Abstract:

A rust removing composition is described. The composition, based on the total mass of the composition, comprises: 10 to 20% by mass of an inorganic acid; 1 to 10% by mass of an organic acid; 1 to 8% by mass of a penetrant selected from the group consisting of at least one of C₂-C₄ short-chain ethers and short-chain alcohols; 2 to 10% by mass of a sulfonic acid and/or sulfonate type anionic surfactant; 0.5 to 10% by mass of a corrosion inhibitor; and a balance of water.
RUST REMOVING COMPOSITION

TECHNICAL FIELD

The present disclosure relates to a rust removing composition, in particular to a rust removing composition for metals, which is useful for cleansing metal apparatuses for medical or commercial use.

BACKGROUND

Stainless steel medical apparatuses tend to rust and corrode during use, mainly for the following three reasons. Firstly, the apparatuses often come into contact with organic contaminants such as disinfectants, human secretions, bodily fluids or blood stains. Salts and iodides contained in the organic contaminants are corrosive and destructive to the chromium layer of the apparatuses. Particularly, dried organic contaminants on the apparatuses are more destructive. Secondly, the apparatuses are generally subjected to chemical or physical disinfection after use. Chlorine-containing disinfectant solutions, peracetic acid, acidic electrolyzed water as well as high-temperature and high-humidity environments will oxidize and corrode the nickel-chromium layer or even the iron of the apparatuses. Thirdly, during cleansing of the apparatuses, many improper operations, such as using a steel wire ball or a hard bristle brush to scrub the dried blood on the apparatuses, will lead to the destruction of the chromium layer of the apparatuses.

In order to lengthen the service lifetime of the apparatuses and reduce hospital expenditure, many hospitals use rust removing agents to remove rust from rusty apparatuses so that they can be recycled. Currently marketed liquid rust removing agents suffer from the major disadvantages of unsatisfactory rust removing effect, and corrosiveness to metal in the case of prolonged use, which instead results in more severe secondary rusting and corrosion or even complete uselessness of the apparatuses.

Description of rust removing agents in relevant patents and literatures mainly focuses on those for industrial use. These rust removing agents are generally compositions of hydrochloric acid and surfactants, and as such they are highly corrosive to metals (e.g. U.S. Patent No. 5,215,676). Some literatures disclose rust removing agents which are compositions of phosphates, surfactants and corrosion inhibitors but have slow speed and moderate rate of rust removal (e.g. U.S. publication No. 2009032058A, CN101463481A, etc).

Therefore, there still exists a need to develop a rust removing composition having a faster speed and
a high rate of rust removal and a lower corrosiveness to metals.

SUMMARY

In some embodiments, the present disclosure provides a rust removing composition capable of being used for removing rust from metal apparatuses for medical or commercial use, especially stainless steel apparatuses. In some embodiments, the composition has not only a faster speed and a high rate of rust removal but also a lower corrosiveness to metals.

Accordingly, in some embodiments, the present disclosure provides a rust removing composition, comprising, based on the total mass of the composition:

10 to 20% by mass of an inorganic acid;

1 to 10% by mass of an organic acid;

1 to 8% by mass of a penetrant selected from the group consisting of at least one of C2-C4 short-chain ethers and short-chain alcohols;

2 to 10% by mass of a sulfonic acid and/or sulfonate type anionic surfactant;

0.5 to 10% by mass of a corrosion inhibitor; and

a balance of water.

In some embodiments, the rust removing composition of the present disclosure (sometimes referred to as "highly effective rust removing corrosion inhibitor composition" in the present specification) can effectively remove rust spots, corrosion spots as well as other corrosive substances, and is especially suitable for soaking rusty metals after dilution. Moreover, in some embodiments, the composition will not, after use, result in severe corrosion to metal surfaces and re-rusting, thus preventing secondary rusting and corrosion of metals. It is a water soluble rust removing agent, being easy to dilute for use, and is safe to use. In some embodiments, the rust removing composition achieves a rust removal rate of more than 50% for rust spots of common stainless steel medical apparatuses after soaking the apparatuses for 15 minutes.

DETAILED DESCRIPTION

As used herein, unless otherwise specified, the term "physically stable" means no significant changes from the initial state occur due to obvious precipitation, crystallization, phase separation or the like, when kept at room temperature for at least 3 months.
The term "short-chain ethers" means alkyl ethers containing 2 to 4 carbons.

The term "short-chain alcohols" means alkyl alcohols containing 2 to 4 carbons.

