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(57) Abrégé/Abstract:

The present invention relates to a hydrogen sulphide scavenging additive composition for scavenging hydrogen sulphide including sulfur containing compounds and mercaptans, particularly for scavenging hydrogen sulfide in hydrocarbons, wherein the additive composition comprises substantially reduced amount of nitrogen based hydrogen sulfide scavengers, and is also required in substantially reduced amount, and wherein the additive composition scavenges the sulfur containing compounds not only at room temperature, but also at higher temperatures, and comprises at least a combination of: (A) at least one nitrogen based hydrogen sulfide scavenger; and (B) at least one aliphatic tertiary amine, wherein the nitrogen based hydrogen sulfide scavenger comprises triazine based hydrogen sulfide scavenger. In one embodiment, it also relates to a method for scavenging hydrogen sulfide in hydrocarbons, and in another embodiment it relates to a method of using an additive composition of the present invention for scavenging hydrogen sulfide in hydrocarbons. In yet another embodiment, it relates to a composition comprising (i) a hydrocarbon and (ii) a hydrogen sulfide scavenging additive composition for scavenging hydrogen sulfide in hydrocarbons.

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(54) Title: NITROGEN BASED HYDROGEN SULFIDE SCAVENGERS AND METHOD OF USE THEREOF

(57) Abstract: The present invention relates to a hydrogen sulphide scavenging additive composition for scavenging hydrogen sulphide including sulfur containing compounds and mercaptans, particularly for scavenging hydrogen sulfide in hydrocarbons, wherein the additive composition comprises substantially reduced amount of nitrogen based hydrogen sulfide scavengers, and is also required in substantially reduced amount, and wherein the additive composition scavenges the sulfur containing compounds not only at room temperature, but also at higher temperatures, and comprises at least a combination of: (A) at least one nitrogen based hydrogen sulfide scavenger; and (B) at least one aliphatic tertiary amine, wherein the nitrogen based hydrogen sulfide scavenger comprises triazine based hydrogen sulfide scavenger. In one embodiment, it also relates to a method for scavenging hydrogen sulfide in hydrocarbons, and in another embodiment it relates to a method of using an additive composition of the present invention for scavenging hydrogen sulfide in hydrocarbons. In yet another embodiment, it relates to a composition comprising (i) a hydrocarbon and (ii) a hydrogen sulfide scavenging additive composition for scavenging hydrogen sulfide in hydrocarbons.



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Title of the invention:

Nitrogen Based Hydrogen Sulfide Scavengers and Method of Use Thereof.

Field of the invention:

The present invention generally relates to nitrogen based hydrogen sulfide scavengers and method of use thereof, and a method for scavenging hydrogen sulfide from hydrocarbons including hydrocarbon streams.

Particularly, it relates to nitrogen based hydrogen sulfide scavengers including triazine based hydrogen sulfide scavengers and a method of use thereof, and a method for scavenging hydrogen sulfide from hydrocarbons including hydrocarbon streams.

Background of the invention:

The toxicity of hydrogen sulfide in hydrocarbons or hydrocarbon streams is well known in the industry and considerable expense and efforts are expended annually to reduce its content to a safe level. Many regulations require pipeline gas to contain no more than four (4) ppm hydrogen sulfide.

In large production facilities, it is generally more economical to install a regenerative system for treating streams containing hydrogen sulphide. These systems typically employ a compound used in an absorption tower to contact the produced fluids and selectively absorb the hydrogen sulfide and possibly other toxic materials such as carbon dioxide and mercaptans. The absorption compound is then regenerated and reused in the system. Typical hydrogen sulfide absorption materials include alkanolamines, hindered amines, and the like, i.e. nitrogen containing compounds. However, such approach is not economically feasible for development stage of a field or in small producing fields.

The nitrogen containing compounds, such as triazine, particularly monoethanolamine triazine (herein after the 'monoethanolamine triazine' may be referred to as 'MEA Triazine' or 'MEAT'; and 'triazine' and 'monoethanolamine triazine' collectively may be referred to as 'triazines') are known as hydrogen sulfide scavengers (re PCT publication no. WO 90/07467; and US publication nos. US 2004/0096382 and US 2011/0220551).

However, use of triazines as hydrogen sulfide scavengers suffers from difficulties and problems. For example, triazines are not substantially effective for scavenging hydrogen sulfide in liquid hydrocarbon streams, and dry gas streams. Further, use of triazines may also result in scale formation particularly in sea water containing calcium ions and dissolved carbon dioxide. To overcome problem of scale formation, one has to

flush an acid to remove the scales formed. Therefore, the industry aims to minimize the amount of nitrogen based hydrogen sulfide scavengers, i.e. triazines.

Need of the Invention:

Accordingly, there is a need of an improved additive composition which, at least,
5 comprises substantially reduced amount of nitrogen based hydrogen sulfide scavengers,
and is also required in substantially reduced amount, and is suitable for scavenging sulfur
containing compounds including, but not limited to hydrogen sulfide and mercaptans,
particularly hydrogen sulfide in the hydrocarbons including hydrocarbon streams, and
overcomes one or more of above-described problems of the prior art, and wherein the
10 additive composition is capable of scavenging the sulfur containing compounds not only
at room temperature, but also at higher temperatures.

Problem to be solved by the Invention:

Therefore, the present invention primarily aims at providing a solution to one or
more of above-described existing industrial problems by providing an improved additive
15 composition for scavenging sulfur containing compounds including, but not limited to
hydrogen sulfide and mercaptans, particularly hydrogen sulfide in hydrocarbons
including hydrocarbon streams without causing any problem, wherein the additive
composition comprises substantially reduced amount of nitrogen based hydrogen sulfide
scavengers, and is also required in substantially reduced amount, and wherein the
20 additive composition is capable of scavenging the sulfur containing compounds not only
at room temperature, but also at higher temperatures.

Objects of the Invention:

Accordingly, the main object of present invention is to provide an improved
additive composition for scavenging sulfur containing compounds including, but not
25 limited to hydrogen sulfide and mercaptans, particularly hydrogen sulfide in
hydrocarbons including hydrocarbon streams and asphalt and which, at least, reduces the
above-discussed problems of the prior art, wherein the additive composition comprises
substantially reduced amount of nitrogen based hydrogen sulfide scavengers, i.e.
triazines, and is also required in substantially reduced amount, and wherein the additive
30 composition scavenges the sulfur containing compounds not only at room temperature,
but also at higher temperatures.

This is also an object of present invention to provide a method for scavenging
sulfur containing compounds including, but not limited to hydrogen sulfide and
mercaptans, particularly hydrogen sulfide in hydrocarbons including hydrocarbon
35 streams and asphalt by employing the additive composition of the present invention

which comprises substantially reduced amount of nitrogen based hydrogen sulfide scavengers, i.e. triazines, and is also used in substantially reduced amount to scavenge the sulfur containing compounds, and wherein the additive composition scavenges the sulfur containing compounds not only at room temperature, but also at higher
5 temperatures.

