Basic blending proportions (by weight) in 1 kg of rust-removing/preventing agent

Orthophosphoric acid (H₃PO₄) : 50 - 600g
DL-malic acid (HOOCCH₂CH(OH)COOH) : 0.2 - 20g
Sodium dihydrogen phosphate dihydrate (NaH₂PO₄ · 2H₂O) : 0.2 - 2g
Water (H₂O) : Xg

1,000g

The weight X (g) of water (H₂O) is a weight obtained by subtracting, from 1,000 g, the total weight of orthophosphoric acid, DL-malic acid and sodium dihydrogen phosphate dihydrate used.
Basic blending proportions (by weight) in 1 kg of rust-removing/preventing agent

Orthophosphoric acid (H₃PO₄) : 50 - 600g
DL-malic acid (HOOCCH₂CH(OH)COOH) : 0.2 - 20g
Sodium dihydrogen phosphate dihydrate (NaH₂PO₄ · 2H₂O) : 0.2 - 2g
Water (H₂O) : Xg
1,000g

The weight X (g) of water (H₂O) is a weight obtained by subtracting, from 1,000 g, the total weight of orthophosphoric acid, DL-malic acid and sodium dihydrogen phosphate dihydrate used.

Preferred blending proportions (by weight) in 1 kg of rust-removing/preventing agent

Orthophosphoric acid (H₃PO₄) : 496g
DL-malic acid (HOOCCH₂CH(OH)COOH) : 2g
Sodium dihydrogen phosphate dihydrate (NaH₂PO₄ · 2H₂O) : 2g
Water (H₂O) : 500g
1,000g
Fig. 3

Rust-removing Process (S1)

Drying and wiping Process (S2)

Plating Process (S3)  Painting Process (S4)
Basic blending proportions (by weight) in 1 kg of rust-removing/preventing agent

Orthophosphoric acid \((H_3PO_4)\): 50 - 600g  
DL-malic acid \((HOOCCH_2CH(OH)COOH)\): 0.2 - 20g  
Sodium dihydrogen phosphate dihydrate \((NaH_2PO_4 \cdot 2H_2O)\): 0.2 - 2g  
Surfactant (propylene glycol: \(CH_3CH(OH)CH_2OH\)): 0.1-1.5g  
Water \((H_2O)\): \(X\)g  

1,000g

The weight \(X\) (g) of water \((H_2O)\) is the weight of the balance obtained by subtracting, from 1,000 g, the total weight of the other components used.

Preferred blending proportions (by weight) in 1 kg of rust-removing/preventing agent

Orthophosphoric acid \((H_3PO_4)\): 495g  
DL-malic acid \((HOOCCH_2CH(OH)COOH)\): 2g  
Sodium dihydrogen phosphate dihydrate \((NaH_2PO_4 \cdot 2H_2O)\): 2g  
Surfactant (propylene glycol: \(CH_3CH(OH)CH_2OH\)): 1g  
Water \((H_2O)\): 500g  

1,000g
Basic blending proportions (by weight) in 1 kg of rust-removing/preventing agent

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orthophosphoric acid (H₃PO₄)</td>
<td>50 - 600g</td>
</tr>
<tr>
<td>DL-malic acid (HOOCCH₂CH(OH)COOH)</td>
<td>0.2 - 20g</td>
</tr>
<tr>
<td>Sodium dihydrogen phosphate dihydrate (NaH₂PO₄ · 2H₂O)</td>
<td>0.2 - 2g</td>
</tr>
<tr>
<td>Surfactant (propylene glycol: CH₃CH(OH)CH₂OH)</td>
<td>0.1-1.5g</td>
</tr>
<tr>
<td>Acetic acid (CH₃COOH)</td>
<td>0.1-5.0g</td>
</tr>
<tr>
<td>Water (H₂O)</td>
<td>Xg</td>
</tr>
</tbody>
</table>

1,000g

The weight X (g) of water (H₂O) is the weight of the balance obtained by subtracting, from 1,000 g, the total weight of the other components used.

Preferred blending proportions (by weight) in 1 kg of rust-removing/preventing agent

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orthophosphoric acid (H₃PO₄)</td>
<td>493g</td>
</tr>
<tr>
<td>DL-malic acid (HOOCCH₂CH(OH)COOH)</td>
<td>2g</td>
</tr>
<tr>
<td>Sodium dihydrogen phosphate dihydrate (NaH₂PO₄ · 2H₂O)</td>
<td>2g</td>
</tr>
<tr>
<td>Surfactant (propylene glycol: CH₃CH(OH)CH₂OH)</td>
<td>1g</td>
</tr>
<tr>
<td>Acetic acid (CH₃COOH)</td>
<td>2g</td>
</tr>
<tr>
<td>Water (H₂O)</td>
<td>500g</td>
</tr>
</tbody>
</table>

1,000g
Fig. 8

Basic blending proportions (by weight) in 1 kg of rust-removing/preventing agent

Orthophosphoric acid (H₃PO₄): 50 - 600g
DL-malic acid (HOOCCH₂CH(OH)COOH): 0.2 - 20g
Sodium dihydrogen phosphate dihydrate (NaH₂PO₄ · 2H₂O): 0.2 - 2g
Surfactant (propylene glycol: CH₃CH(OH)CH₂OH): 0.1 - 1.5g
Acetic acid (CH₃COOH): 0.1 - 5.0g
Aliphatic acid (RCOOH): 1.0 - 10g
Water (H₂O): Xg

1,000g

The weight X (g) of water (H₂O) is the weight of the balance obtained by subtracting, from 1,000 g, the total weight of the other components used.

Fig. 9

Preferred blending proportions (by weight) in 1 kg of rust-removing/preventing agent

Orthophosphoric acid (H₃PO₄): 488g
DL-malic acid (HOOCCH₂CH(OH)COOH): 2g
Sodium dihydrogen phosphate dihydrate (NaH₂PO₄ · 2H₂O): 2g
Surfactant (propylene glycol: CH₃CH(OH)CH₂OH): 1g
Acetic acid (CH₃COOH): 2g
Aliphatic acid (RCOOH): 5g
Water (H₂O): 500g

1,000g
Fig. 10

Basic blending proportions (by weight) in 1 kg of rust-removing/preventing agent

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Weight Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orthophosphoric acid (H₃PO₄)</td>
<td>50 - 600g</td>
</tr>
<tr>
<td>DL-malic acid (HOOCCH₂CH(OH)COOH)</td>
<td>0.2 - 20g</td>
</tr>
<tr>
<td>Sodium dihydrogen phosphate dihydrate (NaH₂PO₄ · 2H₂O)</td>
<td>0.2 - 2g</td>
</tr>
<tr>
<td>Acetic acid (CH₃COOH)</td>
<td>0.1-5.0g</td>
</tr>
<tr>
<td>Water (H₂O)</td>
<td>Xg</td>
</tr>
</tbody>
</table>

1,000g

The weight X (g) of water (H₂O) is the weight of the balance obtained by subtracting, from 1,000 g, the total weight of the other components used.

