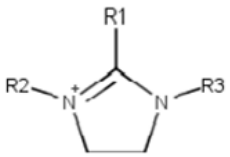
intermittently or continuously in controlled amounts into a body of flowing fluid. As examples, polyvinyls and polyesters have been demonstrated to provide particularly useful corrosion inhibitors for protecting carbon steel that is exposed to acidic flow conditions.

However, currently available solutions may prove inadequate for preventing corrosion of metal, in particular steel surfaces, under harsher or more severe flow conditions, e.g., high pressure conditions wherein one or more gaseous components exists as supercritical fluids. Under such conditions, the rate of corrosion of metal is typically more pronounced, which may render the provision of protective layers or sacrificial layers impractical and costly due to the constant need for replacement and/or re-coating. More importantly, damage caused to the gas transport equipment or piping by corrosive fluids or severe flow conditions may result in flow interruption and operation downtime, which reduces flow assurance. Supercritical fluid environments may also impair the ability of conventional corrosion inhibitors to adsorb onto the surface of the material being protected, in particular, since these interactions are non-covalent interactions.

Accordingly, there is a need to provide a composition for preventing corrosion of metal surfaces that overcomes, or at least ameliorates, one or more of the disadvantages described above.

Summary

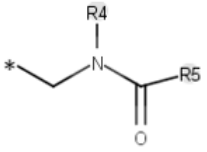
In an aspect of the present disclosure, there is provided a composition for use as a corrosion inhibitor in a fluid environment having a CO2 partial pressure of up to 150 bars, the composition comprising at least one substituted imidazoline of Formula (I) and a thiosulfate salt:



Formula I

wherein

R1 is a hydrophobic group;

R2 is a polar group having the following structural formula 

, wherein * denotes that attachment point, wherein R4 and R5 are independently H, halogen, optionally substituted alkyl, haloalkyl, optionally substituted alkenyl and optionally substituted alkynyl; and

R3 is H, optionally substituted alkyl, optionally substituted alkenyl, or optionally substituted alkynyl.

In another aspect of the present disclosure, there is provided a method of inhibiting or reducing corrosion on a metal surface being exposed to a flowing fluid stream, the method comprising a

step of contacting the metal surface with a corrosion inhibitor composition comprising at least one substituted imidazoline of Formula (I) as defined herein and a thiosulfate salt, or a composition as disclosed herein.

In a further aspect of the present disclosure, there is provided a use of a corrosion inhibitor composition as disclosed herein for inhibiting or reducing corrosion of a steel surface.

In a further aspect of the present disclosure, there is also provided a system for transporting a fluid, said system comprising at least one metal conduit for conveying said fluid therethrough, and wherein said system comprises at least one inlet means that is fluidly communicated with a source of a corrosion inhibitor composition as disclosed herein, and wherein said inlet means is configured to discharge the corrosion inhibitor composition into the fluid during transport of said fluid.

According to the present disclosure, there is provided a composition comprising at least one substituted imidazoline and a thiosulfate salt. The disclosed composition may be suitable for use as a corrosion inhibitor. In embodiments, the disclosed composition may serve as a corrosion inhibitor for preventing or reducing corrosion of a metal surface that is being exposed to supercritical fluid flow, e.g., supercritical carbon dioxide (CO_2). The disclosed composition may be advantageously suited for use in reducing corrosion rate under fluid environments with CO_2 partial pressure of up to 150 bars. In embodiments disclosed herein, the metal surface may refer to a steel surface, or a carbon steel surface, or other alloys of steel thereof.

Examples

A non-limiting example of the invention will be further described in greater detail, which should not be construed as in any way limiting the scope of the invention.

Example 1

A set of comparative experimental results are shown in Fig. 2. In this Example, the performance (measured by corrosion rate, mm/year) of a corrosion inhibitor composition according to the present invention comprising a substituted imidazoline (Formula II) and sodium thiosulfate (Product A) is being compared against conventional CI compositions product B and product C. Line D of Figure 2 shows the corrosion rate (uninhibited) wherein no corrosion inhibitor has been added.

The testing conditions are as follows:

Piping surface material: Carbon steel

Fluid / Gas flow rate: 1m/s superficial liquid velocity

Fluid / Gas flow composition: CO_2 gas with water (70 mol. %)

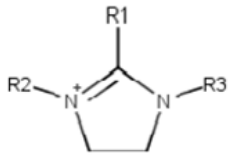
Fluid / gas flow conditions: 120 bar, 80 °C

Compositions A-C:

	Composition
Product A	20% corrosion inhibitor of formula (II) with 5% thiosulfate salt
Product B	40% Imidazoline derivative with thioglycolate salt
Product C	20% Imidazoline derivative with thioglycolate salt

Claims

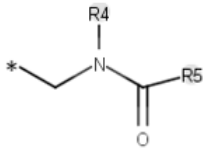
1. A composition for use as a corrosion inhibitor in a fluid environment having a CO_2 partial pressure of up to 150 bars, the composition comprising at least one substituted imidazoline of Formula (I) and a thiosulfate salt:



Formula I

wherein

R1 is a hydrophobic group;

R2 is a polar group having the following structural formula 

, wherein * denotes that attachment point, wherein R4 and R5 are independently H, halogen, optionally substituted alkyl, haloalkyl, optionally substituted alkenyl and optionally substituted alkynyl; and

R3 is H, optionally substituted alkyl, optionally substituted alkenyl, or optionally substituted alkynyl.