This is also an object of present invention to provide a method of using the additive composition of the present invention for scavenging sulfur containing compounds including, but not limited to hydrogen sulfide and mercaptans, particularly hydrogen sulfide in hydrocarbons including hydrocarbon streams and asphalt, wherein
10 the additive composition comprises substantially reduced amounts of nitrogen based hydrogen sulfide scavengers, i.e. triazines, and thereby, makes the composition and its use economical, industrially feasible and convenient.

Other objects and advantages of present invention will become more apparent from the following description when read in conjunction with examples, which are not
15 intended to limit scope of present invention.

Description and Preferred Embodiments of the Invention:

With aim to overcome above-described problems of prior art and to achieve above-described objects of the invention, the inventor has found that when an hydrocarbon comprising sulfur containing compounds including, but not limited to
20 hydrogen sulfide and mercaptans is treated with an additive composition comprising at least a combination of (a) at least one nitrogen based hydrogen sulfide scavenger; and (b) at least one aliphatic amine comprising at least one aliphatic tertiary amine, the sulfur containing compound including hydrogen sulfide is scavenged or removed.

With aim to overcome above-described problems of prior art and to achieve
25 above-described objects of the invention, the inventor has also found that the scavenging of the sulfur containing compounds is achieved even when the additive composition of the present invention comprises a substantially reduced amount of nitrogen based hydrogen sulfide scavengers, i.e. triazines, and/or is used in a substantially reduced amount.

30 With aim to overcome above-described problems of prior art and to achieve above-described objects of the invention, the inventor has further found that the additive composition of the present invention scavenges the sulfur containing compounds not only at room temperature, but also at higher temperatures.

Accordingly, in main embodiment, the present invention, relates to a hydrogen
35 sulfide scavenging additive composition for scavenging hydrogen sulfide in

hydrocarbons comprising sulfur containing compounds including, but not limited to hydrogen sulfide and mercaptans, wherein said additive composition comprises at least a combination of (a) at least one nitrogen based hydrogen sulfide scavenger; and (b) at least one aliphatic amine comprising at least one aliphatic tertiary amine, wherein the nitrogen based hydrogen sulfide scavenger comprises triazine based hydrogen sulfide scavenger.

Accordingly, in another embodiment, the present invention, relates to a method for scavenging hydrogen sulfide in hydrocarbons comprising sulfur containing compounds including, but not limited to hydrogen sulfide and mercaptans, wherein the method comprises adding a hydrogen sulfide scavenging additive composition comprising at least a combination of (a) at least one nitrogen based hydrogen sulfide scavenger; and (b) at least one aliphatic amine comprising at least one aliphatic tertiary amine, wherein the nitrogen based hydrogen sulfide scavenger comprises triazine based hydrogen sulfide scavenger to the hydrocarbons.

Accordingly, in still another embodiment, the present invention, relates to a method of using a hydrogen sulfide scavenging additive composition comprising at least a combination of (a) at least one nitrogen based hydrogen sulfide scavenger; and (b) at least one aliphatic amine comprising at least one aliphatic tertiary amine, wherein the nitrogen based hydrogen sulfide scavenger comprises triazine based hydrogen sulfide scavenger for scavenging hydrogen sulfide in hydrocarbons comprising sulfur containing compounds including, but not limited to hydrogen sulfide and mercaptans, wherein the method comprises treating the hydrocarbon with the additive composition to scavenge the sulfur containing compounds including hydrogen sulfide.

Accordingly, in yet another embodiment, the present invention, relates to a composition for scavenging hydrogen sulfide in hydrocarbons comprising sulfur containing compounds including, but not limited to hydrogen sulfide and mercaptans, wherein the composition comprises at least a combination of (A) a hydrocarbon; and (B) a hydrogen sulfide scavenging additive composition, wherein the hydrogen sulfide scavenging additive composition comprises at least a combination of (a) at least one nitrogen based hydrogen sulfide scavenger; and (b) at least one aliphatic amine comprising at least one aliphatic tertiary amine, wherein the nitrogen based hydrogen sulfide scavenger comprises triazine based hydrogen sulfide scavenger.

In accordance with one of the preferred embodiments of the present invention, the nitrogen based hydrogen sulfide scavengers comprise triazine based hydrogen sulfide scavengers.

In accordance with one of the preferred embodiments of the present invention, the triazines comprise (or include) monoethanolamine triazine (MEAT) based hydrogen sulfide scavengers.

In accordance with one of the preferred embodiments of the present invention, the
5 MEAT of any activity may be used.

In accordance with one of the preferred embodiments of the present invention, the MEAT may be of 32% activity or 50% activity or as may be supplied by its supplier/manufacturer.

In accordance with one of the preferred embodiments of the present invention, the
10 aliphatic tertiary amine comprises tri-isopropanolamine (TIPA).

In accordance with one of the preferred embodiments of the present invention, the aliphatic tertiary amine comprises N,N,N',N'-Tetrakis (2-hydroxyethyl) ethylene-diamine (THEED).

In accordance with one of the preferred embodiments of the present invention, the
15 aliphatic tertiary amine comprises ethylene oxide (EO) derivative of TIPA or ethoxylated TIPA (EO-TIPA).

In accordance with one of the preferred embodiments of the present invention, the aliphatic tertiary amine comprises propylene oxide (PO) derivative of TIPA or propoxylated TIPA (PO-TIPA).

20 In accordance with one of the preferred embodiments of the present invention, the aliphatic tertiary amine comprises ethylene oxide (EO) derivative of ethylene diamine or ethoxylated EDA (EO-EDA).

In accordance with one of the preferred embodiments of the present invention, the aliphatic tertiary amine comprises propylene oxide (PO) derivative of ethylene diamine
25 or propoxylated EDA (PO-EDA).

In accordance with another preferred embodiment of the present invention, the aliphatic tertiary amine comprises tri-isopropanolamine (TIPA), N,N,N',N'-Tetrakis (2-hydroxyethyl) ethylene-diamine (THEED), ethylene oxide (EO) derivative of TIPA (EO-TIPA), propylene oxide (PO) derivative of TIPA (PO-TIPA), ethylene oxide (EO)
30 derivative of ethylene diamine (EO-EDA), propylene oxide (PO) derivative of ethylene diamine (PO-EDA), or a mixture thereof.

In accordance with one of the preferred embodiments of the present invention, the mixture of aliphatic tertiary amines may be obtained by mixing one or more of the aliphatic tertiary amines of the present invention, i.e. TIPA, THEED, EO-TIPA, PO-TIPA, EO-EDA, and PO-EDA in any weight (or mole) ratio.
35

In accordance with one of the preferred embodiments of the present invention, the ethoxylated TIPA (EO-TIPA) may be obtained by reacting 1 mole of TIPA with at least 1 mole of ethylene oxide (EO).

For example, the ethoxylated TIPA may be obtained by reacting 1 mole of TIPA
5 with 1 to 50 moles of ethylene oxide (EO).

