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(54) Titre : AGENTS MOUSSANTS A BASE D'IMIDAZOLINE DESTINES A L'INJECTION EN FOND DE TROU
(54) Title: IMIDAZOLINE-BASED FOAMERS FOR DOWNHOLE INJECTION

(57) Abrégé/Abstract:
A method of removing metals and amines from crude oil comprising adding an effective metal removing amount of one or more hydroxycarboxylic acids selected from lactic acid and malic acid and salts thereof to said crude oil; adding wash water to said crude oil; mixing said crude oil, acid and wash water to form an emulsion; and resolving said emulsion into an aqueous phase and crude oil having a reduced metals content.

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(54) Title: FOAMERS FOR DOWNHOLE INJECTION

(57) Abstract: A method of removing metals and amines from crude oil comprising adding an effective metal removing amount of one or more hydroxycarboxylic acids selected from lactic acid and malic acid and salts thereof to said crude oil; adding wash water to said crude oil; mixing said crude oil, acid and wash water to form an emulsion; and resolving said emulsion into an aqueous phase and crude oil having a reduced metals content.

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IMIDAZOLINE-BASED FOAMERS FOR DOWNHOLE INJECTION

TECHNICAL FIELD

[001] This invention relates generally to methods of using foamer compositions for treatment of oil and gas wells to enhance production. More specifically, the invention relates to foamer compositions including an imidazoline-based compound. The invention has particular relevance to such compositions that also include corrosion-reducing properties.

BACKGROUND

[002] Declining reservoir pressure in natural gas wells may lead to gas production decreases. The typical cause of this decrease is liquid loading that occurs when water and condensate enter the bottom of the well. Foaming agents (sometimes referred to as "foamers") are frequently used to aid in the unloading of water and condensate accumulated in the wellbore, thereby increasing production from a loaded well. Such agents are generally applied either by batch treatments or continuous applications via injecting down a capillary string or via the casing/tubing annulus. Foamers function by reducing the surface tension and fluid density in the wellbore, and may also be used in conjunction with a lift gas to enhance oil recovery from oil wells.

[003] U.S. Pat. App. Pub. No. 2006/0128990 teaches a method of treating a gas well comprising a chloride-free amphoteric surfactant. U.S. Pat. No 7,122,509 discloses a method of preparing a foamer composition having an anionic surfactant and a neutralizing amine. In U.S. Pat. App. Pub. 2005/0137114 an aqueous foaming composition comprising an anionic surfactant, a cationic surfactant, and a zwitterionic compound is disclosed. PCT App. Pub. No. WO 02/092963 and U.S. Pat. App. Pub. No. 2007/0079963 disclose methods for recovering oil from a gas-lifted oil well using a lift gas and a foaming surfactant which consists of nonionic surfactants, anionic surfactants, betaines, and siloxanes.

[004] While such foamers represent a significant contribution to the art of unloading fluids in oil and gas wells, there still remains a need for improved foamers and methods of using improved foamers. It is thus an objective of this invention to provide a cost-effective foamer for unloading oil, water, or mixtures thereof from oil and/or gas wells. Such improved foamers would also ideally be compatible with anti-corrosive and anti-scale agents.

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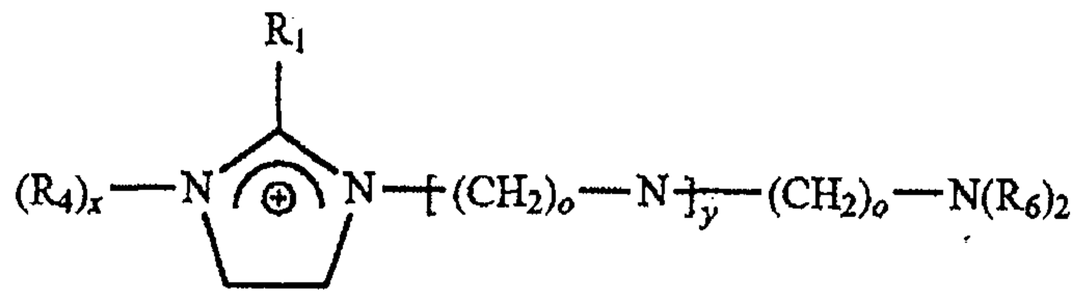
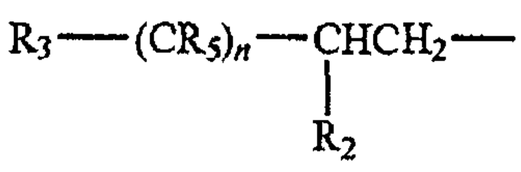
SUMMARY