Fig. 11

Preferred blending proportions (by weight) in 1 kg of rust-removing/preventing agent

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orthophosphoric acid (H₃PO₄)</td>
<td>494g</td>
</tr>
<tr>
<td>DL-malic acid (HOOCCH₂CH(OH)COOH)</td>
<td>2g</td>
</tr>
<tr>
<td>Sodium dihydrogen phosphate dihydrate (NaH₂PO₄ · 2H₂O)</td>
<td>2g</td>
</tr>
<tr>
<td>Acetic acid (CH₃COOH)</td>
<td>2g</td>
</tr>
<tr>
<td>Water (H₂O)</td>
<td>500g</td>
</tr>
</tbody>
</table>

1,000g
### Basic blending proportions (by weight) in 1 kg of rust-removing/preventing agent

<table>
<thead>
<tr>
<th>Component</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orthophosphoric acid (H$_3$PO$_4$)</td>
<td>50 - 600g</td>
</tr>
<tr>
<td>DL-malic acid (HOOCCH$_2$CH(OH)COOH)</td>
<td>0.2 - 20g</td>
</tr>
<tr>
<td>Sodium dihydrogen phosphate dihydrate (NaH$_2$PO$_4$ · 2H$_2$O)</td>
<td>0.2 - 2g</td>
</tr>
<tr>
<td>Aliphatic acid (RCOOH)</td>
<td>1.0-10g</td>
</tr>
<tr>
<td>Water (H$_2$O)</td>
<td>Xg</td>
</tr>
</tbody>
</table>

The weight X (g) of water (H$_2$O) is the weight of the balance obtained by subtracting, from 1,000 g, the total weight of the other components used.

### Preferred blending proportions (by weight) in 1 kg of rust-removing/preventing agent

<table>
<thead>
<tr>
<th>Component</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orthophosphoric acid (H$_3$PO$_4$)</td>
<td>491g</td>
</tr>
<tr>
<td>DL-malic acid (HOOCCH$_2$CH(OH)COOH)</td>
<td>2g</td>
</tr>
<tr>
<td>Sodium dihydrogen phosphate dihydrate (NaH$_2$PO$_4$ · 2H$_2$O)</td>
<td>2g</td>
</tr>
<tr>
<td>Aliphatic acid (RCOOH)</td>
<td>5g</td>
</tr>
<tr>
<td>Water (H$_2$O)</td>
<td>500g</td>
</tr>
</tbody>
</table>

1,000g
**Fig. 14**

**Basic blending proportions (by weight) in 1 kg of rust-removing/preventing agent**

<table>
<thead>
<tr>
<th>Component</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orthophosphoric acid (H₃PO₄)</td>
<td>50 - 600g</td>
</tr>
<tr>
<td>DL-malic acid (HOOCCH₂CH(OH)COOH)</td>
<td>0.2 - 20g</td>
</tr>
<tr>
<td>Sodium dihydrogen phosphate dihydrate (NaH₂PO₄ · 2H₂O)</td>
<td>0.2 - 2g</td>
</tr>
<tr>
<td>Surfactant (propylene glycol: CH₃CH(OH)CH₂OH)</td>
<td>0.1 - 1.5g</td>
</tr>
<tr>
<td>Aliphatic acid (RCOOH)</td>
<td>1.0 - 10g</td>
</tr>
<tr>
<td>Water (H₂O)</td>
<td>Xg</td>
</tr>
</tbody>
</table>

1,000g

The weight X (g) of water (H₂O) is the weight of the balance obtained by subtracting, from 1,000 g, the total weight of the other components used.

---

**Fig. 15**

**Preferred blending proportions (by weight) in 1 kg of rust-removing/preventing agent**

<table>
<thead>
<tr>
<th>Component</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orthophosphoric acid (H₃PO₄)</td>
<td>490g</td>
</tr>
<tr>
<td>DL-malic acid (HOOCCH₂CH(OH)COOH)</td>
<td>2g</td>
</tr>
<tr>
<td>Sodium dihydrogen phosphate dihydrate (NaH₂PO₄ · 2H₂O)</td>
<td>2g</td>
</tr>
<tr>
<td>Surfactant (propylene glycol: CH₃CH(OH)CH₂OH)</td>
<td>1g</td>
</tr>
<tr>
<td>Aliphatic acid (RCOOH)</td>
<td>5g</td>
</tr>
<tr>
<td>Water (H₂O)</td>
<td>500g</td>
</tr>
</tbody>
</table>

1,000g
Basic blending proportions (by weight) in 1 kg of rust-removing/preventing agent

<table>
<thead>
<tr>
<th>Component</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orthophosphoric acid (H₃PO₄)</td>
<td>50-600g</td>
</tr>
<tr>
<td>DL-malic acid (HOOCCH₂CH(OH)COOH)</td>
<td>0.2-20g</td>
</tr>
<tr>
<td>Sodium dihydrogen phosphate dihydrate (NaH₂PO₄·2H₂O)</td>
<td>0.2-2g</td>
</tr>
<tr>
<td>Acetic acid (CH₃COOH)</td>
<td>0.1-5.0g</td>
</tr>
<tr>
<td>Aliphatic acid (RCOOH)</td>
<td>1.0-10g</td>
</tr>
<tr>
<td>Water (H₂O)</td>
<td>Xg</td>
</tr>
<tr>
<td></td>
<td>1,000g</td>
</tr>
</tbody>
</table>

The weight X (g) of water (H₂O) is the weight of the balance obtained by subtracting, from 1,000 g, the total weight of the other components used.

Preferred blending proportions (by weight) in 1 kg of rust-removing/preventing agent

<table>
<thead>
<tr>
<th>Component</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orthophosphoric acid (H₃PO₄)</td>
<td>489g</td>
</tr>
<tr>
<td>DL-malic acid (HOOCCH₂CH(OH)COOH)</td>
<td>2g</td>
</tr>
<tr>
<td>Sodium dihydrogen phosphate dihydrate (NaH₂PO₄·2H₂O)</td>
<td>2g</td>
</tr>
<tr>
<td>Acetic acid (CH₃COOH)</td>
<td>2g</td>
</tr>
<tr>
<td>Aliphatic acid (RCOOH)</td>
<td>5g</td>
</tr>
<tr>
<td>Water (H₂O)</td>
<td>500g</td>
</tr>
<tr>
<td></td>
<td>1,000g</td>
</tr>
</tbody>
</table>
Blending proportions by weight in 1 kg of rust-removing/preventing agent of the present invention corresponding to claim 1

Orthophosphoric acid: 496 g
DL-malic acid: 2 g
Water: 502 g

The rust removing/preventing agent was produced in an amount of 1 kg.

Blending proportions by weight in 1 kg of washing solution in JP-A-9-1090 (Comparative Example 1)

Nonionic surfactant: 2%
Malic acid condensation: 1%
Citric acid complex: 2%
Dibasic acid complex: 8%
Water: the balance

These components were stirred to produce an additive liquid.
The additive liquid: 2 cc
Phosphoric acid: 150 cc
Surfactant: 2 cc
Water: 846 cc

The washing solution was produced in an amount of 1 liter.
Blending proportions by weight in 1 kg of rust removing/preventing agent using oxalic acid instead of DL-malic acid (Comparative Example 2)

Orthophosphoric acid: 496 g
Oxalic acid: 2 g
Water: 502 g

A liquid was produced in an amount of 1 kg.