For example, the ethoxylated TIPA may comprise:

TIPA ethoxylated by 5 moles of ethylene oxide (EO), herein after may be referred to as 'TIPA-5 mole EO' or 'TI5E';

10 TIPA ethoxylated by 10 moles of ethylene oxide (EO), herein after may be referred to as 'TIPA-10 mole EO' or 'TI10E';

TIPA ethoxylated by 15 moles of ethylene oxide (EO), herein after may be referred to as 'TIPA-15 mole EO' or 'TI15E';

TIPA ethoxylated by 20 moles of ethylene oxide (EO), herein after may be referred to as 'TIPA-20 mole EO' or 'TI20E';

15 TIPA ethoxylated by 25 moles of ethylene oxide (EO), herein after may be referred to as 'TIPA-25 mole EO' or 'TI25E';

TIPA ethoxylated by 30 moles of ethylene oxide (EO), herein after may be referred to as 'TIPA-30 mole EO' or 'TI30E'.

In accordance with one of the preferred embodiments of the present invention, the
20 propoxylated TIPA (PO-TIPA) may be obtained by reacting 1 mole of TIPA with at least 1 mole of propylene oxide (PO).

For example, the propoxylated TIPA may be obtained by reacting 1 mole of TIPA with 1 to 50 moles of propylene oxide (PO).

For example, the propoxylated TIPA may comprise:

25 TIPA propoxylated by 5 moles of propylene oxide (PO), herein after may be referred to as 'TIPA-5 mole PO' or 'TI5P';

TIPA propoxylated by 10 moles of propylene oxide (PO), herein after may be referred to as 'TIPA-10 mole PO' or 'TI10P';

30 TIPA propoxylated by 15 moles of propylene oxide (PO), herein after may be referred to as 'TIPA-15 mole PO' or 'TI15P';

TIPA propoxylated by 20 moles of propylene oxide (PO), herein after may be referred to as 'TIPA-20 mole PO' or 'TI20P';

TIPA propoxylated by 25 moles of propylene oxide (PO), herein after may be referred to as 'TIPA-25 mole PO' or 'TI25P'.

TIPA propoxylated by 30 moles of propylene oxide (PO), herein after may be referred to as 'TIPA-30 mole PO' or 'TI30P'.

In accordance with one of the preferred embodiments of the present invention, the ethoxylated EDA (EO-EDA) may be obtained by reacting 1 mole of EDA with at least 1
5 mole of ethylene oxide (EO).

For example, the ethoxylated EDA may be obtained by reacting 1 mole of EDA with 1 to 50 moles of ethylene oxide (EO).

For example, the ethoxylated EDA may comprise:

EDA ethoxylated by 5 moles of ethylene oxide (EO), herein after may be referred
10 to as 'EDA-5 mole EO' or 'EDA5E';

EDA ethoxylated by 10 moles of ethylene oxide (EO), herein after may be referred to as 'EDA-10 mole EO' or 'EDA10E';

EDA ethoxylated by 15 moles of ethylene oxide (EO), herein after may be referred to as 'EDA-15 mole EO' or 'EDA15E';

15 EDA ethoxylated by 20 moles of ethylene oxide (EO), herein after may be referred to as 'EDA-20 mole EO' or 'EDA20E';

EDA ethoxylated by 25 moles of ethylene oxide (EO), herein after may be referred to as 'EDA-25 mole EO' or 'EDA25E';

20 EDA ethoxylated by 30 moles of ethylene oxide (EO), herein after may be referred to as 'EDA-30 mole EO' or 'EDA30E'.

In accordance with one of the preferred embodiments of the present invention, the propoxylated EDA (PO-EDA) may be obtained by reacting 1 mole of EDA with at least 1 mole of propylene oxide (PO).

For example, the propoxylated EDA may be obtained by reacting 1 mole of EDA
25 with 1 to 50 moles of propylene oxide (PO).

For example, the propoxylated EDA may comprise:

EDA propoxylated by 5 moles of propylene oxide (PO), herein after may be referred to as 'EDA-5 mole PO' or 'EDA5P';

30 EDA propoxylated by 10 moles of propylene oxide (PO), herein after may be referred to as 'EDA-10 mole PO' or 'EDA10P';

EDA propoxylated by 15 moles of propylene oxide (PO), herein after may be referred to as 'EDA-15 mole PO' or 'EDA15P';

EDA propoxylated by 20 moles of propylene oxide (PO), herein after may be referred to as 'EDA-20 mole PO' or 'EDA20P';

EDA propoxyated by 25 moles of propylene oxide (PO), herein after may be referred to as 'EDA-25 mole PO' or 'EDA25P';

EDA propoxyated by 30 moles of propylene oxide (PO), herein after may be referred to as 'EDA-30 mole PO' or 'EDA30P'.

5 With aim to overcome above-described problems of prior art and to achieve above-described objects of the invention, the inventor has also found that if the hydrogen sulfide scavenging additive composition of the present invention further comprises oxide derivative of nonyl phenol (NP), then the scavenging of the sulfur containing compounds is also achieved even when the additive composition of the present invention comprises a
10 substantially reduced amount of nitrogen based hydrogen sulfide scavengers, i.e. triazines, and/or is used in a substantially reduced amount.

Therefore, in accordance with another embodiment of the present invention, the present additive composition may further comprise at least one oxide derivative of nonyl phenol (NP).

15 In accordance with one of the preferred embodiments of the present invention, the oxide derivative of nonyl phenol may comprise an ethylene oxide (EO) derivative of nonyl phenol (EO-NP), propylene oxide (PO) derivative of nonyl phenol (PO-NP), or a mixture thereof.

In accordance with one of the preferred embodiments of the present invention, the
20 present composition does not comprise aliphatic secondary amine, aliphatic di-amine, aliphatic primary amine, aliphatic mono-amine, alkanolamine including monoalkanolamine, particularly including monoethanolamine (MEA), and triethanolamine (TEA).

In accordance with one of the preferred embodiments of the present invention, the
25 hydrocarbon comprises (or includes) hydrocarbon stream including, but not limited to crude oil, fuel oil, sour gas, asphalts and refined products contained in storage tanks, vessels, and pipelines.

In accordance with one of the preferred embodiments of the present invention, the hydrogen sulfide containing compounds comprise (or include) sulfur containing
30 compounds, or mercaptans, or a mixture thereof.

Accordingly, in accordance with one of the preferred embodiments of the present invention, in carrying out the method of scavenging or method of use of the present additive composition for scavenging the hydrogen sulfide in hydrocarbon including hydrocarbon stream, the scavenging additive composition is added to the hydrocarbon or

gas stream or hydrocarbon stream in a concentration sufficient to substantially scavenge hydrogen sulfide therein.

In accordance with one of the preferred embodiments of the present invention, the present invention relates to a composition for scavenging hydrogen sulfide, wherein the composition comprises:

- (a) a hydrocarbon comprising sulfur containing compounds; and
- (b) a hydrogen sulfide scavenging additive composition;

wherein the hydrogen sulfide scavenging additive composition comprises at least a combination of:

- (A) at least one nitrogen based hydrogen sulfide scavenger; and
- (B) at least one aliphatic tertiary amine,

wherein the nitrogen based hydrogen sulfide scavenger comprises triazine based hydrogen sulfide scavenger; and

wherein the aliphatic tertiary amine is the one as described herein.

