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METHOD OF INHIBITING CORROSION

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ABSTRACT OF THE DISCLOSURE

An improved corrosion inhibitor, and its use in an effective amount, for protecting ferrous metal exposed to hydrocarbons containing hydrogen sulfide and water, said inhibitor consisting essentially of a mixture of an alkyl monoamine of 1 to 10 carbon atoms, for example isopropylamine, and a substantially neutral salt of an alkyl monoamine of 2 to 18 carbon atoms, for example, 2-ethylhexylamine, and a mixed mono- and dialkyl ester of orthophosphoric acid wherein said alkyl groups contain 4 to 18 carbon atoms, for example, mixed mono- and di-oxotridecyl phosphate.

Severe corrosion problems are encountered in ferrous metal equipment used in the processing of hydrocarbon compositions containing hydrogen sulfide and water as minor components. Particularly severe corrosion occurs in fractionation and stripping equipment which comes in contact with hydrocarbon vapors containing hydrogen sulfide and water during the distillation of petroleum products. The overhead vapor line and condensing portions of the distillation equipment are especially vulnerable to corrosive attack. Such corrosion problems may be encountered, for example, in equipment associated with the processing of crude oil as well as hydrotreated petroleum fractions such as dehydrosulfurized and hydrocracked fractions. Moreover, corrosion problems are also encountered in ferrous metal equipment such as pipelines used in the gathering, distribution and refining of gaseous hydrocarbon mixtures such as natural gas or gaseous-liquid hydrocarbon mixtures such as those obtained as oil well gases. In addition, equipment such as that used for transferring low boiling hydrocarbons such as propane and butane during underground storage is also subject to corrosion. All of these hydrocarbon compositions can contain hydrogen sulfide and water.

Heretofore, amines, amine salts of phosphate esters, carboxylic acids and amine salts of carboxylic acids have been used to prevent corrosion caused by petroleum oils. However, the corrosion encountered in the handling of hydrocarbon compositions containing hydrogen sulfide and water differs from the normal type of corrosion in that it is caused by a vapor or gas phase containing a particular combination of corrosive contaminants. It is believed that the hydrogen sulfide content of these vapors acts upon the ferrous metal surface of the equipment to form an iron sulfide coating which normally affords a certain amount of protection to the metal. However, when water vapor is also present, iron oxides form on the surface which react with the iron sulfide to form the highly undesirable ferrous sulfate. Experience has shown that commercially available basic amine, phosphate-amine salt, carboxylic acid and carboxylic acid-amine salt type corrosion inhibitors are, at best, only partially effective in controlling this particular type of corrosion.

It is an object of this invention to provide a method of inhibiting corrosion in ferrous metal equipment used to handle hydrocarbon compositions containing hydrogen sulfide and water. Another object is to provide a corrosion inhibitor for the protection of ferrous metal equipment exposed to hydrocarbon compositions containing hydrogen sulfide and water. These and other objects will become apparent from the following description of this invention.

It has now been found that corrosion of ferrous metal equipment used to handle hydrocarbon compositions containing hydrogen sulfide and water can be inhibited by adding to the hydrocarbon composition an effective amount of corrosion inhibitor containing (a) a substantially neutral amine salt of a mixed monoalkyl and dialkyl ester of orthophosphoric acid in which each alkyl group has 4 to 18 carbon atoms and the amine is alkyl monoamine having 2 to 18 carbon atoms, and (b) 0.5 to 5 moles per mole of amine salt, of alkyl monoamine having 1 to 10 carbon atoms.

By using the corrosion inhibitors disclosed herein, corrosion of ferrous metal equipment handling hydrocarbon compositions containing hydrogen sulfide and water is practically eliminated. While not intending to be limited to any particular theory, it is believed that the free amine promotes reaction of the ferrous metal surface with hydrogen sulfide to form a protective FeS–FeS_2 film. The amine phosphate salt then protects the FeS–FeS_2 film by preventing the formation of oxides of iron which can destroy this film through oxidation.

The hydrocarbon compositions to which the present invention relates may be any hydrocarbon or mixture of hydrocarbons containing hydrogen sulfide and water. The amount of hydrogen sulfide and water contained in the hydrocarbon mixture is not particularly important. Only small amounts of each are necessary to cause corrosion problems in ferrous metal equipment. The maximum amount of hydrogen sulfide and water is determined only by their solubility limit in the hydrocarbon composition. In typical hydrocarbon compositions the amount of hydrogen sulfide and water will vary widely within these limits.