Blending proportions by weight in 1 kg of rust removing/preventing agent using citric acid instead of DL-malic acid (Comparative Example 3)

Orthophosphoric acid: 496 g
Citric acid: 2 g
Water: 502 g

A liquid was produced in an amount of 1 kg.
<table>
<thead>
<tr>
<th>Rust-removing agent</th>
<th>10 minutes</th>
<th>20 minutes</th>
<th>30 minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Example 1</td>
<td>○</td>
<td></td>
<td>○</td>
</tr>
<tr>
<td>B Comparative Example 1</td>
<td>×</td>
<td>×</td>
<td></td>
</tr>
<tr>
<td>C Comparative Example 2</td>
<td></td>
<td></td>
<td>○</td>
</tr>
<tr>
<td>D Comparative Example 3</td>
<td></td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>E Example 2</td>
<td></td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

A: Rust removing/preventing agent of the invention in claim 1 (Example 1)
C: Comparative Example 2: Liquid using oxalic acid
D: Comparative Example 3: Liquid using citric acid
E: Rust removing/preventing agent of the invention in claim 2 (Example 2)

○: Very good
△: Allowable
×: Bad

Performance-comparison result of various rust-removing agents
Performance-compared result of various rust-removing agents

Rust removal at a temperature of 20 °C for 30 minute
Humidity cabinet test at a temperature of 50 °C and a humidity of 100% for 2 hours

<table>
<thead>
<tr>
<th>Rust-removing agent</th>
<th>A Example 1</th>
<th>B Comparative Example 1</th>
<th>C Comparative Example 2</th>
<th>D Comparative Example 3</th>
<th>E Example 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rust-removing time</td>
<td>30 minutes</td>
<td>☺</td>
<td>✗</td>
<td>✗</td>
<td>☺</td>
</tr>
</tbody>
</table>

A: Rust removing/preventing agent of the invention in claim 1 (Example 1)
C: Comparative Example 2: Liquid using oxalic acid
D: Comparative Example 3: Liquid using citric acid
E: Rust removing/preventing agent of the invention in claim 2 (Example 2)
### Performance-compared result of various rust-removing agents

<table>
<thead>
<tr>
<th>Rust-removing agent</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example 1</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Comparative Example 1</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Comparative Example 2</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Comparative Example 3</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>O</td>
<td>O</td>
</tr>
</tbody>
</table>

- **A**: Rust removing/preventing agent of the invention in claim 1 (Example 1)
- **C**: Comparative Example 2: Liquid using oxalic acid
- **D**: Comparative Example 3: Liquid using citric acid
- **E**: Rust removing/preventing agent of the invention in claim 2 (Example 2)

Rust removal at a temperature of 20°C for 30 minutes.

Humidity cabinet test at a temperature of 40°C and a humidity of 100% for 24 hours.
Acid-used washing process

Acid-used oil- and rust-removing process

Water-used washing-off process  Neutralizing process

Neutralizing process  Alkali-used rust-prevention treating process

Alkali-treating process  Drying process

Plating process  Rust-prevention treating process

Rust-preventing liquid removing process  Washing process

Painting process
BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention
[0002] The present invention relates to a rust-removing/preventing agent for removing rust from a surface of a metal or giving a rust-preventing function onto the metal surface after the rust is removed; and a rust-removing method using this agent.
[0003] 2. Description of the Related Art
[0004] It is presumed that, in Japan, iron rusts in an amount of about 1 ton per minute, that is, about 500,000 tons per year at present (written by Noboru Masuko, who is an emeritus professor of the Tokyo University, and published by the Japanese Standards Association). The total amount of damage based on rust has been considerable large by air pollution based on environmental deterioration.

[0005] General examples of loss generated by generation of "rust" include (1) shutdown of facilities or apparatus, (2) decrease in the yield of products based on contamination or leakage thereof, (3) disasters based on accidents, and (4) costs for exchanging parts.

[0006] Deteriorations of material which cause troubles in instruments using a metal material, such as devices, structures, or pipes are largely classified into the following three: corrosion, embrittlement, and fatigue. Corrosion embrittlement or corrosion fatigue, which is induced and promoted by "rust", is generated in many cases. Various aspects of troubles caused by "rust" are as follows:

[0007] (1) Pollution: a product is polluted by rust of a water supply pipe.
[0008] (2) Rusting: mobile portions are fixed onto each other by rust, so that the instrument is damaged. Corrosion products (such as rust, and scale) cause the thermal conductivity to decrease, so as to cause the temperature of the instrument to rise. Accordingly, the productivity decreases.
[0009] (3) Rust clogging: rust or scale gathers in a single position in a device, so that the function thereof lowers.
[0010] (4) Wall thickness reduction: the wall thickness of a device is locally reduced by rust, so that the function thereof lowers, which is the most typical trouble.
[0011] (5) Leakage: joint portions of pipes are deteriorated by gap-corrosion or the like, so that leakage is caused. Leakage accidents are most frequently caused by rust.
[0012] (6) Cracking: stress corrosion cracking, and cracking caused by corrosion fatigue or the like are generated.

[0013] As described above, troubles caused by a matter that a metal material "rusts" produce a large number of ripple effects. As a result, a larger loss is caused in many cases.

[0014] FIG. 25 is a process chart showing a surface treatment that has been hitherto conducted in order to remove and prevent rust of a metal before the surface of the metal is plated or coated with a paint to prevent the above-mentioned accidents based on rust. First, in step S10, washing is performed using diluted hydrochloric acid, diluted sulfuric acid or the like to remove rust from a metal. Next, in step S11, an oil component or rust adhering on the surface of the metal is removed with an acid.

[0015] When plating is performed, the present process is shifted from step S11 to step S12 and the solution wherein the rust is removed with the acid is washed away with water. Furthermore, in step S13, the solution is neutralized. After this neutralizing step, the process is shifted to step S14, and treatment with a water-soluble alkali is conducted. The process is further shifted to step S15, i.e., a plating step. In this way, the generation of rust is prevented at the stage before the metal surface is plated.

[0016] When coating with a paint is performed, the process is shifted from step S11 to step S16 and the acid is neutralized. Thereafter, in step S17, rust-preventing treatment with an alkali is conducted. The process is then shifted to step S18 and drying is performed. After this drying step, in step S19 a rust-preventing treatment (according to the parkerizing process) is conducted for making a surface coating on the metal surface from a phosphate solution.

[0017] Thereafter, in step 20, the rust-preventing solution used in step S19 is removed. Thereafter, in step S21, a washing step is performed, and subsequently the metal surface is coated with a paint (see step S22). In this way, the generation of rust is prevented at the stage before the metal surface is coated with the paint.