In accordance with one of the preferred embodiments of the present invention, the present invention also relates to a hydrogen sulfide scavenging additive composition for scavenging hydrogen sulfide in hydrocarbon comprising sulfur containing compounds, wherein said additive composition comprises at least a combination of:

- (A) at least one nitrogen based hydrogen sulfide scavenger; and

- (B) at least one aliphatic tertiary amine,

wherein the nitrogen based hydrogen sulfide scavenger comprises triazine based hydrogen sulfide scavenger;

wherein the aliphatic tertiary amine comprises:

- (i) tri-isopropanolamine (TIPA);
- (ii) N,N,N',N'-Tetrakis (2-hydroxyethyl) ethylene-diamine (THEED);
- (iii) ethylene oxide derivative of TIPA (EO-TIPA);
- (iv) propylene oxide derivative of TIPA (PO-TIPA);
- (v) ethylene oxide derivative of ethylene diamine (EO-EDA);
- (vi) propylene oxide derivative of ethylene diamine (PO-EDA); or
- (vii) a mixture thereof.

In accordance with one of the preferred embodiments of the present invention, the present invention also relates to a hydrogen sulfide scavenging additive composition for scavenging hydrogen sulfide in hydrocarbon comprising sulfur containing compounds, wherein said additive composition does not comprise:

- a) monoethanol amine (MEA);

- b) diethanol amine (DEA); and
- c) triethanol amine (TEA).

In accordance with one of the embodiments of the present invention, it also relates to a method for scavenging hydrogen sulphide in hydrocarbon comprising sulfur
5 containing compounds, wherein the method comprises contacting the hydrocarbon with the hydrogen sulfide scavenging additive composition of the present invention, wherein the hydrogen sulfide scavenging additive composition comprises at least a combination of:

(A) at least one nitrogen based hydrogen sulfide scavenger; and

- 10 (B) at least one aliphatic tertiary amine,
wherein the nitrogen based hydrogen sulfide scavenger comprises triazine based hydrogen sulfide scavenger.

In accordance with one of the embodiments of the present invention, it also relates to a method of using the hydrogen sulfide scavenging additive composition of the
15 present invention for scavenging hydrogen sulphide in hydrocarbon comprising sulfur containing compounds, wherein the method comprises adding to the hydrocarbon the hydrogen sulfide scavenging additive composition of the present invention, wherein the hydrogen sulfide scavenging additive composition comprises at least a combination of:

(A) at least one nitrogen based hydrogen sulfide scavenger; and

- 20 (B) at least one aliphatic tertiary amine,
wherein the nitrogen based hydrogen sulfide scavenger comprises triazine based hydrogen sulfide scavenger.

In accordance with one of the preferred embodiments of the present invention, the hydrogen sulfide scavenging may be carried at a suitable temperature.

25 From the foregoing description and following supported examples, a reference to which is drawn here, it may be noted that:

Efficiency of nitrogen based hydrogen sulphide scavengers including triazine based hydrogen sulphide scavengers for scavenging hydrogen sulphide improves substantially on addition of the aliphatic tertiary amine of the present invention both at
30 room temperature and at high temperature.

The improvement in efficiency of the nitrogen based hydrogen sulphide scavengers including triazine based hydrogen sulphide scavengers for hydrogen sulphide scavenging is substantially much higher on addition of the aliphatic tertiary amine of the present invention at high temperature as compared to that at room temperature.

The present invention is now described with the help of following examples, which are not intended to limit scope of present invention, but have been incorporated to illustrate advantages of present invention and best mode to perform it. The following examples also demonstrate surprising and unexpected effectiveness (synergistic effects) of the scavenging additive composition of present invention.

EXAMPLES:

In the present examples, following abbreviations have been used:

MEAT is mono-ethanolamine triazine, it is taken in its two concentrations of 50% or 32%;

10 TIPA is tri-isopropanolamine;

EO-TIPA is ethylene oxide (EO) derivative of TIPA;

PO-TIPA is propylene oxide (PO) derivative of TIPA;

THEED is N,N,N',N'-Tetrakis (2-hydroxyethyl) ethylene-diamine;

EDA is ethylene diamine;

15 EO-EDA is ethylene oxide (EO) derivative of EDA;

PO-EDA is propylene oxide (PO) derivative of EDA;

NP is nonyl phenol;

EO-NP is ethylene oxide (EO) derivative of NP;

PO-NP is propylene oxide (PO) derivative of NP;

20 'TIPA-PO 4 mole' or may be written as 'TIPA-4 mole PO' or 'TI4P' is propylene oxide (PO) derivative of TIPA, and is obtained by reacting 1 mole of TIPA with 4 moles of propylene oxide (PO);

'TIPA-PO 8 mole' or may be written as 'TIPA-8 mole PO' or 'TI8P' is propylene oxide (PO) derivative of TIPA, and is obtained by reacting 1 mole of TIPA with 8 moles of propylene oxide (PO);

'TIPA-PO 10 mole' or may be written as 'TIPA-10 mole PO' or 'TI10P' is propylene oxide (PO) derivative of TIPA, and is obtained by reacting 1 mole of TIPA with 10 moles of propylene oxide (PO);

30 'TIPA-PO 16 mole' or may be written as 'TIPA-16 mole PO' or 'TI16P' is propylene oxide (PO) derivative of TIPA, and is obtained by reacting 1 mole of TIPA with 16 moles of propylene oxide (PO);

'TIPA-PO 20 mole' or may be written as 'TIPA-20 mole PO' or 'TI20P' is propylene oxide (PO) derivative of TIPA, and is obtained by reacting 1 mole of TIPA with 20 moles of propylene oxide (PO);

‘TIPA-PO 25 mole’ or may be written as ‘TIPA-25 mole PO’ or ‘TI25P’ is propylene oxide (PO) derivative of TIPA, and is obtained by reacting 1 mole of TIPA with 25 moles of propylene oxide (PO);

5 ‘TIPA-PO 30 mole’ or may be written as ‘TIPA-30 mole PO’ or ‘TI30P’ is propylene oxide (PO) derivative of TIPA, and is obtained by reacting 1 mole of TIPA with 30 moles of propylene oxide (PO);

‘TIPA-EO 10 mole’ or may be written as ‘TIPA-10 mole EO’ or ‘TI10E’ is ethylene oxide (EO) derivative of TIPA and is obtained by reacting 1 mole of TIPA with 10 moles of ethylene oxide (EO).

10 ‘TIPA-EO 15 mole’ or may be written as ‘TIPA-15 mole EO’ or ‘TI15E’ is ethylene oxide (EO) derivative of TIPA and is obtained by reacting 1 mole of TIPA with 15 moles of ethylene oxide (EO).

‘TIPA-EO 20 mole’ or may be written as ‘TIPA-20 mole EO’ or ‘TI20E’ is ethylene oxide (EO) derivative of TIPA and is obtained by reacting 1 mole of TIPA with 15 20 moles of ethylene oxide (EO).

‘TIPA-EO 20.8 mole’ or may be written as ‘TIPA-20.8 mole EO’ or ‘TI208E’ is ethylene oxide (EO) derivative of TIPA and is obtained by reacting 1 mole of TIPA with 20.8 moles of ethylene oxide (EO).

‘TIPA-EO 26 mole’ or may be written as ‘TIPA-26 mole EO’ or ‘TI26E’ is 20 ethylene oxide (EO) derivative of TIPA and is obtained by reacting 1 mole of TIPA with 26 moles of ethylene oxide (EO).