The hydrocarbon compositions may be derived from a wide variety of sources. Hydrocarbon compositions containing hydrogen sulfide and water are encountered in a number of operations during the refining of petroleum. For example, the original crude fed to a crude still can contain hydrogen sulfide and water. Many of the hydrogen treating steps such as hydrodesulfurization and hydrocracking convert sulfur-containing compounds to hydrogen sulfide and oxygen-containing compounds to water. Water may also originate during aqueous caustic and water washing steps. Other sources of hydrocarbon compositions containing hydrogen sulfide and water include petroleum refinery gas streams, oil well gas including natural gas, and gases such as propane and butane which have been stored in underground caverns. In addition to the hydrocarbon, hydrogen sulfide and water, these hydrocarbon compositions may also contain other constituents such as hydrogen, oxygen, sulfur-containing organic compounds, nitrogen, carbon dioxide, catalyst residues, mineral salts and the like.

The substantially neutral amine salts contained in the corrosion inhibitors used in accordance with this invention are derived from mixed monoalkyl and dialkyl phosphate esters in which each alkyl group has 4 to 18 carbon atoms. Suitable esters include mixtures in which only one or two of the three acidic hydrogen atoms of orthophosphoric acid have been replaced by an alkyl group, i.e., mixtures of monoalkyl dihydrogen phosphates and dialkyl hydrogen phosphates. Such esters may be obtained according to the general methods of the art which involve reacting an alkanol with phosphorus pentoxide (P_2O_5). From about 2.5 to about 3.5 moles of the alkanol may be used per mole of P_2O_5. Preferably, about three moles of the alkanol per mole of P_2O_5 are used to yield

mixtures of monoalkyl and dialkyl esters of orthophosphoric acid containing about 40 to 60 mole percent of the monoalkyl ester and about 60 to 40 mole percent of the dialkyl ester.

The alkanol used to prepare the phosphate ester may be a straight or branched-chain primary alkanol having 4 to 18 carbon atoms or a mixture of two or more such alkanols. Suitable readily available straight-chain alkanols include butanol, hexanol, octanol, decanol, dodecanol, tetradecanol, hexadecanol and octadecanol.

The branched-chain primary alkanols are preferably those made by the well-known oxo process from CO, H_2 and a branched-chain olefin such as the C_7 to C_{15} monoolefinic polymers and interpolymers of propylene and butylene, as described, for example, by Smith et al. in U.S. Pat. No. 2,824,836 and Rudel et al. in U.S. Pat. No. 2,884,379. Examples of preferred oxo-alcohols that may be used are isooctanol from the propylene-butylene dimer, branched tridecanol from triisobutylene or tetrapropylene, and the branched hexadecanol from pentapropylene.

Other branched-chain primary alkanols that can be used are those prepared by alkaline condensation of two primary alkanols of the structure RCH_2CH_2OH wherein R is alkyl having two to six carbon atoms to produce primary alkanols that are branched in the 2-position, i.e., $RCH_2CH_2—CHRCH_2OH$. For example, 2-hexyldecanol-1 is produced by heating n-octanol with caustic and zinc dust, and similarly 2-ethyl-hexanol-1- from butanol-1, as described by Carter in U.S. Pat. No. 2,457,866. Other alkanols of the formula $R'CH_2CHRCH_2OH$ wherein R and R' are the same or different alkyl groups having 2 to 6 carbon atoms, which may be prepared by the latter method as well as other methods known in the art, may be used to prepare the phosphate esters used in the present invention.

The branched alkanols may also be prepared by the conventional aldolization of suitable aldehydes followed by hydrogenation. In this way, the well-known oxo-octaldehyde, which is obtained from heptene-1, CO and H_2 and which is a mixture containing dimethylhexaldehyde, ethylhexaldehyde and methylheptaldehyde, all having the grouping $—CH_2CH=O$, is converted into 2-hexyldecanol, $R'CHRCH_2OH$, where R stands for C_6 alkyl groups such as dimethylbutyl, methylpentyl, and ethylbutyl, and R' stands for C_8 alkyl groups such as dimethylhexyl, ethylhexyl and trimethylpentyl groups.

The preferred alkyl phospshates are mono- and di-isobutyl phosphate, mono- and di-oxo-octyl phosphate and mono- and di-oxo-tridecyl phosphate mixtures.

The amines used to neutralize the alkyl esters of orthophosphoric acid are alkyl monoamines containing 2 to 18 carbon atoms. The amines may be primary, secondary or tertiary amines and the alkyl radical may be straight or branched-chain.