Generally, the present disclosure provides a rust removing composition, comprising, based on the total mass of the composition:

5 10 to 20% by mass of an inorganic acid;
1 to 10% by mass of an organic acid;
1 to 8% by mass of a penetrant selected from the group consisting of at least one of C2-C4 short-chain ethers and short-chain alcohols;
2 to 10% by mass of a sulfonic acid and/or sulfonate type anionic surfactant;
10 0.5 to 10% by mass of a corrosion inhibitor; and

a balance of water.

Inorganic acids

Inorganic acids suitable for use in the present disclosure are preferably medium strong acids, including but not limited to phosphoric acid, metaphosphoric acid, boric acid etc. Such inorganic acids are very reactive with metal ions and prone to form chelates with metals dissolved out, serving the purpose of masking. Also, these inorganic acids are poorly volatile and will not generate acid mist, therefore they will not contaminate the surroundings and do harm to the users. More preferable inorganic acids are phosphoric acid or metaphosphoric acid. Phosphate or metaphosphate ions have a good ability to complex ferrous and ferric ions, forming a dense passivation film on the surfaces of stainless steel substrates and preventing further corrosion of the stainless steel metal.

Generally, the inorganic acids are present in the composition in an amount in the range of from 10 to 20% by mass, preferably from 15 to 20% by mass, and more preferably from 18 to 20% by mass. An amount of below 10% by mass will not achieve the expected rust removing effect; while an amount of more than 20% by mass will be corrosive to metal surfaces.

Organic acids

Organic acids are preferably anionic compounds which are capable of complexing with multivalent metal ions, serving the purpose of accelerating rust removal and lengthening the lifetime of the rust removing agent. Examples of organic acids include but are not limited to citric acid, oxalic acid, aminosulfonic acid, lactic acid, malic acid, tartaric acid, glycolic acid, acetic acid, propionic acid, benzoic acid, nonylbenzoic acid etc., more preferably citric acid and aminosulfonic acid, and most preferably
citric acid. The organic acids are present in the composition in an amount in the range of from 1 to 10% by mass, preferably from 4 to 10% by mass, and more preferably from 5 to 8% by mass.

**Penetrants**

Penetrants can be organic or inorganic penetrants. They can help the bulk rust removing agent to rapidly penetrate a rust film, and, during this process, loosen the adherence of the rust film to the underlying steel surface, thereby promoting penetration and wetting and enhancing the rust removing effect. Examples of penetrants include but are not limited to dipropylene glycol monomethyl ether, ethylene glycol butyl ether, ethylene glycol ethyl ether, sodium chloride, magnesium chloride, sodium sulfite, etc.

In some embodiments, the preferable penetrants are organic fatty alcohol polyether penetrants. In some compositions of the present disclosure, such penetrants can not only facilitate rust removal, but also form some anti-corrosion components by complexing with iron ions, and inhibiting the generation of acid mist as well. The most preferable penetrant is dipropylene glycol monomethyl ether, which has a low surface tension and can rapidly penetrate the rust layer through the pores therein, thereby facilitating the accelerated penetration of the bulk rust removing agent. The penetrants are present in an amount in the range of from 1 to 8% by mass, preferably from 1 to 5% by mass, and more preferably from 2 to 5% by mass, based on the total mass of the composition.

**Surfactants**

The composition also comprise sulfonic acid and/or sulfonate type anionic surfactants, preferably sulfonate type anionic surfactants. Examples of sulfonic acid and/or sulfonate type anionic surfactants include but are not limited to alkylsulfonic acids, benzene-containing sulfonic acids and alkyl sulfonates, etc. More preferable anionic surfactants of the present invention are alkyl sulfonate surfactants, preferably C12 to C16 alkyl sulfonate surfactants. The surfactants are present in the composition in an amount in the range of from 2 to 10% by mass, preferably from 4 to 8% by mass, and more preferably from 5 to 6% by mass.

**Corrosion Inhibitors**

The composition also comprises corrosion inhibitors. Examples of corrosion inhibitors include but are not limited to inorganic acid salts such as chromates and nitrites etc., or nitrogen-containing organic compounds such as aniline, pyridine, quinoline, diethylamine, cyclohexylandamine, thiourea and derivatives thereof, more preferably thiourea. The corrosion inhibitors are present in the composition in an amount in
the range of from 0.5 to 10% by mass, preferably from 0.5 to 4% by mass, and more preferably from 0.5
to 2% by mass.

Generally, the rust removing composition can be diluted with water, e.g., at a ratio of 1:5 to 1:20
upon use.