‘NP-EO 16 mole’ or may be written as ‘NP-16 mole EO’ or ‘NP16E’ is ethylene oxide (EO) derivative of nonyl phenol (NP) and is obtained by reacting 1 mole of nonyl phenol (NP) with 16 moles of ethylene oxide (EO).

25 ‘NP-EO 20 mole’ or may be written as ‘NP-20 mole EO’ or ‘NP20E’ is ethylene oxide (EO) derivative of nonyl phenol (NP) and is obtained by reacting 1 mole of nonyl phenol (NP) with 20 moles of ethylene oxide (EO).

‘NP-EO 40 mole’ or may be written as ‘NP-40 mole EO’ or ‘NP40E’ is ethylene oxide (EO) derivative of nonyl phenol (NP) and is obtained by reacting 1 mole of nonyl 30 phenol (NP) with 40 moles of ethylene oxide (EO).

‘NP-PO 40 mole’ or may be written as ‘NP-40 mole PO’ or ‘NP40P’ is propylene oxide (PO) derivative of nonyl phenol (NP) and is obtained by reacting 1 mole of nonyl phenol (NP) with 40 moles of propylene oxide (PO).

‘EDA-PO 8 mole’ or may be written as ‘EDA-8 mole PO’ or ‘EDA8P’ is propylene oxide (PO) derivative of ethylene diamine (EDA) and is obtained by reacting 1 mole of EDA with 8 moles of propylene oxide (PO).

‘EDA-PO 16 mole’ or may be written as ‘EDA-16 mole PO’ or ‘EDA16P’ is propylene oxide (PO) derivative of ethylene diamine (EDA) and is obtained by reacting 1 mole of EDA with 16 moles of propylene oxide (PO).

‘EDA-PO 20 mole’ or may be written as ‘EDA-20 mole PO’ or ‘EDA20P’ is propylene oxide (PO) derivative of ethylene diamine (EDA) and is obtained by reacting 1 mole of EDA with 20 moles of propylene oxide (PO).

‘EDA-PO 25 mole’ or may be written as ‘EDA-25 mole PO’ or ‘EDA25P’ is propylene oxide (PO) derivative of ethylene diamine (EDA) and is obtained by reacting 1 mole of EDA with 25 moles of propylene oxide (PO).

‘EDA-PO 31 mole’ or may be written as ‘EDA-31 mole PO’ or ‘EDA31P’ is propylene oxide (PO) derivative of ethylene diamine (EDA) and is obtained by reacting 1 mole of EDA with 31 moles of propylene oxide (PO).

Polypropylene glycol having molecular weight of about 400 Daltons (PPG400);

Polypropylene glycol having molecular weight of about 1000 Daltons (PPG1000);

Polypropylene glycol having molecular weight of about 2000 Daltons (PPG2000);

Polypropylene glycol having molecular weight of about 3000 Daltons (PPG3000);

Polypropylene glycol having molecular weight of about 4000 Daltons (PPG4000),

which are polymers made from propylene oxide.

Polyethylene glycol having molecular weight of about 200 Daltons (PEG200);

Polyethylene glycol having molecular weight of about 400 Daltons (PEG400);

Polyethylene glycol having molecular weight of about 600 Daltons (PEG600).

which are polymers made from ethylene oxide.

One of ordinary skill in the art may calculate active content dosage and ratio of the components (ingredients) of the present composition as known in the art. For example, as follows:

Additive	Dosage (in ppm)	Active dosage (in ppm) would be
MEAT(32%) + TIPA-PO 30 mole in 90/10 weight ratio	500 + 17.5	160 + 17.5

Total active dosage = $160 + 17.5 = 177.5$ ppm

5 MEAT contribution would be = $160/177.5 \times 100 = 90.14\% \sim 90\%$;

TIPA-PO contribution would be = $17.5/177.5 \times 100 = 9.86\% \sim 10\%$.

Therefore, the weight ratio of MEAT(32%) and 'TIPA-PO 30 mole' would be 90:10.

10 By applying the above method, one of ordinary skill in the art may calculate the weight ratio, as taken in the present examples from the ppm dosages thereof.

The average molecular weight of the additives used in the present examples may be calculated by using gel permeation chromatography (GPC) in Daltons. For example, the average molecular weight of some of the additive amines used in the present invention is as tabulated herein below merely for the sake of information without any
15 intention to limit the scope thereof:

TABLE – I

Additive	Mol. Wt. (by GPC in Daltons)
TIPA as such	193
TIPA-PO, 30 mole	2264
EDA-PO, 16 mole	1117
TIPA-EO, 26 mole	1328
NP-PO, 40 mole	1921
NP-EO, 20 mole	1193

20

The H₂S was purged in 100 ml of kerosene till concentration of H₂S vapor reaches to 2000 ppm in blank sample [Blank – I]. To the resulted solution, a dosage of the prior art additive consisting of triazine and the additive composition of the present invention as given in following tables was added and H₂S scavenging capabilities in %
25 efficiency were measured at 50⁰C for 15 minutes. The residual H₂S in vapor was detected by a gas detector tube (Unifos). The results are presented in the following tables.

The hydrogen sulphide scavenging efficiency of some of the individual amines was also measured for dosages of 10 ppm, 100 ppm and 200 ppm. It may be noted that in the compositions of the present examples, the amine was added in an amount of less than 50 ppm, therefore, these comparative tests with dosages of 10 ppm, 100 ppm and 200 ppm are sufficient to know whether the individual amine would have hydrogen sulphide scavenging efficiency or not. It was found that the individual amines do not have hydrogen sulphide scavenging efficiency.

TABLE – II

Amine	Dosage (in ppm)	Efficiency (in % at 50°C)
TIPA	50	5
TIPA	100	10
TIPA	200	12.5
EDA	50	10
TIPA-PO, 25 mole	50	10
TIPA-PO, 30 mole	50	10
TIPA-PO, 30 mole	100	10
TIPA-PO, 30 mole	200	15
EDA-PO 16 mole	100	7.5
EDA-PO 16 mole	200	12.5

Similarly, the hydrogen sulphide scavenging efficiency of MEAT of 32% activity and of 50% activity was also measured. It was found that the MEAT has hydrogen sulphide scavenging efficiency, but it was found to be substantially low.

TABLE – III

Dosage (in ppm) [MEAT]	MEAT (32% active)
500	45.5
600	72.7
700	77.3
900	84.1

TABLE – IV

Additive	Dosage (ppm) as such	% Efficiency (RT, 26°C)	% Efficiency (60°C)	% Efficiency (80°C)	% Efficiency (100°C)
MEAT (50% active)	50	25	15	11	5
	100	50	40	20	15
	200	65	50	30	20
	300	75	70	60	45

The hydrogen sulphide scavenging efficiency of the present compositions comprising combination of MEAT (50% active) and amines of the present invention was measured at various temperatures, i.e. at room temperature (26°C), and at 60°C, 80°C and 100°C, and has been presented in Table V. It has been found that the hydrogen sulphide scavenging efficiency of the MEAT surprising and unexpectedly improves on addition of amines of the present invention, thereby confirming the synergistic effect of the present compositions.