Examples of suitable amines include primary amines such as ethylamine; propylamine; isopropylamine; butylamine; isobutylamine; pentylamine; hexylamine; octylabine; 2-ethylhexylamine; t-octylamine; t-dodecylamine; laurylamine; hexadecylamine; octadecylamine; t-nonylamine, a commercially available mixture consisting mainly of the C_9 amine with small amounts of the C_8 and C_{10} amines; commercially available mixed t-alkyl primary amine fractions having 12 to 14 carbon atoms; cocoamine, a mixture of C_8 to C_{18} n-alkyl primary amines with the C_{12} amine predominating; and tallowamine, a mixture of stearyl, palmityl and oleyl amines. Examples of useful secondary amines include dimethylamine, diethylamine, dipropylamine, di-n-butylamine, di-sec.-isobutylamine, diamylamine, di-2-ethylhexylamine and diisooctylamine. Suitable tertiary amines include trimethylamine, triethylamine, tripropylamine, tri-iso-propylamine, tributylamine, trihexylamine and N,N-dimethyloleylamine. The preferred amines are ethylamine, 2-ethylhexylamine and laurylamine.

The substantially neutral amine salts are prepared by neutralizing the mixed monoalkyl and dialkyl phosphate ester with the alkyl monoamine. Normally about one mole of amine is required for each mole of phosphate ester to produce substantially neutral salt since the second hydrogen in the monoalkyl phosphate is not reactive with the amine. These neutral salts generally have an apparent pH of about 6.5 to 8 and preferably about 7.0 to 7.6.

The corrosion inhibitors used in accordance with this invention also contain a free alkyl monoamine having 1 to 10 carbon atoms. The amines may be primary, secondary or tertiary amines and the alkyl radical may be straight or branched-chain.

Examples of suitable amines include primary amines such as methylamine, ethylamine, propylamine, isopropylamine, butylamine, isobutylamine, pentylamine, hexylamine, octylamine, 2-ethylhexylamine, t-octylamine and t-nonylamine. Examples of useful secondary amines include dimethylamine, diethylamine, dipropylamine, di-n-butylamine, di-sec.-isobutylamine and diamylamine. Suitable tertiary amines include trimethylamine, triethylamine, tripropylamine and tri-isopropylamine. The corrosion inhibitor should contain about 0.5 to 5 moles of free amine per mole of amine salt. Preferably about 2 to 4 moles of amine are present for each mole of amine salt. A particularly preferred corrosion inhibitor is a substantially neutral 2-ethylhexylamine salt of mixed mono- and di-oxo-tridecyl phosphate and 2 to 4 moles of isopropylamine per mole of amine salt.

Since the amine phosphate salt and free amine components of the corrosion inhibitor form a solid complex, it is convenient to introduce the corrosion inhibitor into the hydrocarbon composition as a liquid concentrate prepared in a solvent. Generally the concentrate contains 30 to 300% by weight, based on the active ingredients, of a solvent, and preferably about 70 to 150%. Suitable solvents include aliphatic hydrocarbon alcohols having 1 to 20 carbon atoms and aliphatic and aromatic hydrocarbons. Preferably the solvent is an aliphatic hydrocarbon alcohol. Suitable alcohols include alkyl and alkenyl alcohols such as methyl, ethyl, propyl, isopropyl, propenyl, butyl, isobutyl, amyl, methylamyl, hexyl, hexenyl, octyl, isooctyl, 2-ethylhexyl, nonyl, nonenyl, decyl, lauryl, tridecyl, cetyl, stearyl and oleyl. Volatile alkyl alcohols having 1 to 3 carbon atoms are most preferred. Of course, the solid active ingredients can be incorporated directly into the hydrocarbon composition, if desired.

The corrosion inhibitor concentrate may be introduced as such into the hydrocarbon composition or as a more dilute hydrocarbon solution, e.g., dissolved in a naphtha fraction. The point of introduction may be the feed, overhead or reflux lines of a refining column, still or stripper or the gas phase in a gas transmission line. The corrosion inhibitor, preferably an alcoholic concentrate in a hydrocarbon diluent, is introduced in the proper ratio by means of suitable proportioning equipment, periodically or continuously, but preferably continuously.

The hydrocarbon composition containing hydrogen sulfide and water should contain an effective amount of corrosion inhibitor. By "effective amount" is meant the amount required to produce a useful inhibitor effect for the particular hydrocarbon composition being handled under particular conditions in ferrous metal equipment. Various factors such as the amount of hydrogen sulfide and water present and the temperature at which the equipment is operated will dictate the amount of corrosion inhibitor necessary to provide a useful effect.