[0018] As described above, a work for removing/preventing rust of iron steel is typically according to the parkerizing method of removing the rust with diluted hydrochloric acid or the like, and then performing washing and neutralizing; that is, a method of making a surface coating from a phosphate solution and then applying a paint onto the coating to prevent rust. At present, the following rust-preventing method has been developed: "a method of forming a rust-preventing composition into which a complex wherein a polymer made from silane or a derivative thereof is intercalated into gaps between layers of zinc phosphate is incorporated" or the like.

[0019] As described above, however, after removal of rust from metal, it is necessary in the plating process to perform the acid-removing step, the water-used washing step, the neutralizing step, and the alkali-used treating step. It is also necessary in the coating (or painting) process to perform many steps, which include the acid-removing step, the neutralizing step, the alkali-used rust-prevention treating step, the rust-preventing step, the rust-preventing liquid removing step, and the washing step. As a result, many costs and much time are required, so as to cause a problem that the work efficiency is very bad. Such a situation has been lasting at present. It is considered without any doubt that these steps are naturally performed.

[0020] In the case of disposing of the solution wherein the diluted hydrochloric acid, the diluted sulfuric acid or the like that has been used for the washing is neutralized, the following problem also arises: this solution has toxicity; therefore, the solution is unable to be disposed of unless the solution is diluted with a large amount of water.

[0021] Furthermore, an ordinarily rust-removing agent needs to be washed away from a metal with water since the agent has toxicity. Unless the metal is subjected to rust-preventing treatment, the metal rusts immediately. Even if the surface of the metal is subjected to rust-preventing treatment, there is caused a problem that rust is generated on the metal surface outdoors in a short term.

[0022] Most of countermeasures for preventing the rust of iron at present are based on coating with a paint or plating. In stainless steel, which has been developed to prevent rust, also, great pains have been taken on the prevention of rust from neighbors in the present circumstances.

[0023] Examples of a rust-removing agent composition or a rust-removing agent used to remove rust of metal are described in JP-A-202983, and JP-A-9-241877. Examples of

[0024] JP-A-2002983 discloses a rust-removing agent composition containing, as its essential components, at least one selected from the group consisting of organic acids, weakly acidic inorganic acids, and salts thereof, an oxidizer, and a metal having a standard electrode potential of -0.1 V or less.

[0025] JP-A-9-241877 discloses a rust-removing agent containing an ammonium salt of at least one selected from the group consisting of thiglycolic acid monooethanolamine, thiglycolic acid diethanolamine, thiglycolic acid triethanolamine, thiomalic acid monoethanolamine, thiomalic acid diethanolamine, and thiomalic acid triethanolamine.

[0026] The rust-removing agent composition and the rust-removing agent described in JP-A-2002983 and JP-A-9-241877 are each a product which has a function of removing rust but does not have any function of forming a passivation coating on the surface of a metal from which rust is removed, thereby preventing the generation of rust.

[0027] JP-A-2005-248310 discloses a rust-prevention treating solution including one or more metal components selected from Ca, Mg, Mn and Zn, phosphate ions, and an organic compound having an ethylene oxide group. When the rust-prevention treating solution heated to a temperature of 10 to 80°C is painted onto the surface of a steel plate, a dense rust-preventing coating is easily formed regardless of a situation that processing water, stains and others remain.

[0028] JP-A-2005-232460 describes a water-based rust-preventing paint wherein a reaction product made from sodium tripolyphosphate and a water-soluble zinc salt is incorporated into a water-based vehicle. In order to improve storage stability, in the reaction product, the reaction mole ratio of the water-soluble zinc salt to sodium tripolyphosphate is from 0.5 to 10.

[0029] It is reported that this water-based rust-preventing paint is a water-based rust-preventing paint which is excellent in rust-preventing power and contains a non-environmental-pollution type rust-preventing pigment composition that produces no bad effect onto the storage stability of any water-based paint when the composition is incorporated into the water-based paint.

[0030] JP-A-2005-977015 states that in the case of using a rust-preventing agent which contains a phosphate, an oxidizer, a nonionic surfactant, and water as the balance and preferably has a pH of 8 to 11, a protective coating having the same durability as any chromate coating can be formed on the surface of a metal regardless of the type of the metal.


[0033] Black scale formed on the surface of iron temporarily exhibits rust-preventing effect. However, the scale is weak in adhesiveness onto the iron surface; therefore, a paint cannot be painted onto the surface of the black scale. It is therefore necessary to remove the black scale by shot blast or with a chisel.

[0034] Moreover, in the case of removing oxidation scale (in black) generated in welded regions of stainless steel when the steel is welded, or removing rust on the surface of a metal, the shot blast or the chisel is used to remove the scale or rust. In this case, a large amount of dust is blown up (rust is scattered up). Thus, a serious problem is caused from an environmental or hygienic viewpoint. Many costs are necessary for countermeasures against the problem in the present circumstances.

[0035] Even if rust on the surface of a metal is removed by shot blast or a chisel operation, the rust cannot be completely removed and the rust certainly remains partially on the metal surface. Thus, even if a rust-preventing paint or primer coating is repeatedly applied to the surface, there is always a risk of the generation of rust.

[0036] Incidentally, for example, JP-A-9-1090 is known as a product made of a single solution having both of rust-removing and rust-preventing functions.

[0037] JP-A-9-1090 describes a washing solution, for removing/preventing rust, produced by adding, to water, phosphoric acid, a surfactant, and an organic acid derivative including a mixture of a maleic acid condensation, a citric acid complex and a dibasic acid complex or including an acetic acid complex at a predetermined ratio therebetween.

[0038] According to JP-A-9-1090, rust generated on the inner face of a mold-cooling section is removed with the washing solution, and further the prevention of rust is attempted by forming, in the inner face of the mold section, a rust-preventing coating made of iron phosphate, wherein phosphoric acid in the washing solution is chemically combined with iron of a mold-forming material.

[0039] For the washing solution, a blend composed of 2% of a nonionic surfactant, 1% of a maleic acid condensation, 2% of a citric acid complex, 8% of a dibasic acid complex, and water as the balance is stirred to prepare an additive solution. Furthermore, 2 cc of this additive solution is mixed with 150 cc of phosphoric acid, 2 cc of a surfactant, and 846 cc of water to produce one liter of the washing solution.

[0040] As will be described later, however, the rust-removing/preventing agent of the present invention is compared with the washing solution of JP-A-9-1090 on the basis of measurement results, a remarkable difference is generated in the removal/prevention of rust. The washing solution of JP-A-9-1090 produces remarkably poorer effects of removing/preventing rust than the invention.

[0041] As will also be described later, none of the components used in the invention described in JP-A-9-1090 are food additives, which is different from the present invention. Thus, in the case of disposing of the washing solution, it is necessary to conduct some treatment for making the components harmless. As a result, a problem that additional costs are generated remains.

[0042] In light of the above-mentioned problems, the present invention has been made. An object of the present invention is to provide a rust-removing/preventing agent which can attain the following (1) to (11), and a rust-removing method using the same:

[0043] (1) Rust is completely removed only by immersing a rusted metallic product into a single liquid (i.e., a rust-removing/preventing agent) or painting a rust-removing/preventing agent onto the rust on the surface, and further the
metal from which the rust is removed does not need to be subjected to any post-treatment, such as washing.