[005] The present invention relates to a method of foaming a fluid and unloading the fluid from an oil or gas well, the method comprising: (A) introducing into the fluid at a downhole end of the oil or gas well a foam-forming amount of a composition comprising at least one imidazoline-based compound of the general formula:



wherein: R_1 is an optionally substituted branched, chain, or ring alkyl having from 5 to about 29 carbon atoms in the main chain thereof, or an optionally substituted branched, chain, or ring alkenyl having from 5 to about 29 carbon atoms in the main chain thereof, each o is, independently, from 0 to 10, x is 0 or 1, y is from 0 to 4, at least one R_6 is R_4, and the other R_6 is H or R_4, R_4 has the following structure:



each R_2 is, independently, H, a linear alkyl having from 1 to 10 carbon atoms or a linear alkenyl moiety having from 1 to 10 carbon atoms, each R_3 is, independently, selected from the group consisting of $-CO_2H$, $-SO_3H$, $-PO_3H_2$, $-CO_2R_5$, $-CONH_2$, $-CONHR_5$, $-CON(R_5)_2$, and a combination thereof, each R_5 is, independently, selected from the group consisting of H, an optionally substituted linear alkyl, a branched alkyl, an aryl, an alkylaryl, a cycloalkyl, and a heteroaromatic group having from 1 to 10 carbon atoms in the main chain thereof, n is from 0 to 8, and wherein a method of monitoring foaming rates is used to decide an effective foam-forming amount of the composition to introduce into the fluid; (B) forming a foam comprising the fluid and the composition; and (C) recovering the foam from the well.

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[006] In another aspect, the imidazoline-based compound is formed from a reaction between at least one long chain fatty acid and at least one polyalkylene polyamine. The intermediate imidazoline produced by this reaction is then further reacted with at least one unsaturated acid or acid derivative to form the imidazoline-based compound.

[007] It is an advantage of the invention to provide novel foaming agents for downhole injection in oil and gas wells.

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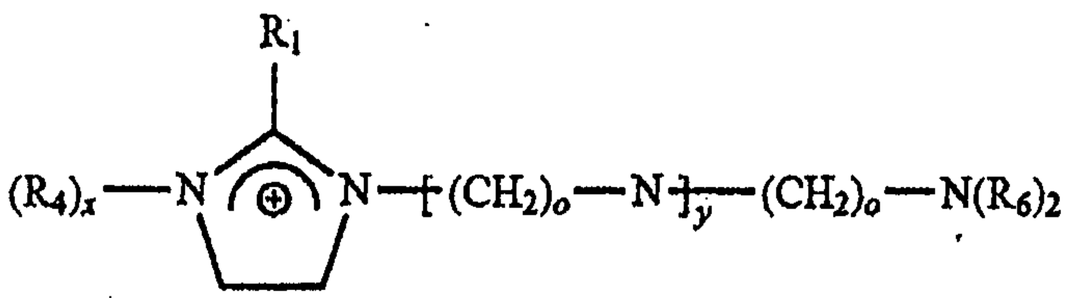
CLAIMS:

1. A method of foaming a fluid and unloading the fluid from an oil or gas well, the method comprising:

(A) introducing into the fluid at a downhole end of the oil or gas well a foam-forming amount of a composition comprising at least one imidazoline-based compound of the general formula:



wherein:

R_1 is an optionally substituted branched, chain, or ring alkyl having from 5 to 29 carbon atoms in the main chain thereof, or an optionally substituted branched, chain, or ring alkenyl having from 5 to 29 carbon atoms in the main chain thereof,

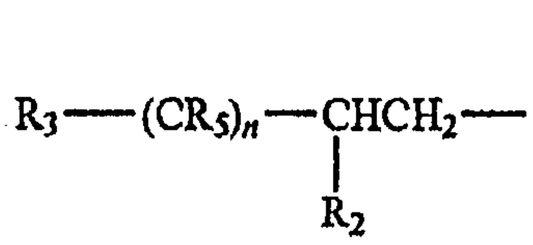
each o is, independently, from 0 to 10,

x is 0 or 1,

y is from 0 to 4,

at least one R_6 is R_4, and the other R_6 is H or R_4,

R_4 has the following structure:



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each R_2 is, independently, H, a linear alkyl having from 1 to 10 carbon atoms or a linear alkenyl moiety having from 1 to 10 carbon atoms,

each R_3 is, independently, selected from the group consisting of $-CO_2H$, $-SO_3H$, $-PO_3H_2$, $-CO_2R_5$, $-CONH_2$, $-CONHR_5$, $-CON(R_5)_2$, and a combination thereof,

each R_5 is, independently, selected from the group consisting of H, an optionally substituted linear alkyl, a branched alkyl, an aryl, an alkylaryl, a cycloalkyl, and a heteroaromatic group having from 1 to 10 carbon atoms in the main chain thereof,

n is from 0 to 8,

and wherein a method of monitoring foaming rates is used to decide an effective foam-forming amount of the composition to introduce into the fluid;

(B) forming a foam comprising the fluid and the composition; and

(C) recovering the foam from the well.