In general, the amount of corrosion inhibitor employed will be in the range of about 0.0001 to 0.005% by weight of active ingredients based on the hydrocarbon composition, which corresponds to about 0.25 to 12.5 pounds of active ingredients per 1000 barrels (42,000 gallons) of hydrocarbon composition. By "active ingredients" is meant the alkyl phosphate-amine salt and free amine. Preferably about 0.0002 to 0.002% is employed which corresponds to about 0.5 to 5 pounds per 1000 barrels.

The following examples, illustrating the novel method of this invention and novel corrosion inhibiting compositions used therein, are presented without any intention that the invention can be limited thereto. All parts and percentages are by weight unless otherwise stated.

EXAMPLE 1

Corrosion inhibitors were prepared as follows:

(A) To 148.6 parts (0.40 mole) of the mixed 40 to 60 mole percent mono- and 60 to 40 mole percent di-oxo-tri-decyl phosphate was added 51.7 parts (0.40 mole) of 2-ethylhexylamine in a reaction vessel equipped with agitator and condenser. The contents were heated and 50 parts of methanol added to achieve a uniform consistency. The mixture was agitated for 30 minutes after which the apparent pH was 7.3 ±0.3. The resulting 250.3 parts of product consisted of 200.3 parts (0.4 mole) of 2-ethylhexylamine salt of mixed mono- and di-oxo-tridecyl phosphate as an 80% solution in methanol. To 47.6 parts of this product containing 38.1 parts (0.076 mole) of the 2-ethylhexylamine salt, in a vessel equipped with agitator and a condenser, was added 15.0 parts (0.254 mole) of isopropylamine in 37.4 parts of chilled methanol. The mixture was stirred until a uniform consistency was achieved. The composition thus obtained was used as such as the corrosion inhibitor concentrate.

(B) To 174.7 parts (0.40 mole) of the mixed 40 to 60 mole percent mono- and 60 to 40 mole percent di-hexadecyl phosphate was added 107.8 parts (0.40 mole) of octadecylamine in a reaction vessel equipped with agitator and condenser. The contents were heated and 46 parts of methanol added to achieve a uniform consistency. The mixture was agitated for 30 minutes after which the apparent pH was 7.3 ±0.3. The resulting 328.5 parts of product consisted of 282.5 parts (0.40 mole) of octadecylamine salt of mixed mono- and di-hexadecyl phosphate as an 86% solution in methanol. To 62.4 parts of this product containing 53.7 parts (0.076 mole) of the octadecylamine salt, in a vessel equipped with agitator and a condenser, was added 11.4 parts (0.254 mole) of ethylamine in 26.2 parts of chilled methanol. The mixture was stirred until a uniform consistency was achieved. The composition thus obtained was used as the corrosion inhibitor concentrate.

(C) To 72.9 parts (0.40 mole) of the mixed 40 to 60 mole percent mono- and 60 to 40 mole percent di-n-butyl phosphate was added 18 parts (0.40 mole) of ethylamine in a reaction vessel equipped with agitator and condenser. The contents were heated and 25.6 parts of methanol added to achieve a uniform consistency. The mixture was agitated for 30 minutes after which the apparent pH was 7.3±0.3. The resulting 116.5 parts of product consisted of 90.9 parts (0.4 mole) of ethylamine salt of mixed mono- and di-n-butyl phosphate as a 78% solution in methanol. To 22.2 parts of this product containing 17.3 parts (0.076 mole) of the ethylamine salt, in a vessel equipped with agitator and a condenser, was added 11.4 parts (0.254 mole) of ethylamine in 66.4 parts of chilled methanol. The mixture was stirred until a uniform consistency was achieved. The composition thus obtained was used as such as the corrosion inhibitor concentrate.

(D) To 72.9 parts (0.40 mole) of the mixed 40 to 60 mole percent mono- and 60 to 40 mole percent di-n-butyl phosphate was added 107.8 parts (0.40 mole) of octadecylamine in a reaction vessel equipped with agitator and condenser. The contents were heated and 24.6 parts of methanol added to achieve a uniform consistency. The mixture was agitated for 30 minutes after which the apparent pH was 7.3±0.3. The resulting 205.3 parts of product consisted of 180.7 parts (0.4 mole) of octadecylamine salt of mixed mono- and di-n-butyl phosphate as an 88% solution in methanol. To 39.0 parts of this product containing 34.3 parts (0.076 mole) of the octadecylamine salt, in a vessel equipped with agitator and a condenser, was added 11.4 parts (0.254 mole) of ethylamine in 49.6 parts of chilled methanol. The mixture was stirred until a uniform consistency was achieved. The composition thus obtained was used as such as the corrosion inhibitor concentrate.

