one or more oil-soluble titanium compounds are used in an amount from 0.01 wt% to 5 wt% based on the total weight of the lubricating oil composition, and further wherein the one or more oil-soluble titanium compounds are represented by the general formula:



wherein $R^1$, $R^2$, $R^3$ and $R^4$ are independently a hydrocarbyloxy-containing group.

2. The use according to Claim 1, wherein the base oil of lubricating viscosity is selected from the group consisting of a Group I base oil, Group II base oil, Group III base oil, Group IV base oil, Group V base oil, and mixtures thereof.

3. The use according to Claim 1 or Claim 2, wherein the one or more dispersants are selected from the group consisting of a succinimide, carboxylic acid amide, hydrocarbyl monoamine, hydrocarbyl polyamine, Mannich base, phosphonamide, thiophosphonamide and phosphoramide, thiazole, triazole, a copolymer which contain a carboxylate ester with one or more additional polar functions, a borate post-treated succinimide, an ethylene carbonate post-treated succinimide, and mixtures thereof.

4. The use according to Claims 1-3, wherein the one or more dispersants is an alkenyl succinimide.

5. The use according to Claim 1, wherein each $R^1$, $R^2$, $R^3$ and $R^4$ is independently a $C_1$ to $C_{20}$ alkoxy group.

6. The use according to Claim 1, wherein at least two of $R^1$, $R^2$, $R^3$ and $R^4$ of the oil-soluble titanium compound are the same $C_1$ to $C_{20}$ alkoxy group.

7. The use according to Claim 1, wherein at least three of $R^1$, $R^2$, $R^3$ and $R^4$ of the oil-soluble titanium compound are the same $C_1$ to $C_{20}$ alkoxy group.

8. The use according to Claim 1, wherein each of $R^1$, $R^2$, $R^3$ and $R^4$ of the oil-soluble titanium compound is the same $C_1$ to $C_{20}$ alkoxy group.

9. The use according to Claims 1-8, wherein the lubricating oil composition comprises 0.05 to 15 wt. % of the one or more dispersants, based on the total weight of the lubricating oil composition.

10. The use according to Claims 1-9, wherein the lubricating oil composition further comprises one or more lubricating oil additives selected from the group consisting of an antioxidant, detergent, rust inhibitor, dehazing agent, demulsifying agent, metal deactivating agent, friction modifier, antiwear agent, pour point depressant, antifoaming

agent, co-solvent, package compatibiliser, corrosion-inhibitor, dye, extreme pressure agent, and mixtures thereof.

11. The use according to Claims 1-9, wherein the internal combustion engine is a compression-ignited diesel engine.

12. The use according to Claims 1-9, wherein the internal combustion engine is an internal combustion heavy duty diesel engine.