Table – V

Composition	Dosage (ppm) as such	% Efficiency (RT, 26°C)	% Efficiency (60°C)	% Efficiency (80°C)	% Efficiency (100°C)
Blank		--	--	--	--
MEAT	50	25	15	11	5
	100	50	40	20	15
	200	65	50	30	20
	300	75	70	60	45
MEAT (50 ppm) + TIPA (5 ppm)	50+ 2.5	35	45	65	69
	100 + 5	60	75	85	90
MEAT (50 ppm) + TIPA-10 mole EO (5 ppm)	50 + 2.5	50	60	63	72
	100 + 5	80	80	80	90
MEAT (50 ppm) + TIPA-15 mole EO (5 ppm) +	50	55	60	70	75
	100	80	80	85	85
MEAT (50 ppm) + TIPA-20.8 mole EO (5 ppm)	50	60	65	75	80
	100	85	85	90	90
MEAT (50 ppm) + TIPA-26 mole EO (5 ppm)	50	55	65	75	80
	100	85	85	90	90
MEAT (50 ppm) + TIPA-4 mole PO (5 ppm)	50 + 2.4	30	40	65	74
	100 + 5	55	70	90	90
MEAT (50 ppm) + TIPA - 4 mole PO (5 ppm)	50	40	50	70	81
	100	65	80	95	100
MEAT (50 ppm) + TIPA-8 mole PO (5 ppm)	50 + 2.5	60	75	85	98
	100 + 5	70	90	100	100
MEAT (50 ppm) + TIPA-10 mole PO (5 ppm)	50	65	70	85	98
	100	70	85	100	100
MEAT (50 ppm) + TIPA - 16 mole PO (5 ppm)	50	75	80	90	100
	100	90	97	100	100
MEAT (50 ppm) + TIPA - 10 mole PO + TIPA 16	50	72	78	ND	ND
	100	87	95	ND	ND

mole PO (5 ppm in 1:1 ratio)					
MEAT (50 ppm) + TIPA - 20 mole PO (5 ppm)	50	79	75	90	95
	100	95	90	100	100

The hydrogen sulphide scavenging efficiency of the present compositions comprising combination of MEAT (50% active) and amines of the present invention was also measured at temperature of 50°C for different durations, i.e. at 1 hr., 2 hrs., 4 hrs., 6 hrs., and 48 hrs., and has been presented in Table VI. It has been found that the hydrogen sulphide scavenging efficiency of the MEAT surprising and unexpectedly improves on addition of amines of the present invention even after longer durations of time, thereby confirming the synergistic effect of the present compositions.

Table – VI

Additive	Dosage ppm as such	Efficiency, % (1 hr.)	Efficiency, % (2 hrs)	Efficiency, % (4 hrs)	Efficiency, % (6 hrs)	Efficiency, % (48 hrs)
MEA Triazine (50%)	50 ppm	20	25	30	35	50
MEA Triazine (50%) + TIPA-PO 20 mole	50+2.5 ppm	50	75	85	90	99
SR 1954 (MEAT-50, BKC80-5/water-45)	50 ppm	35	45	55	60	90

For the comparative purpose, the hydrogen sulphide scavenging efficiency of the compositions comprising combination of MEAT (50% active) and PPG and PEG of various molecular weights (as measured by GPC in Daltons), and prior art additive BKC (benzalkonium quaternary ammonium salt) was also measured at various temperatures, i.e. at room temperature (26°C), and at 60°C, 80°C and 100°C, and has been presented in Table VII. It has been found that the hydrogen sulphide scavenging efficiency of the MEAT improves, but very marginally on addition of PPG, PEG, prior art additive BKC, thereby confirming that the PPG and PEG do not have synergistic effect.

Table – VII

Composition (dosage in ppm)	Dosage (ppm) as such	% Efficiency (RT, 26°C)	% Efficiency (60°C)	% Efficiency (80°C)	% Efficiency (100°C)
Blank		--	--	--	--
MEAT	50	25	15	11	5
	100	50	40	20	15
	200	65	50	30	20
	300	75	70	60	45

MEAT/PPG-400 (MEAT-50/PPG400-5)	50	30	15	13	8
	100	49	38	23	18
MEAT/PPG-1000 (MEAT-50/PPG1000-5)	50	26	18	15	10
	100	49	40	25	20
MEAT/PPG-2000 (MEAT-50/PPG2000-5)	50	30	15	15	10
	100	49	40	30	25
MEAT/PPG-3000 (MEAT-50/PPG3000-5)	50	28	20	20	15
	100	51	43	35	30
MEAT/PPG-4000 (MEAT-50/PPG4000-5)	50	31	23	23	20
	100	54	48	40	35
MEAT/PEG-200 (MEAT-50/PEG200-5)	50	28	18	10	10
	100	50	44	20	15
MEAT/PEG-400 (MEAT-50/PEG400-5)	50	25	18	15	10
	100	48	46	20	20
MEAT/PEG-600 (MEAT-50/PEG600-5)	50	35	21	15	10
	100	58	49	18	23
SR 1954 (MEAT-50/BKC-5)	50	45	30	30	30
	100	80	60	50	45
	200	99	70	65	60
	300	100	80	80	70

The hydrogen sulphide scavenging efficiency of the present compositions comprising combination of MEAT (50% active) and amines of the present invention was also measured at temperature of 50°C for duration of 15 min., and compared with diethyl amine (DEA, which contains “-OH” group, but is a secondary amine), trimethylamine (TEA), tetraethylenepentamine (TEPA, which is a secondary and mono amine, and does not contain -OH group), and has been presented in Table VIII. It has been found that the hydrogen sulphide scavenging efficiency of the MEAT surprising and unexpectedly improves on addition of amines of the present invention even after shorter durations of 15 mins., thereby confirming the synergistic effect of the present compositions.

For example, there is substantial improvement in the hydrogen sulphide scavenging efficiency at all dosages for composition comprising MEAT and TIPA, particularly at 700 ppm dosage the % efficiency for H₂S scavenging improves from 70% to 95% and at 900 ppm dosage the improvement is from 77.5% to >99.5%. Same synergistic effect was found for the present compositions comprising MEAT and PO-TIPA. Similarly, there is substantial improvement at all dosages, particularly at 700 ppm dosage the % efficiency for H₂S scavenging improves from 70% to 87.5%, and at 900 ppm dosage the improvement is from 77.5% to 95% for the present composition comprising MEAT and THEED.

On the contrary, the comparative composition comprising MEAT and DEA did not show improvement at all dosages. For example, at 700 ppm dosage the % efficiency

for H₂S scavenging improves very marginally from 70% to 72.5%, and at 900 ppm dosage there is no improvement. i.e. it remains at 77.5%.

Similarly, the another comparative composition comprising MEAT and TEA also did not show improvement at all dosages. For example, at 700 ppm dosage the % efficiency for H₂S scavenging improves very marginally from 70% to 75%, and at 900 ppm dosage there is no improvement. i.e. it remains at 77.5%.

Similarly, the another comparative composition comprising MEAT and TEPA also did not show improvement at all dosage. For example, at 700 ppm dosage the % efficiency for H₂S scavenging improves marginally from 70% to 75%, and at 900 ppm dosage also it improves marginally from 77.5% to 80%.