(E) To 174.7 parts (0.40 mole) of the mixed 40 to 60 mole percent mono- and 60 to 40 mole percent di-hexadecyl phosphate was added 18 parts (0.40 mole) of ethylamine in a reaction vessel equipped with agitator and condenser. The contents were heated and 34 parts of methanol added to achieve a uniform consistency. The mixture was agitated for 30 minutes after which the apparent pH was 7.3±0.3. The resulting 226.7 parts of product consisted of 192.7 parts (0.4 mole) of ethylamine salt of mixed mono- and di-hexadecyl phosphate as an 85% solution in methanol. To 43.0 parts of this product containing 36.6 parts (0.076 mole) of the ethylamine salt, in a vessel equipped with agitator and a condenser, was added 11.4 parts (0.254 mole) of ethylamine in 45.6 parts of chilled methanol. The mixture was stirred until a uniform consistency was achieved. The composition thus obtained was used as such as the corrosion inhibitor concentrate.

(F) To 148.6 parts (0.40 mole) of the mixed 40 to 60 mole percent mono- and 60 to 40 mole percent di-oxo-tridecyl phosphate was added 51.7 parts (0.40 mole) of 2-ethylhexylamine in a reaction vessel equipped with agitator and condenser. The contents were heated and 50 parts of methanol added to achieve a uniform consistency. The mixture was agitated for 30 minutes after which the apparent pH was 7.3±0.3. The resulting 250.3 parts of product consisted of 200.3 parts (0.4 mole) of 2-ethylhexyl amine salt of mixed mono- and di-oxo-tridecyl phosphate as an 80% solution in methanol. To 47.6 parts of this product containing 38.1 parts (0.076 mole) of the 2-ethylhexylamine salt, in a vessel equipped with agitator and a condenser was added 39.9 parts (0.254 mole) of decylamine in 12.5 parts of chilled methanol. The mixture was stirred until a uniform consistency was achieved. The composition thus obtained was used as such as the corrosion inhibitor concentrate.

The effectiveness of the above corrosion inhibitors was determined as follows:

Corrosion test procedure

Type 1020 steel corrosion coupons which had been weighed and measured for surface area were suspended in the liquid, vapor and reflux phases of boiling isooctane containing 0.125 volume percent water and a corrosion inhibitor. The isooctane-water mixture after being brought to reflux was saturated with hydrogen sulfide and refluxing was continued in a closed system at atmospheric pressure. After a 24-hour exposure to the hydrocarbon composition containing wet hydrogen sulfide, the coupons were removed, polished to remove corrosion and weighed to determine the corrosion rate. The corrosion inhibitors were formulated to contain 3.3 moles of free amine per mole of neutral amine salt of alkyl phosphate and were tested at equivalent molar concentrations.

For comparison, a control experiment was carried out in which no corrosion inhibitor was added. The following data were obtained.

TABLE 1

Corrosion inhibitor		Corrosion rate, mils per year		
Composition	Concentration, percent active ingredients	Reflux	Vapor	Liquid
A	0.0022	20.0	4.0	6.0
B	0.0027	26.3	12.3	4.7
C	0.0012	33.5	34.8	42.2
D	0.0019	16.9	31.8	3.4
E	0.0020	40.0	28.1	78.1
F	0.0032	3.8	22.3	1.3
Control	None	491.0	393.0	187.0

EXAMPLE 2

Three corrosion tests were conducted in the fractionating section of a commercial refinery during actual refining operations. Hydrocarbon streams containing predominantly C_4 to C_{15} hydrocarbons and small amounts of hydrogen sulfide and water were heated to 340° F. and passed into a fractionating column. The overhead stream from the column at a temperature of 190° F. was condensed at about 125° F. and sent to a separator where the aqueous phase was separated. Corrosion inhibitor A described in Example 1 was added to the overhead stream just beyond the reflux zone at the rate of 0.0007% active ingredients based on the hydrocarbon stream. Corrosion coupons were inserted between the condenser and the separator where corrosion rate was the greatest. Corrosion tests were run for 30 days. At the end of each test, the corrosion coupons were removed, polished and weighed to determine the quantitative rate of corrosion.

