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# CLEANING STAINLESS STEEL

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6 Claims. (Cl. 252—136)

This invention relates to improved aqueous phosphoric acid solutions containing minor amounts of ferric ion as a corrosion inhibitor, and to their use in cleaning stainless steels.

Phosphoric acid solutions have found widespread usage for cleaning stainless steel equipment. Also, phosphoric acid is being used widely in the petroleum industry as a catalyst for the polymerization of hydrocarbons at elevated temperatures. However, heretofore there has been a serious disadvantage in employing phosphoric acid for these usages in that phosphoric acid solutions are corrosive to stainless steels, particularly when used at elevated temperatures.

To counteract this corrosiveness of hot phosphoric acid solutions, the petroleum industry in many instances has been forced to use higher alloy expensive stainless steels such as Nionel, which contains 40% nickel and 21% chromium. This of course greatly increases the capital investment in such equipment.

I have found that the corrosion of stainless steels during contact with phosphoric acid solutions can be minimized by using solutions initially containing minor amounts of ferric ion as a corrosion inhibitor.

Almost any ionizable ferric salt can be employed as the inhibiting agent, the effective moiety apparently being the ferric ion. Where maximum corrosion inhibition is desired, it is preferred to have present in my phosphoric acid solutions at least about 1 gram per liter of ferric ion and preferably 2 grams per liter or more. Much greater amounts of ferric ion, such as 10 grams per liter or more, can be tolerated in the phosphoric acid solutions of the invention with no apparent undesirable effects on the corrosiveness of the solutions. The upper limit of ferric ion concentration is determined by the amount that can be tolerated in the solution, depending upon the particular usage, and cost considerations.

The amount of phosphoric acid present in my solutions can vary widely depending upon the usage for which the solution is to be applied. Phosphoric acid cleaning solutions containing amounts ranging from about ½% to 85% by weight are conventionally used at the present time. Solutions of this entire range of concentrations can be inhibited in accordance with my discovery.

The solutions of my invention can also contain various additives, such as wetting agents to facilitate cleaning. Likewise, they can contain other agents such as oxalic acid and/or sodium bisulfate to improve their cleansing properties.

My solutions are made by dissolving in aqueous solutions of phosphoric acid a ferric salt, such as ferric sulfate, ferric oxalate, and the like. While almost any soluble ionizable ferric salt can be used, preferably the source of ferric ion is not a chloride or fluoride, since the chloride and fluoride ions tend to promote corrosion, as is well known. Where the phosphoric acid solution does contain some chloride or fluoride it is desirable to use somewhat greater amounts of ferric ion.



To more clearly demonstrate the practice of the invention, the following examples are given in addition to those set forth above:

*Example 1*

An 85% by weight phosphoric acid boiling aqueous solution containing 2 grams per liter ferric oxalate is prepared by dissolving the ferric oxalate in the acid solution.

A sample of A. I. S. I. 304 stainless steel is immersed in this solution for 10 hours. Examination of the steel shows that it corroded at the rate of 0.007 inches per month. In contrast, a similar sample of A. I. S. I. 304 stainless steel when immersed in an 85% phosphoric acid solution containing no added ferric iron inhibitor corroded at the rate of 7.0 inches per month.

*Example 2*

Boiling aqueous solutions containing the ingredients are prepared in accordance with the procedure of Example 1.

| | | | |
|---|---|---|---|
| A. | Phosphoric acid | percent | 5 |
| | Ferric oxalate | g./l. | 4 |
| | Water | | Balance |
| B. | Phosphoric acid | percent | 50 |
| | Ferric sulfate | g./l. | 1 |
| | Water | | Balance |
| C. | Phosphoric acid | percent | 30 |
| | Ferric nitrate | g./l. | 10 |
| | Water | | Balance |

Samples of the following stainless steels are then treated as in Example 1: A. I. S. I. 304; A. I. S. I. 316; A. I. S. I. 301. Minimum corrosion, as compared to samples exposed to uninhibited solutions, results in each instance.

*Example 3*

A 3% by weight phosphoric acid solution containing 2 grams/liter ferric oxalate is prepared. This solution is used to clean A. I. S. I. 301 stainless steel equipment by applying it to the equipment and allowing it to stand for 15 minutes before rinsing it off with water. It is found that this treatment causes no substantial corrosion of the stainless steel equipment.

The method of the present invention wherein stainless steel is treated with phosphoric acid solutions inhibited against corrosion by the inclusion of a minor amount of ferric iron in the solution is practiced in the same manner and with similar results on other types of stainless steels, such as A. I. S. I. 347, A. I. S. I. 302, A. I. S. I. 321, A. I. S. I. 430, A. I. S. I. 446 stainless steels. Also the method appears to be applicable to the so-called "substitute stainless steels," that is chrome-manganese-nickel steels, such as steels of the following alloy composition, preferably using relatively higher ferric ion concentrations:

16% chrome, 17% manganese, 1% nickel
15% chrome, 17% manganese, 1% nickel
17.6% chrome, 5.6% manganese, 4.4% nickel

Since the practice of the present invention appears to be applicable not only to the chrome-nickel A. I. S. I. 300 series stainless steels, but also to the straight chrome A. I. S. I. 400 series and the "substitute stainless steels" of the above described type, as used herein the term "stainless steel" is intended to include the stainless steels of all these types.

I claim:

1. The method of cleaning stainless steel comprising incorporating in an aqueous phosphoric acid solution, in concentration up to and including about 85% by weight phosphoric acid, a ferric ion-contributing salt other than an iron halide in an amount sufficient to yield from about 1.0 to 10.0 grams per liter of ferric iron in said solution,

and thereafter contacting said stainless steel with said solution.

2. The method in accordance with claim 1 wherein sufficient of said ferric ion-contributing salt is incorporated to yield from about 2.0 to 10.0 grams per liter of ferric iron.

3. The method in accordance with claim 1 wherein said ferric ion-contributing salt is ferric sulfate.

4. An aqueous acid solution that is inhibited against corroding stainless steels, said solution containing from about ½% to 85% by weight phosphoric acid and a ferric ion-contributing salt other than an iron halide in an amount sufficient to yield from about 1.0 to 10.0 grams per liter of ferric iron.

5. An aqueous acid solution in accordance with claim 4 wherein sufficient of said ferric ion-contributing salt is incorporated to yield from about 2.0 to 10.0 grams per liter of ferric iron.

6. An aqueous acid solution in accordance with claim 4 wherein said ferric ion-contributing salt is ferric sulfate.



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