Table – VIII

Composition [MEAT + Amine]	Dosage (in ppm) [MEAT + Amine]	% Efficiency (at 50°C)
MEAT	500	37.5
	600	65.0
	700	70.0
	900	77.5
MEAT + TIPA (Present Composition)	500 + 25	55.0
	600 + 30	90.0
	700 + 35	95.0
	900 + 45	>99.5
MEAT + TIPA-PO, 25 mole (Present Composition)	500 + 25	98.9
	600 + 30	>99.95
	700 + 35	>99.95
	900 + 45	>99.95
MEAT + TIPA-PO, 30 mole (Present Composition)	500 + 25	99.1
	600 + 30	>99.95
	700 + 35	>99.95
	900 + 45	>99.95
MEAT + THEED (Present Composition)	500 + 25	47.5
	600 + 30	75.0
	700 + 35	87.5
	900 + 45	95.0
MEAT + DEA (Comparative Composition)	500 + 25	40.0
	600 + 30	67.5
	700 + 35	72.5
	900 + 45	77.5
MEAT + TEA (Comparative Composition)	500 + 25	42.5
	600 + 30	67.5
	700 + 35	75.0
	900 + 45	77.5
MEAT + TEPA Comparative Composition)	500 + 25	45.0
	600 + 30	70.0
	700 + 35	75.0
	900 + 45	80.0

The hydrogen sulphide scavenging efficiency of the present compositions comprising combination of MEAT (32% active) and amines of the present invention was also measured at temperature of 50°C for duration of 15 min., and has been presented in Tables IX to XV. It has been found that the hydrogen sulphide scavenging efficiency of the MEAT surprisingly and unexpectedly improves on addition of amines of the present invention, thereby confirms the synergistic effect of the present compositions.

TABLE – IX

Dosage (in ppm) [MEAT + Amine]	MEAT + TIPA in 90:10 weight ratio
500 + 17.5	75
600 + 21	82.5
700 + 24.5	89
900 + 31.5	91

The data in Table IX confirms that on addition of TIPA to MEAT, a synergistic effect (improvement in percent (%) hydrogen sulfide scavenging efficiency) is seen.

TABLE – X

Dosage (in ppm) [MEAT + Amine + Oxide derivative of NP]	MEAT + TIPA + 'NP-EO 40 mole' in 90:7:3 weight ratio	Dosage (in ppm) [MEAT + Amine + Oxide derivative of NP]	MEAT + TIPA + 'NP-EO 40 mole' in 90:5:5 weight ratio
300 + 7.35 + 3.15	93	300 + 5.25 + 5.25	66.25
400 + 9.8 + 4.2	99.8	400 + 7 + 7	80
500 + 12.25 + 5.25	>99.95	500 + 8.75 + 8.75	92.5
600 + 14.7 + 6.3		600 + 10.5 + 10.5	99.2

The data in Table X confirms that on addition of (ethylene) oxide derivative of nonyl phenol (NP) to a combination of MEAT and TIPA, a synergistic effect (improvement in percent (%) hydrogen sulfide scavenging efficiency) is seen.

TABLE – XIa

Dosage (in ppm) [MEAT + Amine]	MEAT + 'TIPA-PO 30 mole' in 90:10 weight ratio	Dosage (in ppm) [MEAT + Amine + Oxide derivative of NP]	MEAT + 'TIPA-PO 30 mole' + 'NP-EO 20 mole' in 90:7:3 weight ratio	Dosage (in ppm) [MEAT + Amine + Oxide derivative of NP]	MEAT + 'TIPA-PO 30 mole' + 'NP-EO 20 mole' in 90:5:5 weight ratio
500 + 17.5	91.2	300 + 7.35 + 3.15	72.7	300 + 5.25 + 5.25	72.5
600 + 21	99.6	400 + 9.8 + 4.2	87.5	400 + 7 + 7	87.5
700 + 24.5	99.95	500 + 12.25 + 5.25	99.9	500 + 8.75 + 8.75	98
900 + 31.5	>99.95	600 + 14.7 + 6.3	>99.95	600 + 10.5 + 10.5	>99.95

The data in Table XIa confirms that on addition of TIPA-PO to MEAT, and on addition of (ethylene) oxide derivative of nonyl phenol (NP) to a combination of MEAT and TIPA-PO, a synergistic effect (improvement in percent (%) hydrogen sulfide scavenging efficiency) is seen.

TABLE – XIb

Dosage (in ppm of composition)	MEAT	MEAT + TI16P in 90:10 weight ratio	MEAT + TI20P in 90:10 weight ratio	MEAT + TI25P in 90:10 weight ratio	MEAT + TI30P in 90:10 weight ratio
500	45.5	81.8	90.9	90.0	91.2
600	72.7	ND	99.1	99.5	99.6
700	77.3	97.7	99.8	99.95	99.95
900	84.1	99.5	99.95	>99.95	>99.95

The data in Table XIb confirms that on addition of TIPA-PO to MEAT, a synergistic effect (improvement in percent (%) hydrogen sulfide scavenging efficiency) is seen.

TABLE – XII

Dosage (in ppm) [MEAT + Amine]	MEAT + 'TIPA-PO 30 mole' in 90:10 weight ratio	Dosage (in ppm) [MEAT + Amine + Oxide derivative of NP]	MEAT + 'TIPA-PO 30 mole' + 'NP-PO 40 mole' in 90:7:3 wt. ratio	Dosage (in ppm) [MEAT + Amine + Oxide derivative of NP]	MEAT + 'TIPA-PO 30 mole' + 'NP-PO 40 mole' in 90:5:5 wt. ratio
500 + 17.5	91.2	300 + 7.35 + 3.15	67.5	300 + 5.25 + 5.25	67.5
600 + 21	99.6	400 + 9.8 + 4.2	82.5	400 + 7 + 7	82.5
700 + 24.5	99.95	500 + 12.25 + 5.25	95	500 + 8.75 + 8.75	94
900 + 31.5	>99.95	600 + 14.7 + 6.3	>99.95	600 + 10.5 + 10.5	99.8

The data in Table XII confirms that on addition of TIPA-PO to MEAT, and on addition of (propylene) oxide derivative of nonyl phenol (NP) to a combination of MEAT and TIPA-PO, a synergistic effect (improvement in percent (%) hydrogen sulfide scavenging efficiency) is seen.

TABLE – XIII

Dosage (in ppm) [MEAT + Amine + Oxide derivative of NP]	MEAT + 'TIPA-EO 26 mole' + 'NP-EO 40 mole' in 90:7:3 weight ratio	Dosage (in ppm) [MEAT + Amine + Oxide derivative of NP]	MEAT + 'TIPA-EO 26 mole' + 'NP-EO 40 mole' in 90:5:5 weight ratio
300 + 7.35 + 3.15	67.5	300 + 5.25 + 5.25	66.25
400 + 9.8 + 4.2	82.5	400 + 7 + 7	81.25
500 + 12.25 + 5.25	94.5	500 + 8.75 + 8.75	93.75
600 + 14.7 + 6.3	99.9	600 + 10.5 + 10.5	98

The data in Table XIII confirms that on addition of (ethylene) oxide derivative of nonyl phenol (NP) to combination of MEAT and TIPA-EO, a synergistic effect (improvement in percent (%) hydrogen sulfide scavenging efficiency) is seen.

