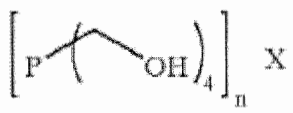
CLAIMS

1. A method for reducing a trace element of a heavy metal in a crude oil, comprising:

a) mixing the crude oil containing the heavy metal with a composition comprising a compound of Formula (I) in an aqueous solvent for a sufficient amount of time for the compound to form a water soluble heavy metal complex in an oil-water emulsion;



(I)

wherein X is an anion of valency n;

b) separating the oil-water emulsion in a phase separation device to obtain a water phase containing the water soluble heavy metal complex ~~from the crude oil in a phase separation device for the~~ and a crude oil ~~to have~~ having a reduced concentration of ~~the heavy metal~~mercury; wherein the heavy metal is selected from the group of lead, arsenic, zinc, and mercury.

2. The method of claim 1, wherein X is selected from the group consisting of chloride, bromide, iodide, lower alkyl carboxylates, bisulfite, bisulfate, hydrocarbyl sulfonates, dihydrogenphosphate, nitrate, hexafluorophosphate, sulfate, sulfite, monohydrogenphosphate, and phosphate.

3. The method of any of claims 1-2, wherein the compound of Formula (I) is selected from tetrakis(hydroxymethyl)phosphonium sulfate and tetrakis(hydroxymethyl)phosphonium chloride.

4. The method of any of claims 1-2, wherein the compound of Formula (I) is tetrakis(hydroxymethyl)phosphonium sulfate.

5. The method of any of claims 1-2, wherein the compound of Formula (I) is tetrakis(hydroxymethyl)phosphonium chloride.

~~6. The method of any of claims 1-2, wherein the heavy metal is selected from the group of lead, arsenic, zinc, and mercury.~~

~~7~~6. The method of any of claims 1-2, wherein the heavy metal is mercury.

~~8~~7. The method of any of claims 1-2, wherein the molar ratio of the compound having Formula (I) to the trace element of a heavy metal in the crude oil is in the range of 1:1 to 50:1.

~~9~~8. The method of claim ~~8~~7, wherein the molar ratio is in the range of 1.5:1 to 10:1.

~~10~~9. The method of claim ~~9~~8, wherein the molar ratio is in the range of 2:1 to 5:1.

~~11~~10. A method for reducing a trace element of mercury in a crude oil, comprising:

a) mixing the crude oil containing mercury with a composition comprising an amine or ammonium derivative with tetrakis(hydroxymethyl)phosphonium sulfate for a sufficient amount of time to form a mercury complex in an oil-water emulsion;

b) separating the water containing the mercury complex from the crude oil in a phase separation device for the crude oil to have a reduced concentration of mercury.

~~12~~11. A method for reducing a trace element of mercury in a crude oil, comprising:

a) mixing the crude oil containing mercury with a composition comprising an amine or ammonium derivative with tetrakis(hydroxymethyl)phosphonium chloride for a sufficient amount of time to form a mercury complex in an oil-water emulsion;

b) separating the water containing the mercury complex from the crude oil in a phase separation device for the crude oil to have a reduced concentration of mercury.

~~13~~12. The method of any of claims 1-2, and ~~11~~10- ~~12~~11, wherein the reduced concentration is less than 100 ppb in mercury.

~~14~~13. The method of any of claims ~~13~~12, wherein the reduced concentration is less than 50 ppb in mercury.

~~15~~14. The method of any of claims 1-2, and ~~11~~10- ~~12~~11, wherein the composition further comprises an amine or ammonium derivative.

~~16~~15. The method of claim ~~15~~14, wherein the amine or ammonium derivative is selected from the group consisting of alkylamines and their conjugate acids thereof.

~~17~~16. The method of claim ~~16~~15, wherein the alkylamine and conjugate acids thereof is selected from the group consisting of methylamine, ethylamine, propylamine, isopropylamine, butylamine, tertbutylamine, and conjugate acids thereof.