(0044) The metallic product taken out from a liquid of a rust-removing/preventing agent does not need to be washed with water, and the effect of preventing rust is exhibited over a long term whether the product is present indoors or outdoors only by drying the product naturally or wiping off the liquid from the product.

(0045) A single liquid of a rust-removing/preventing agent has two functions of rust-removing and rust-preventing functions.

(0046) After rust is removed with a liquid of a rust-removing/preventing agent, the process for the treated metallic product can be smoothly shifted to a plating step or a painting step without performing many steps, such as an acid-removing step, a neutralizing step, a rust-prevention treating step, and a rust-preventing liquid removing step.

(0047) Before a plating step or a painting step, many steps, such as an acid-removing step, a neutralizing step, a rust-prevention treating step, and a rust-preventing liquid removing step, are made unnecessary, and the line for the production is simplified. Thus, costs and time are decreased, thereby improving the production efficiency greatly.

(0048) A shot blast treatment or a charplet operation, which is a manner of removing rust, is made unnecessary, thereby preventing the scattering of rust (environmental pollution).

(0049) Black scale, and oxidation scale generated when stainless steel is welded are removed as well as rust is removed.

(0050) A zero energy operation, wherein no energy is consumed, is attained in rust-removing/preventing treatment.

(0051) A rust-removing/preventing agent itself is supplied at low costs.

(0052) Even in a region where rust cannot be removed by a shot blast treatment or a charplet operation, rust is completely removed.

(0053) There is provided a rust-removing/preventing method which makes it possible to apply rust-removing treatment and rust-preventing treatment simultaneously to an article which cannot be immersed into a bath in which the liquid of a rust-removing/preventing agent is put, such as a large-sized mold having a complicated shape, a column, or a ceiling.

SUMMARY OF THE INVENTION

(0054) Therefore, according to a first aspect of the present invention, there is provided a rust-removing/preventing agent including orthophosphoric acid, DL-malic acid, and water, in which, in the case that the total weight of the agent is assumed to be 1 kg, the weight of the orthophosphoric acid is from 50 to 600 g, the weight of the DL-malic acid is from 0.2 to 20 g, and the balance comprises the water.

(0055) According to a second aspect of the present invention, there is provided the rust-removing/preventing agent to which sodium dihydrogen phosphate dihydrate is added.

(0056) According to a third aspect of the present invention, there is provided the rust-removing/preventing agent in which the above-mentioned case, the weight of sodium dihydrogen phosphate dihydrate is from 0.2 to 2 g.

(0057) According to a fourth aspect of the present invention, there is provided the rust-removing/preventing agent wherein the water is processed water, molecular clusters of which are substantially uniform.

(0058) According to a fifth aspect of the present invention, there is provided the rust-removing/preventing agent wherein the water is processed water, to which magnetism is applied.

(0059) According to a sixth aspect of the present invention, there is provided the rust-removing/preventing agent to which a surfactant is added at a weight of 0.1 to 1.5 g in the above-mentioned case.

(0060) According to a seventh aspect of the present invention, there is provided the rust-removing/preventing agent to which acetic acid is added at a weight of 0.1 to 5.0 g in the above-mentioned case.

(0061) According to an eighth aspect of the present invention, there is provided the rust-removing/preventing agent wherein the water is processed water, molecular clusters of which are substantially uniform.

(0062) According to a ninth aspect of the present invention, there is provided the rust-removing/preventing agent to which acetic acid is added at a weight of 0.1 to 5.0 g, or an aliphatic acid is added at a weight of 1.0 to 10 g in the above-mentioned case.

(0063) According to a tenth aspect of the present invention, there is provided the rust-removing/preventing agent wherein the water is processed water, molecular clusters of which are substantially uniform.

(0064) According to an eleventh aspect of the present invention, there is provided the rust-removing/preventing agent to which acetic acid is added at a weight of 0.1 to 5.0 g, and an aliphatic acid is added at a weight of 1.0 to 10 g in the above-mentioned case.

(0065) According to a twelfth aspect of the present invention, there is provided a rust-removing method including the steps of painting the rust-removing/preventing agent according to the above-mentioned aspects onto a mold, a column, or a ceiling made of a metal material, and causing a piece of paper or nonwoven cloth which can hold the rust-removing/preventing agent without drying the agent for a predetermined time to adhere onto the painted rust-removing/preventing agent, thereby removing rust of the metal material.

(0066) According to a thirteenth aspect of the present invention, there is provided a rust-removing method wherein the rust-removing/preventing agent is further painted onto the piece of the paper or nonwoven cloth.

(0067) According to a fourteenth aspect of the present invention, there is provided a rust-removing method wherein the rust-removing/preventing agent is further painted onto the piece of the paper or nonwoven cloth.

(0068) According to the rust-removing/preventing agent of the first aspect of the present invention, rust of a rusted metallic product is completely removed only by immersing the metallic product into a single liquid of the rust removing/preventing agent or painting the rust-removing/preventing agent on the rust on the surface. Thus, it can be made unnecessary to subject the metal from which the rust is removed to any post-treatment, such as washing. On the surface of the metal, from which the rust is removed, a phosphate coating is formed to give rust-preventing function onto the surface. Two functions of rust-removing and rust-preventing functions can be caused to have the single liquid of the rust removing/preventing agent.

(0069) In the case of using the rust removing/preventing agent of the invention as a rust-preventing agent, the agent is used as follows: about an iron product wherein no rust is
generated, the liquid of this rust removing/preventing agent is diluted and the diluted liquid is put into a bath; the iron product is immersed in the liquid in the bath for 10 minutes or more, and then the iron product is dried by natural drying or the wiping of the liquid without washing the liquid with water; and after the liquid is volatilized, a phosphate coating is formed on the surface of the metallic material. As a result, the effect of preventing rust is exhibited over a long term.

[0070] In the case of using the rust removing/preventing agent of the invention as a rust-removing agent, a material is immersed into the liquid of the rust removing/preventing agent or is coated with the liquid, thereby removing rust generated on the surface of the material. At the same time when this rust is removed, a strong phosphate coating is formed on the material surface, thereby giving the effect of preventing rust to the surface. The material, from which the rust is removed, will not rust again indoors. A verification test demonstrates a result that the generation of rust is not observed indoors for 10 years.

[0071] The rust removing/preventing agent of the invention makes it possible to not only remove rust but also remove black scale and oxidation scale generated when stainless scale is welded. Furthermore, when a rusted metallic material is immersed in the liquid of the rust removing/preventing agent, rust can be completely treated even in a region where rust is unable to be removed by a chaflet operation or shot blast treatment conducted.

[0072] For this reason, rust is not scattered so that a hygienically good result is produced and environmental pollution is not generated, either, which is different from conventional techniques, wherein rust is scattered by a chaflet operation or shot blast, so that environmental pollution is caused.

[0073] In the case that a mold for concrete is made of a metal such as iron, concrete adheres onto the surface of the mold so as not to be taken off therefrom; however, when the mold is coated with the (liquid of) the rust removing/preventing agent of the invention or immersed into a bath wherein the liquid is put, the concrete can be completely removed from the mold with ease.