For comparison, a control run was carried out in which no corrosion inhibitor was employed. The following data were obtained.

TABLE 2

Test:	Corrosion rate, mils per year
1	6.0
2	<0.5
3	1.0
Control	50.0

EXAMPLE 3

Three additional 30-day corrosion tests were conducted in commercial processing equipment during actual operations. Feed stock containing predominantly C_1 to C_6 hydrocarbons and small amounts of hydrogen sulfide and water was passed into a fractionating column operating at a feed temperature of 175° F., a pressure of 460 p.s.i.g., and a bottoms temperature of 300° F. Corrosion inhibitor A described in Example 1 was added to the overhead vapor line just beyond the reflux zone at the rate of 0.0009% active ingredients based on the hydrocarbon composition. The overhead stream at a temperature of 140° F. was condensed at about 125° F. and sent to a separator where uncondensable gas, oil phase and water were separated. Corrosion coupons were inserted between the condenser and the separator where corrosion was greatest. At the end of each 30-day test period, the corrosion coupons were removed and the rate of corrosion coupons were removed and the rate of corrosion was determined.

For comparison, a control run was carried out in which no corrosion inhibitor was used. The following data were obtained.

TABLE 3

Test:	Corrosion rate, mils per year
1	0.5
2	10.0
3	9.0
Control	140.0

EXAMPLE 4

A corrosion test was conducted in the stripper section of a commercial refinery during actual petroleum refining operations. A portion of a petroleum mixture which had been hydrogenated in a "Unifiner" unit thereby converting sulfur compounds to hydrogen sulfide and oxygenated compounds to water was passed into a stripping column operating at a bottoms temperature of 680° F. The overhead vapor stream at a temperature of 200° F. and a pressure of 70 p.s.i.g. was passed through a condenser to a separator where incondensable fuel gas containing 20 volume percent hydrogen sulfide was separated from the hydrocarbon and aqueous phases. Corrosion inhibitor A described in Example 1 was added to the overhead vapor stream just beyond the reflux zone, at the rate of 0.0005% active ingredients based on the hydrocarbon composition. Corrosion coupons were inserted in the overhead vapor line just ahead of the condenser. The corrosion rate was found to be 1.1 mils per year.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A method of inhibiting corrosion of ferrous metal equipment caused by the vapors of a hydrocarbon composition, hydrogen sulfide and water, which method comprises adding to the hydrocarbon composition an effective amount of a corrosion inhibitor consisting essentially of
   (a) a substantially neutral amine salt of a mixed monoalkyl and dialkyl ester of orthophosphoric acid in which each alkyl group has 4 to 18 carbon atoms and the amine is alkyl monoamine having 2 to 18 carbon atoms, and
   (b) 0.5 to 5 moles per mole of amine salt, of alkyl monoamine having 1 to 10 carbon atoms.

2. The method of claim 1 which comprises adding 0.0001 to 0.005% by weight, based on the hydrocarbon composition, of corrosion inhibitor consisting essentially of
   (a) a substantially neutral amine salt of a mixed 40 to 60 mole percent monoalkyl and 60 to 40 mole percent dialkyl ester of orthophosphoric acid in which the alkyl group is isobutyl, isooctyl, or, oxo-tridecyl and the amine is ethylamine, 2-ethylhexylamine or laurylamine,
   (b) 2 to 4 moles, per mole of amine salts, of ethylamine or isopropylamine, and
   (c) 30 to 300% by weight, based on (a) and (b), of an aliphatic hydrocarbon alcohol having 1 to 20 carbon atoms.

3. The method of claim 1 which comprises adding 0.0002 to 0.002% by weight, based on the hydrocarbon composition, of corrosion inhibitor consisting essentially of
   (a) a substantially neutral 2-ethylhexylamine salt of a mixed 40 to 60 mole percent mono- and 60 to 40 mole percent di-oxo-tridecyl phosphate,
   (b) 2 to 4 moles of isopropylamine per mole of amine salt, and
   (c) 70 to 150% by weight, based on (a) and (b), of an alkanol having 1 to 3 carbon atoms.

4. The method of claim 3 in which the hydrocarbon composition is a petroleum refinery gas stream.

5. The method of claim 3 in which the hydrocarbon composition is a hydrodesulfurized petroleum product.

6. The method of claim 3 in which the hydrocarbon composition is a hydrocracked petroleum product.

7. The method of claim 3 in which the hydrocarbon composition is natural gas.

8. The method of claim 3 in which the hydrocarbon composition is a petroleum refinery crude oil.

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