2. The composition of claim 1, wherein said substituted imidazoline of Formula (I) and the thiosulfate salt are blended in a mixture.

3. The composition of claims 1 or 2, comprising 1% to 10% by weight of said thiosulfate salt.

4. The composition of claim 3, comprising 10% to 30% by weight of said substituted imidazoline of Formula (I).

5. The composition of any preceding claim, comprising from 20 wt. % to 30 wt. % of said substituted imidazoline of Formula (I), 1 wt. % to 10 wt. % of said thiosulfate salt and 40 wt. % to 89 wt. % of a solvent, wherein the total weight percent is 100 %.

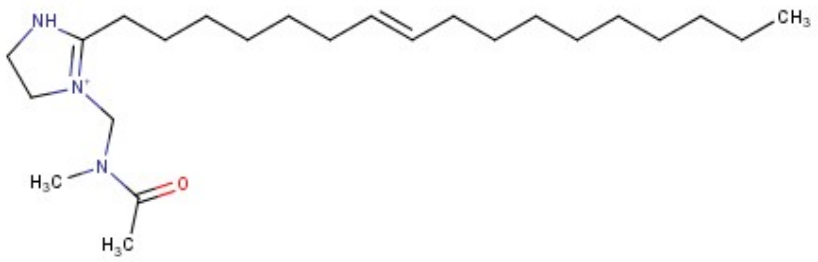
6. The composition of claim 5, comprising from 30 wt. % of said substituted imidazoline of Formula (I), 5 wt. % sodium thiosulfate and 65 wt. % of water.

7. The composition of any one of claims 1 to 6, wherein

R1 is an optionally substituted alkyl group, an optionally substituted heteroalkyl group, an optionally substituted alkenyl group, an optionally substituted heteroalkenyl group, or an optionally substituted alkynyl group.

8. The composition of claim 7, wherein R1 is a C_{10-40} alkyl or a heteroalkyl comprising at least one unsaturated carbon or at least one heteroatom expressing a lone pair of electrons.

9. The composition of any preceding claim, wherein the imidazoline is a compound of **formula (II):**



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10. A method of inhibiting or reducing corrosion on a metal surface being exposed to a flowing fluid stream, the method comprising a step of contacting the metal surface with a

corrosion inhibitor composition comprising at least one substituted imidazoline of Formula (I) as defined in any one of claims 1 to 9 and a thiosulfate salt, or a composition as defined in any one of claims 1 to 9.

11. The method of claim 10, wherein the fluid stream comprises carbon dioxide and water.

12. The method of claim 11, wherein the fluid stream comprises supercritical carbon dioxide.

13. The method of any one of claims 10 to 12, wherein said fluid stream is characterized by a partial pressure of CO_2 of from greater than 0 bar to 150 bars.

14. The method of claim 13, wherein said fluid stream is characterized by a partial pressure of CO_2 of from 60 bars to 150 bars.

15. The method any one of claims 10 to 14, wherein the fluid stream is characterized by a temperature of 15 °C to 100 °C.

16. The method of any one of claims 10 to 15, wherein the fluid stream is at critical temperature and critical pressure of carbon dioxide.

17. The method of any one of claims 10 to 16, wherein the fluid stream is substantially free of hydrogen sulfide.

18. The method of any one of claims 10 to 17, wherein the fluid stream consists essentially of supercritical carbon dioxide.

19. The method of any one of claims 10 to 17, wherein the fluid stream comprises liquid water in an amount of from 0 to 10,000 ppm.

20. The method of claim 19, wherein the fluid stream is supercritical carbon dioxide that is water saturated.

21. The method of any one of claims 10 to 20, wherein the flowing fluid stream is characterized by a CO_2 partial pressure of at least 73 bar, a temperature of at least 32 °C.

22. The method of any one of claims 10 to 21, wherein the contacting step comprises mixing said corrosion inhibitor composition into the flowing fluid stream in an amount effective to inhibit or reduce corrosion of the metal surface.

23. The method of any one of claims 10 to 22, wherein said corrosion inhibitor composition is added in an amount to achieve a concentration of 0.01 ppm to 500 ppm in said flowing fluid stream.

24. The method of claims 20 or 21, wherein the substituted imidazoline is added to said fluid stream in an amount to obtain a concentration from 0.01 ppm to 500 ppm in said fluid stream.

25. Use of a corrosion inhibitor composition as defined in any one of claims 1 to 9 for inhibiting or reducing corrosion of a steel surface.

26. A system for transporting a fluid, said system comprising at least one metal conduit for conveying said fluid therethrough, and wherein said system comprises at least one inlet means that is fluidly communicated with a source of a corrosion inhibitor composition as defined in any one of claims 1 to 9, and wherein said inlet means is configured to discharge the corrosion inhibitor composition into the fluid during transport of said fluid.

27. The system of claim 26, wherein said fluid being transported comprises a supercritical fluid.

28. The system of claim 26 or 27, wherein said fluid being transported comprises supercritical CO_2 and water in an amount of up to 7,000 ppm.