TABLE – XIV

Dosage (in ppm) [MEAT + Amine]	MEAT + 'EDA-PO 16 mole' in 90:10 weight ratio	Dosage (in ppm) [MEAT + Amine + Oxide derivative of NP]	MEAT + 'EDA-PO 16 mole' + 'NP-EO 40 mole' in 90:7:3 wt. ratio
500 + 17.5	92	300 + 7.35 + 3.15	75
600 + 21	94.1	400 + 9.8 + 4.2	92
700 + 24.5	99.5	500 + 12.25 + 5.25	99.9
900 + 31.5	>99.95	600 + 14.7 + 6.3	>99.95

The data in Table XIV confirms that on addition of EDA-PO to MEAT, and on addition of (ethylene) oxide derivative of nonyl phenol (NP) to combination of MEAT and EDA-PO, a synergistic effect (improvement in percent (%) hydrogen sulfide scavenging efficiency) is seen.

TABLE – XV

Dosage (in ppm) [MEAT + Amine + Oxide derivative of NP]	MEAT + EDA-PO 16 mole + NP-PO 40 mole in 90:7:3 weight ratio	Dosage (in ppm) [MEAT + Amine + Oxide derivative of NP]	MEAT + EDA-PO 16 mole + NP-PO 40 mole in 90:5:5 weight ratio
300 + 7.35 + 3.15	80	300 + 5.25 + 5.25	82.5
400 + 9.8 + 4.2	95	400 + 7 + 7	96.5
500 + 12.25 + 5.25	99.9	500 + 8.75 + 8.75	99.9
600 + 14.7 + 6.3	>99.95	600 + 10.5 + 10.5	>99.95

The data in Table XV confirms that on addition of EDA-PO and NP-PO to MEAT, a synergistic effect (improvement in percent (%) hydrogen sulfide scavenging efficiency) is seen.

The foregoing examples confirm synergistic effects, i.e. surprising and unexpected effects of the present invention over the prior art.

Therefore, the foregoing experiments confirm that nitrogen based compositions are capable of scavenging H₂S. However, when the present composition comprising a combination of nitrogen based H₂S scavengers and one or more aliphatic tertiary amine is used, the H₂S scavenging efficiency of the nitrogen based H₂S scavengers is, surprisingly and unexpectedly, substantially increased confirming synergistic effect of the scavenging additive composition of the present invention.

The above experimental findings confirm surprising, and unexpected technical effects and advantages, and synergistic property of the presently provided hydrogen sulfide scavenging additive compositions.

The above findings also confirm that compositions of the present invention have technical advantages and surprising effects over the prior art and comparative additives and compositions.

It may be noted that the present invention has been described with the help of
5 foregoing examples, which are not intended to limit scope of the present invention, but are only illustrative.

Furthermore, as amount of the prior art additive (i.e. triazine) has been substantially reduced to achieve desired scavenging efficiency, the present compositions are more economical and environmental friendly.

10 It may be noted that the term “about” as employed herein is not intended to enlarge scope of claimed invention, but has been incorporated only to include permissible experimental errors of the field of the present invention.

Claims

1. A hydrogen sulfide scavenging additive composition for scavenging hydrogen sulfide in hydrocarbon comprising sulfur containing compounds, wherein said additive composition comprises at least a combination of:
 - (A) at least one nitrogen based hydrogen sulfide scavenger; and
 - (B) at least one aliphatic tertiary amine,wherein the nitrogen based hydrogen sulfide scavenger comprises triazine based hydrogen sulfide scavenger; and
wherein the aliphatic tertiary amine comprises tri-isopropanolamine (TIPA), N,N,N',N'-Tetrakis (2-hydroxyethyl) ethylene-diamine (THEED), ethylene oxide (EO) derivative of TIPA (EO-TIPA), propylene oxide (PO) derivative of TIPA (PO-TIPA), ethylene oxide (EO) derivative of ethylene diamine (EO-EDA), propylene oxide (PO) derivative of ethylene diamine (PO-EDA), or a mixture thereof; and
wherein the composition does not comprise:
 - a) monoethanol amine (MEA);
 - b) diethanol amine (DEA); and
 - c) triethanol amine (TEA).
2. The additive composition as claimed in **Claim 1**, wherein the triazine based hydrogen sulfide scavenger comprises mono-ethanolamine triazine (MEAT) based hydrogen sulfide scavenger.
3. The additive composition as claimed in **Claim 1 or Claim 2**, wherein the composition further comprises oxide derivative of nonyl phenol (NP).
4. The additive composition as claimed in **Claim 3**, wherein the oxide derivative of nonyl phenol comprises an ethylene oxide (EO) derivative of nonyl phenol (EO-NP) or propylene oxide (PO) derivative of nonyl phenol (PO-NP), or a mixture thereof.

5. The additive composition as claimed in any one of the preceding **Claims 1 to 4**, wherein the hydrocarbon comprising sulfur containing compounds comprises crude oil, fuel oil, sour gas, asphalts, or refined products.
6. The additive composition as claimed in any one of the preceding **Claims 1 to 5**, wherein the sulfur containing compounds comprise hydrogen sulfide containing compounds, mercaptans, or a mixture thereof.
7. A composition comprising:
 - (a) a hydrocarbon; and
 - (b) a hydrogen sulfide scavenging additive composition;wherein the hydrogen sulfide scavenging additive composition comprises at least a combination of:
 - (A) at least one nitrogen based hydrogen sulfide scavenger; and
 - (B) at least one aliphatic tertiary amine,wherein the hydrocarbon comprises sulfur containing compounds;
wherein the nitrogen based hydrogen sulfide scavenger comprises triazine based hydrogen sulfide scavenger; and
wherein the aliphatic tertiary amine is as claimed in **claim 1**.
8. The composition as claimed in **claim 7**, wherein the triazine based hydrogen sulfide scavenger comprises mono-ethanolamine triazine (MEAT) based hydrogen sulfide scavenger.
9. The composition as claimed in **Claim 7 or Claim 8**, wherein the composition further comprises oxide derivative of nonyl phenol (NP).
10. The composition as claimed in **Claim 9**, wherein the oxide derivative of nonyl phenol comprises an ethylene oxide (EO) derivative of nonyl phenol (EO-NP) or propylene oxide (PO) derivative of nonyl phenol (PO-NP), or a mixture thereof.

11. A method for scavenging hydrogen sulphide in hydrocarbon comprising sulfur containing compounds, wherein the method comprises contacting the hydrocarbon with the hydrogen sulfide scavenging additive composition, wherein the hydrogen sulfide scavenging additive composition is as claimed in any one of the preceding **claims 1 to 6**.
12. A method of using the hydrogen sulfide scavenging additive composition for scavenging hydrogen sulphide in hydrocarbon comprising sulfur containing compounds, wherein the method comprises adding to the hydrocarbon the hydrogen sulfide scavenging additive composition as claimed in any one of the preceding **claims 1 to 6**.