[0074] Hitherto, in order to remove rust of a metallic material, a rust-removing agent has been used, and further a rust-preventing agent has been painted onto the surface of the metallic material after the removal of the rust; however, according to the rust removing/preventing agent of the invention, a rusted metallic material is merely immersed into a single liquid of the rust removing/preventing agent of the invention or is merely coated with the liquid, whereby the rust can be completely removed. Thus, it is not necessary to wash the metallic material taken off from the liquid with water or the like as in the prior art. Only by volatilizing the liquid naturally or wiping away the liquid, the effect of preventing rust is exhibited over a long term whether the metallic material is present indoors or outdoors.

[0075] It is also possible to omit many steps, after removal of rust, necessary in the prior art, such as an acid-removing step, a neutralizing step, a rust-prevention treating step, and a rust-preventing liquid removing step; therefore, the process for the treated metallic product can be smoothly shifted to a plating step or a painting step immediately after the liquid is volatilized or wiped away after the rust-removing step. Before this plating step or painting step, the acid-removing step, the neutralizing step, the rust-prevention treating step and the rust-preventing liquid removing step can be made unnecessary, thereby simplifying the production line. For this reason, costs and time can be decreased, thereby improving the production efficiency greatly.

[0076] It is sufficient to prepare only a bath wherein a metallic material is to be immersed. Both treatments of rust-removal and rust-prevention can be simultaneously attained only by using a simple facility made only of a bath. Costs for the facility in the production line can be decreased.

[0077] In the rust-removing or rust-preventing treatment with the rust removing/preventing agent of the invention, it is unnecessary to heat (the liquid of) the rust removing/preventing agent, and the treatment can be conducted at an ordinary temperature. Accordingly, a zero energy operation, wherein no energy is consumed, can be attained.

[0078] In the material of the rust removing/preventing agent of the invention, orthophosphoric acid, DL-malic acid, and water are used and, in particular, approximately ½ of the weight of the rust removing/preventing agent is based on water; therefore, the rust removing/preventing agent itself can be provided at low costs.

[0079] Moreover, the rust removing/preventing agent is made of a single product having the effect of removing rust and the effect of preventing rust; therefore, the use thereof makes it possible to attain rust-removing and rust-preventing treatments at lower costs than the use of two agents of a rust-removing agent and a rust-preventing agent as in the prior art. Furthermore, only one single stock management is required, and the stock management is easily attained. Additionally, the rust removing/preventing agent of the invention can be poured away, as it is, into a drainage channel since the materials (orthophosphoric acid and DL-malic acid) which constitute the rust removing/preventing agent of the invention are food additives.

[0080] According to the rust removing/preventing agent of the second aspect, sodium dihydrogen phosphate dihydrate is added to the essential components, i.e., orthophosphoric acid, DL-malic acid, and water; therefore, the rust-removing rate or the permeating rate can be made high.

[0081] According to the rust removing/preventing agent of the third aspect, the weight of sodium dihydrogen phosphate dihydrate is set into the range of 0.2 to 2 g under the condition that the total weight of the rust removing/preventing agent is assumed to be 1 kg; therefore, the rust-removing rate or the permeating rate can be made high by use of only a small amount of this compound.

[0082] According to the rust removing/preventing agent of the fourth aspect, the water is processed water wherein clusters of water molecules are small and substantially uniform; therefore, the rust-removing rate can be made high.

[0083] According to the rust removing/preventing agent of the fifth aspect, the water is processed water to which magnetism is applied; therefore, clusters of water molecules can easily be made small and uniform.

[0084] According to the rust removing/preventing agent of the sixth aspect, a surfactant is added at a weight of 0.1 to 1.5 g under the above-mentioned condition; therefore, the permeating power of the agent can be made even higher to make the removal of rust speedier in addition to the advantageous effects of the first aspect.

[0085] According to the rust removing/preventing agent of the seventh aspect, acetic acid is added at a weight of 0.1 to 5.0 g under the above-mentioned condition; therefore, after a metal is subjected to rust-removing treatment, the metal can be caused to express its original color and the metal can be
prevented from getting discolored in addition to the advantageous effects of the first and sixth aspects.

[0086] According to the rust removing/preventing agent of the eighth aspect, an aliphatic acid is added at a weight of 1.0 to 10 g under the above-mentioned condition; therefore, the rust-preventing effect can be further promoted in addition to the advantageous effects of the first, sixth and seventh aspect.

[0087] According to the rust removing/preventing agent of the ninth aspect, acetic acid is added at a weight of 0.1 to 5.0 g, or an aliphatic acid is added at a weight of 1.0 to 10 g under the above-mentioned condition; therefore, in the case that acetic acid is added at a weight of 0.1 to 5.0 g, a metal after subjected to rust-removing treatment can be caused to express its original color and the metal can be prevented from getting discolored in addition to the advantageous effects of the first aspect. In the case that an aliphatic acid is added at a weight of 1.0 to 10 g, the rust-preventing effect can be further promoted in addition to the advantageous effects of the first aspect.

[0088] According to the rust removing/preventing agent of the tenth aspect, a surfactant is added at a weight of 0.1 to 1.5 g and an aliphatic acid is added at a weight of 1.0 to 10 g under the above-mentioned condition; therefore, the permeating power can be promoted to make the removal of rust speedier and the rust-preventing effect can be further promoted in addition to the advantageous effects of the first aspect.

[0089] According to the rust removing/preventing agent of the eleventh aspect, acetic acid is added at a weight of 0.1 to 5.0 g, and an aliphatic acid is added at a weight of 1.0 to 10 g under the above-mentioned condition; therefore, after a metal is subjected to rust-removing treatment, the metal can be caused to express its original color and further the metal can be prevented from getting discolored and the rust-preventing effect can be further promoted in addition to the advantageous effects of the first aspect.

[0090] According to the rust removing method of the twelfth aspect of the invention, the rust-removing/preventing agent of the above mentioned aspects is painted onto a mold, a column, or a ceiling face including a metal material, and then a piece of paper or nonwoven cloth which can hold the rust-removing/preventing agent without drying the agent for a predetermined time is caused to adhere onto this painted rust-removing/preventing agent, thereby removing rust of the metallic material; therefore, even if the mold or the like cannot be immersed into a bath, rust thereof can be removed, and simultaneously the effect of preventing rust can be produced.

[0091] According to the rust-removing method of the thirteenth aspect, rust of the mold or the like can be removed even if the mold or the like cannot be immersed into a bath, and simultaneously the effect of preventing rust can be produced.

[0092] According to the rust-removing method of the fourteenth aspect, the piece of the paper or nonwoven cloth is held on a surface of the column or ceiling face including iron by means of a magnetic sheet having a magnetic effect; therefore, by the magnetic effect of the magnetic sheet, the magnetic sheet adsorbs the column or the ceiling face made of iron, and this adsorbing effect of the magnetic sheet toward the column or the ceiling face makes it possible to hold the paper or nonwoven cloth. Simultaneously, magnetism from the magnetic sheet toward molecules of water, which is one of the components of the rust removing/preventing agent, makes it possible to make clusters of the water molecules small and uniform so that the rust-removing rate can be made high.

