Process, Method, and System for Removing Heavy Metals from Fluids

CROSS-REFERENCE TO RELATED APPLICATIONS

[001] This application claims benefit under 35 USC 119 of US Patent Application Serial No. 12/883,921, with a filing date of September 16, 2010. This application claims priority to and benefits from the foregoing, the disclosures of which are incorporated herein by reference.

TECHNICAL FIELD

[002] The invention relates generally to a process, method, and system for removing heavy metals such as mercury and the like from hydrocarbon fluids such as crude oil.

BACKGROUND

[003] Heavy metals such as lead, zinc, mercury, silver, arsenic and the like can be present in trace amounts in all types of fuels such as crude oils. The amount can range from below the analytical detection limit (0.5 μg/kg) to several thousand ppb depending on the feed source. It is desirable to remove the trace elements of these metals from crude oils.

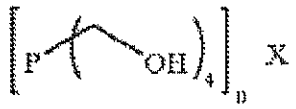
[004] Various methods for removing trace metal contaminants in liquid hydrocarbon feed prior to fractional distillation have been developed. U.S. Pat. No. 6,350,372 B1 discloses utilizing a solubilized sulfur compound in combination with an absorbent carrier. U.S. Pat. No. 4,474,896 claims the use of absorbent compositions, mainly polysulfide based, for removal of elemental mercury from gaseous and liquid hydrocarbon streams. The use of absorbent includes a number of less than desirable attributes. Absorbent beds tend to get clogged by solid particulates in the crude, thus impeding the flow of the feed. Absorbents can also be very costly due to the large quantity needed. In U.S. Pat. No. 4,915,818, removal of mercury from liquid hydrocarbon condensate is disclosed. In this method, the liquid hydrocarbons are treated with a dilute aqueous solution of alkali metal sulfide salt.

[005] There is still a need for improved methods for trace elements extraction from hydrocarbons.

SUMMARY OF THE DISCLOSUREINVENTION

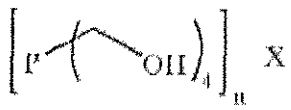
[006] In one embodiment, the disclosureinvention relates to a method to reduce or remove trace elements such as mercury from a crude oil, comprising mixing the crude oil having a first concentration of the trace element with a composition comprising a compound of

Formula (I) in an aqueous solvent for a sufficient amount of time to form an oil-water emulsion with the water containing a complex formed by the compound of Formula (I) chemically reacting with the trace elements



[007] (I).

[007a] In one embodiment, there is provided 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 and a crude oil having a reduced concentration of the heavy metal; wherein the heavy metal is selected from the group of lead, arsenic, zinc, and mercury.

[008] The water containing the heavy metal complex is separated from the crude oil in a phase separation device, for a crude oil having reduced concentration of the trace element.

[009] In yet another embodiment, the composition further includes a complexing additive selected from the group of amine or ammonium derivatives.

[009a] In one embodiment, there is provided 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.

[009b] In one embodiment, there is provided 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.

BRIEF DESCRIPTION OF THE DRAWINGS

[010] Figure 1 is a graph correlating the mercury concentrations in oil and water at different THPS concentrations at different periods for Example 4.

[011] Figure 2 correlates the mercury concentrations in oil and water at different THPCl concentrations at different periods for Example 5.

DETAILED DESCRIPTION

[012] The following terms will be used throughout the specification and will have the following meanings unless otherwise indicated.

[013] "Crude oil" refers to natural and synthetic liquid hydrocarbon products including but not limited to petroleum products, intermediate petroleum streams such as residue, naphtha, cracked stock; refined petroleum products including gasoline, other fuels, and solvents. The liquid hydrocarbon products can be directly from oil wells or after the products have been further processed or derived. The term "petroleum products" refer to crude oil, solid, and semi-solid hydrocarbon products including but not limited to tar sand, bitumen, etc. The term "petroleum products" also refer to petroleum products derived from coal.

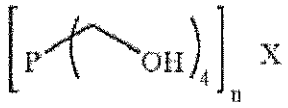
[014] "Trace element" refers to the heavy metals such as mercury, lead, zinc, silver, etc. to be removed from the crude oil or for the concentration to be significantly reduced.

[015] Mercury sulfide may be used interchangeably with HgS, referring to mercurous sulfide, mercuric sulfide, or mixtures thereof. Normally, mercury sulfide is

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 and a crude oil having a reduced concentration of the heavy metal ~~of 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 mercury.