The compositions are preferably physically stable, that is, no significant changes from initial state
occur due to obvious precipitation, crystallization, phase separation and the like, when kept at room
temperature for at least 3 months.

The composition can be formulated using conventional mixing methods.

Preferable compositions have no off-odor, no irritant odor given off, and no acid mist occurring.

In some embodiments, the composition can be used to remove rust spots from the surfaces and joints
of stainless steel medical apparatuses, and at the same time prevent further corrosion of the stainless steel.

In some embodiments, the composition can effectively prevent redox reactions from occurring on metal surfaces and lessen
corrosion of acidic substances to metals. In some embodiments, the composition can be made into a
transparent formulation and is especially suitable for manual removal of rust.

The following examples illustrate various embodiments of the present disclosure in more detail. It
will be appreciated that the examples are intended to be illustrative of the present invention only and not
intended to limit the invention in any way. Unless otherwise specified, all percentages, amounts and ratios
used in the present invention are by mass, and temperatures used are Celsius.

EXAMPLES

A. Experimental procedure for determining rust removal rate.

Tinplate was used in the experiment for determining rust removal rate. The tinplate was cut into a 3
cm × 3 cm piece and the piece was abraded and polished on both sides using a sandpaper. Then the
tinplate piece was placed in a salt mist box (ASTM B117) for 48 hours such that a rust layer occurred on
both sides of it.

The compositions described in Table 1 below were diluted seven-fold with water, and the treated
tinplate piece was soaked in the diluted solution for 15 minutes.

Rust removal rate (%) was expressed in the following formula:
Rust removal rate (%) = \( \frac{a - b}{a - c} \times 100 \)

wherein:

- \( a \) = the weight of the tinplate piece with rust attached before removing rust (g);
- \( b \) = the weight of the tinplate piece after removing rust with the rust removing agent, washing with water and drying (g);
- \( c \) = the weight of the tinplate piece before becoming rusty (g).

The higher the value of the rust removal rate, the better the effect of rust removal.

B: The criteria for rating corrosion is as follows:

In the corrosion rating experiment, an X-rite 8400 color measurement spectrophotometer (ASTM Standard D1003 determination method for turbidity and transmittance coefficient) was used to assess corrosion. In this experiment, sunlight was used as light source and \( L \) values were compared (\( L \): lightness of color, \( a \): greenness-redness value of color, and \( b \): blueness-yellowness of color; \( a \) and \( b \) were not compared here). The lower the \( L \) value, the darker the color of the stainless steel piece after removing rust, suggesting the greater the degree of corrosion. \( 50 < L < 60 \) represents corrosion, \( 60 < L < 75 \) represents mild corrosion, and \( 75 < L \) represents essentially no corrosion.

C: Comparative examples 1-2 and Examples 1-6

According to the formulas in Table 1, the components were mixed and stirred to formulate the compositions of Comparative examples 1-2 and Examples 1-6. The results of test are shown in Table 2.

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<th>Comp. Ex. 2</th>
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<th>Ex. 2</th>
<th>Ex. 3</th>
<th>Ex. 4</th>
<th>Ex. 5</th>
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<th>Ex. 4</th>
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Results show that:

Comparative example 1 that used a strong inorganic acid achieved a good rust removing effect, but also resulted in severe corrosion; Comparative example 2 that used a medium strong inorganic acid at a concentration below 10% yielded a poor rust removing effect, but was essentially non-corrosive to metal.
Example 1-6 all achieved a good rust removing effect without severe corrosion to metal surfaces.
What is claimed is:

1. A rust removing composition, comprising, based on the total mass of the composition:
   - 10 to 20% by mass of an inorganic acid;
   - 1 to 10% by mass of an organic acid;
   - 1 to 8% by mass of a penetrant selected from the group consisting of at least one of C2-C4 short-chain ethers and short-chain alcohols;
   - 2 to 10% by mass of a sulfonic acid and/or sulfonate type anionic surfactant;
   - 0.5 to 10% by mass of a corrosion inhibitor; and
   - a balance of water.

2. The rust removing composition as claimed in claim 1 or 2, wherein the inorganic acid is selected from the group consisting of phosphoric acid, metaphosphoric acid, boric acid, or mixtures thereof.

3. The rust removing composition as claimed in any one of the preceding claims, wherein the organic acid is selected from the group consisting of citric acid, oxalic acid, aminosulfonic acid, lactic acid, malic acid, tartaric acid, glycolic acid, acetic acid, propionic acid, benzoic acid, nonylbenzoic acid, or mixtures thereof.