BRIEF DESCRIPTION OF THE DRAWINGS

[0093] FIG. 1 is a chart showing basic blending proportions (by weight) in 1 kg of a rust-removing/preventing agent according to a first embodiment of the invention;

[0094] FIG. 2 is a chart showing preferred blending proportions (by weight) in 1 kg of a rust-removing/preventing agent according to the first embodiment of the invention;

[0095] FIG. 3 is a process chart showing a plating process or a painting process according to the first embodiment of the invention;

[0096] FIG. 4 is a chart showing basic blending proportions (by weight) in 1 kg of a rust-removing/preventing agent according to a second embodiment of the invention;

[0097] FIG. 5 is a chart showing preferred blending proportions (by weight) in 1 kg of a rust-removing/preventing agent according to the second embodiment of the invention;

[0098] FIG. 6 is a chart showing basic blending proportions (by weight) in 1 kg of a rust-removing/preventing agent according to a third embodiment of the invention;

[0099] FIG. 7 is a chart showing preferred blending proportions (by weight) in 1 kg of a rust-removing/preventing agent according to the third embodiment of the invention;

[0100] FIG. 8 is a chart showing basic blending proportions (by weight) in 1 kg of a rust-removing/preventing agent according to a fourth embodiment of the invention;

[0101] FIG. 9 is a chart showing preferred blending proportions (by weight) in 1 kg of a rust-removing/preventing agent according to the fourth embodiment of the invention;

[0102] FIG. 10 is a chart showing basic blending proportions (by weight) in 1 kg of a rust-removing/preventing agent according to a fifth embodiment of the invention;

[0103] FIG. 11 is a chart showing preferred blending proportions (by weight) in 1 kg of a rust-removing/preventing agent according to the fifth embodiment of the invention;

[0104] FIG. 12 is a chart showing basic blending proportions (by weight) in 1 kg of a rust-removing/preventing agent according to a sixth embodiment of the invention;

[0105] FIG. 13 is a chart showing preferred blending proportions (by weight) in 1 kg of a rust-removing/preventing agent according to the sixth embodiment of the invention;

[0106] FIG. 14 is a chart showing basic blending proportions (by weight) in 1 kg of a rust-removing/preventing agent according to a seventh embodiment of the invention;

[0107] FIG. 15 is a chart showing preferred blending proportions (by weight) in 1 kg of a rust-removing/preventing agent according to the seventh embodiment of the invention;

[0108] FIG. 16 is a chart showing basic blending proportions (by weight) in 1 kg of a rust-removing/preventing agent according to an eighth embodiment of the invention;

[0109] FIG. 17 is a chart showing preferred blending proportions (by weight) in 1 kg of a rust-removing/preventing agent according to the eighth embodiment of the invention;

[0110] FIG. 18 is a chart showing blending proportions (by weight) in a rust removing/preventing agent corresponding to the first aspect when comparison was made in EXAMPLES;

[0111] FIG. 19 is a chart showing blending proportions (by weight) in a washing solution described in JP-A-9-1090.
FIG. 20 is a chart showing blending proportions (by weight) in a rust removing/preventing agent when oxalic acid is used instead of DL-malic acid.

FIG. 21 is a chart showing blending proportions (by weight) in a rust removing/preventing agent when citric acid is used instead of DL-malic acid.

FIG. 22 is a chart showing performance-compared results between the individual rust-removing agents in EXAMPLES.

FIG. 23 is a chart showing performance-compared results between the individual rust-removing agents in EXAMPLES.

FIG. 24 is a chart showing performance-compared results between the individual rust-removing agents in EXAMPLES.

FIG. 25 is a process chart showing a plating process and a painting process in the related art.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

First Embodiment

With reference to the drawings, a first Embodiment of the invention will be described in detail hereinafter. FIG. 1 shows basic blending proportions (by weight) in 1 kg of a colorless, transparent rust-removing/preventing agent of the invention. The agent is composed of 4 ingredients: (1) The weight of orthophosphoric acid (H₃PO₄) is set into the range of 50 to 600 g, (2) the weight of DL-malic acid (HOOCCH₂CH(OH)COOH) is set into the range of 0.2 to 20 g, (3) the weight of sodium dihydrogen phosphate dihydrate (NaH₂PO₄·2H₂O) is set into the range of 0.2 to 2 g, and (4) the weight X (unit: g) of water (H₂O) is a weight obtained by subtracting, from 1,000 g, which is assumed to be the total weight of the rust removing/preventing agent, the total weight of orthophosphoric acid, DL-malic acid and sodium dihydrogen phosphate dihydrate used.

Orthophosphoric acid is made of colorless crystal (melting point: 42.4°C), and is sufficiently dissolved into water to give a highly viscous solution. Orthophosphoric acid is used as an ingredient for producing a phosphat, a metal surface treating agent, a dye, an agent for medicine, a phosphate fertilizer, or a refrigerant, and is a food additive.

DL-malic acid (HOOCCH₂CH(OH)COOH) is made of white crystal or crystalline powder, and is odorless. DL-malic acid is soluble in water, and ethanol, and is slightly soluble in ether.

DL-malic acid is used as an acid taste agent for cool drinks (such as straight, concentrated or powdered cool drink, lactobacillus drink, carbonated drink, lemon pop, and cola), an acid taste agent for cool confectionery (such as sherbet and ice cream), an acid taste agent for processed food (such as gum, fruit drop, jelly, jam, marmalade, catsup, sauce, vinegar, fruit wine, mayonnaise, and margarine), or an agent for medicine (such as drink put in ample for medical use and beauty, and salt-free soy sauce). DL-malic acid is also used as a color tone preservative for fruit drink, or a detergent, or used for acid-washing or coloring. DL-malic acid is also a food additive.

Sodium dihydrogen phosphate dihydrate (NaH₂PO₄·2H₂O) is merely called sodium phosphate in the field of medicine, and is made of colorless tabular crystal. The compound is used for processing a food milk product, or in a detergent, and is also a food additive.

The water (H₂O) may be ordinary tap water or industrial water, and is desirably “process water”, wherein clusters of water molecules would be small and uniform. This “processed water” is, for example, magnetism water, which is obtained by applying magnetism from a 1300-gauss magnet to tap water. A magnet is fitted to a water pipe or is set ahead of a tap; and at the time of letting water run, 1300-gauss magnetism is applied to the water from the magnet.

When this processed water is used, the rust-removing rate can be made high. In order to make the water molecule clusters small and uniform, magnetism is merely applied thereto. This operation can easily be attained with a magnet.

Sodium dihydrogen phosphate dihydrate has effects of improving the rust-removing rate and the permeating rate, but may not be necessarily used. However, it is preferred to use sodium dihydrogen phosphate dihydrate. The weight thereof is from 0.2 to 2 g, which is smaller than the weights of the other components. Thus, the addition of only a small amount thereof makes it possible to raise the rust-removing rate and the permeating rate.