4. The rust removing composition as claimed in any one of the preceding claims, wherein the organic acid is selected from the group consisting of citric acid, aminosulfonic acid, or mixtures thereof.

5. The rust removing composition as claimed in claim 4, wherein the organic acid is citric acid.

6. The rust removing composition as claimed in any one of the preceding claims, wherein the penetrant is selected from the group consisting of dipropylene glycol monomethyl ether, ethylene glycol butyl ether, ethylene glycol ethyl ether, sodium chloride, magnesium chloride, sodium sulfite, or mixtures thereof.

7. The rust removing composition as claimed in claim 6, wherein the penetrant is an organic fatty alcohol polyether penetrant.

8. The rust removing composition as claimed in claim 6, wherein the penetrant is dipropylene glycol monomethyl ether.
9. The rust removing composition as claimed in any one of the preceding claims, wherein the surfactant is a sulfonate type anionic surfactant.

10. The rust removing composition as claimed in any one of claims 1 to 8, wherein the surfactant is selected from the group consisting of alkylsulfonic acids, benzene-containing sulfonic acids and alkylsulfonates, or mixtures thereof.

11. The rust removing composition as claimed in any one of claims 1 to 8, wherein the surfactant is an alkylsulfonate surfactant.

12. The rust removing composition as claimed in any one of the preceding claims, wherein the corrosion inhibitor is selected from the group consisting of inorganic acid salts, nitrogen-containing organic compounds, or mixtures thereof.

13. The rust removing composition as claimed in claim 12, wherein the corrosion inhibitor is an inorganic acid salt is selected from the group consisting of chromates, nitrites, or mixtures thereof.

14. The rust removing composition as claimed in claim 12, wherein the corrosion inhibitor is a nitrogen-containing organic compound is selected from the group consisting of aniline, pyridine, quinoline, diethylamine, cycloethylamine, thiourea and derivatives thereof, or mixtures thereof.

15. The rust removing composition as claimed in claim 14, wherein the nitrogen-containing organic compound is thiourea.

16. The rust removing composition as claimed in any one of the preceding claims, wherein the content of the inorganic acid in the composition is 15% by mass to 20% by mass.

17. The rust removing composition as claimed in any one of the preceding claims, wherein the content of the organic acid in the composition is 4% by mass to 10% by mass.

18. The rust removing composition as claimed in any one of the preceding claims, wherein the content of the penetrant in the composition is 1% by mass to 5% by mass.

19. The rust removing composition as claimed in any one of the preceding claims, wherein the content of the surfactant in the composition is 4% by mass to 8% by mass.
20. The rust removing composition as claimed in any one of the preceding claims, wherein the content of the corrosion inhibitor in the composition is 0.5% by mass to 4% by mass.

21. The rust removing composition as claimed in any one of the preceding claims, which comprises:

   18 to 20% by mass of an inorganic acid selected from the group consisting of phosphoric acid, metaphosphoric acid, boric acid, or mixtures thereof;

   5 to 8% by mass of citric acid;

   2 to 5% by mass of dipropylene glycol monomethyl ether;

   5 to 6% by mass of C12-C16 alkylsulfonate type anionic surfactant;

   0.5 to 2% by mass of thiourea; and

   a balance of water.
### A. CLASSIFICATION OF SUBJECT MATTER

INV. C23G/1/08 C11D1/12 C11D3/02 C11D3/20 C11D3/00

ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

### B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

- **EPO-Internal**

### C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<td>CN 1 041 010 A (RES INST OF HUABEI MINING ADM [CN] SCIENT RESEARCH I OF HUABEI M [CN] 4 April 1990 (1990-04-04) page 3 - page 4; claims</td>
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<td>GB 1 126 476 A (DU PONT) 5 September 1968 (1968-09-05) page 1, line 75 - page 3, line 95; claims; examples</td>
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<td>GB 1 291 627 A (AMCHEM PROD [US]) 4 October 1972 (1972-10-04) page 2, line 45 - page 3, line 34; claims</td>
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<td>CN 101 368 131 A (JIANGSU HAIXUN INDUSTRY GROUP [CN]) 18 February 2009 (2009-02-18) page 2 - page 3</td>
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Further documents are listed in the continuation of Box C. See patent family annex.

- **X** document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- **Y** document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- **A** document member of the same patent family

Date of the actual completion of the international search: 4 November 2011

Date of mailing of the international search report: 22/11/2011

Name and mailing address of the ISA/

European Patent Office; P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk

Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016

Authorized officer

Mauger, Jeremy
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