In the case that the weight of the rust removing/preventing agent is assumed to be 1 kg, the weight of orthophosphoric acid is set into the range of 50 to 600 g; as orthophosphoric acid is incorporated in a larger amount, the time necessary for removing rust can be made shorter. If the weight is 50 g or less, the time is too long so that the work efficiency deteriorates. If the weight is 600 g or more, the time is short but the metal surface discolors into black.

Thus, in the case that the weight of the rust removing/preventing agent is assumed to be 1 kg, the weight of orthophosphoric acid is preferably from 50 to 600 g.

Every time when the temperature when rust is removed with the rust removing/preventing agent of the invention is raised to 10°C, the rust-removing rate becomes about two times larger. For example, when the temperature of the rust removing/preventing agent is raised from 20°C (normal temperature) to 40°C, the rust-removing rate becomes about 4 times larger.

If the temperature of the rust removing/preventing agent is raised to 40°C or higher, the rust removing/preventing agent itself evaporates. It is therefore preferred that the agent is used at a temperature from room temperature (normal temperature) to 40°C or lower.

As described above, the weight of DL-malic acid is set into the range of 0.2 to 20 g, and the effect of preventing rust after the removal of rust can be more satisfactorily exhibited in accordance with the used amount of DL-malic acid. If the weight is 0.2 g or less, the rust-preventing effect is not exhibited with ease. If the weight is 20 g or more, the rust-preventing effect is gradually improved but the economical efficiency is poor. Thus, it is preferred to set the weight of DL-malic acid to be added to 20 g or less.

The weight of sodium dihydrogen phosphate dihydrate is set into the range of 0.2 to 2 g, and the time necessary for removing rust can be made short in accordance with the used amount of sodium dihydrogen phosphate dihydrate. However, if the weight is 0.2 g or less, the addition thereof does not contribute to a reduction in the time very much. If the weight is 2 g or more, the metal surface discolors. Thus, it is preferred to set the weight into range of 0.2 to 20 g.

FIG. 2 shows preferred proportions of the components when the rust removing/preventing agent shown in FIG. 1 is assumed to be 1 kg. In this preferred example, the weights
of orthophosphoric acid, DL-malic acid, sodium dihydrogen phosphate dihydrate and water are set to 496 g, 2 g, 2 g, and 500 g, respectively, so as to make the total weight thereof to 1 kg.

[0133] Next, a method of using the rust removing/preventing agent of the invention will be described hereinafter. When the agent is used as a rust-preventing agent, the agent is used as follows: In the case of an iron product wherein no rust is generated, the liquid of this rust removing/preventing agent is diluted and the resultant is put into a bath. The iron product is immersed in the liquid in the bath for 10 minutes or more, and the product is naturally dried or forcibly dried with hot wind without washing the product with water. The liquid may be wiped away from the product with a cloth.

[0134] After the iron product is dried, a phosphate coating is formed on the metal surface so that the effect of preventing rust is exhibited over a long term. The dilution ratio in the dilution is from about 1/10 to 1/100.

[0135] When the rust removing/preventing agent of the invention is used as a rust-removing agent, the time for the immersion or the dilution ratio is varied in accordance with a situation that rust is generated. In the case of a product wherein rust from a neighbor is generated, the product is immersed into the liquid diluted into 1/5 to 1/10 and is kept as it is at normal temperature for about 10 to 30 minutes. The dilution ratio of this liquid (i.e., the rust removing/preventing agent) and the temperature of the liquid are varied in accordance with the state of the rust.

[0136] The dilution ratio of the liquid is from 1/2 to 1/10. The temperature ranges from normal temperature (room temperature) to 40°C. When the temperature of the liquid is set to a temperature 40°C or higher, the liquid itself unfavorably evaporates. Thus, it is preferred to use the liquid at 40°C or lower. However, from the viewpoint of a zero energy operation, wherein no energy is consumed, it is preferred to use the liquid (i.e., the rust removing/preventing agent of the invention), without being heated, at normal temperature.

[0137] The removal of rust with phosphoric acid is based on hydrogen gas generated when the acid reacts with iron constituting base metal in the same manner as sulfuric acid, nitric acid or hydrochloric acid. The reaction formula thereof is represented by the following formula (1):

\[
Fe + 2H_3PO_4 \rightarrow Fe(H_2PO_4)_2 + H_2
\]

(1)

[0138] However, after a metal such as iron is washed with sulfuric acid, nitric acid or hydrochloric acid, no phosphate coating is formed so that the surface of the metal immediately rusts. However, when rust is removed with the rust removing/preventing agent of the invention, a phosphate coating is formed on the surface of the metal (iron), which is different from the case of sulfuric acid, nitric acid or hydrochloric acid. This phosphate coating exhibits corrosion resistance; therefore, rust is not generated in a short period. This phosphate coating is generated on stainless steel or some other metal also.

[0139] FIG. 3 is a chart corresponding to the chart about the prior art shown in FIG. 25. In the case of plating or painting a material surface, the material is first immersed into the liquid of the rust removing/preventing agent of the invention, or painted with the liquid in step S1, thereby removing rust generated on the material surface. Next, the material surface is naturally dried or dried with hot wind, or the liquid is wiped away from the surface (see step S2).

[0140] At the same time when the rust is removed, a strong phosphate coating is formed on the surface of the material, thereby giving rust-preventing effect to the surface. The material from which the rust is removed is not rusted again indoors. A verification test demonstrates a result that the generation of rust is not observed indoors for 10 years. After the rust of the material is removed as described above, the material is dried to remove the rust removing/preventing agent and then the present metal-treating process is shifted into a plating step (see step S3) or into a painting step (see step S4).

[0141] The metal surface on which the phosphate coating is formed is good in adhesiveness to plating or paint. Thus, in a plating or painting line, pre-treatment can be omitted.

[0142] In an actual example, in order to improve, at the time of coating a body of a car with a paint, the adhesiveness of the coating to the body, the body is immersed into a large-scale device (such as a bath in which the rust removing/preventing agent is put) so as to form a phosphate compound by rust removal and rust prevention, or only by rust prevention.

[0143] The rust removing/preventing agent of the invention makes it possible to not only remove rust but also to remove black scale or oxidation scale generated when stainless steel is welded. Furthermore, when rusted metallic material is immersed into the liquid of the rust removing/preventing agent or coated with the liquid, rust can be completely treated even in a region where rust is unable to be removed by a charplet operation or shot blast treatment conducted in the prior art.

[0144] For this reason, rust is not scattered so that a hygienically good result is produced and environmental pollution is not generated, either, which is different from conventional techniques, wherein rust is scattered by a charplet operation or shot blast so that environmental pollution is caused.

[0145] In the case that a mold for concrete is made of a metal such as iron, concrete adheres onto the surface of the mold so as not to be taken off therefrom; however, when the mold is coated with (the liquid of) the rust removing/preventing agent of the invention or immersed into a bath wherein the liquid is put, the concrete can be completely removed from the mold.

[0146] Hitherto, in order to remove rust of a metallic material, a rust-removing agent has been used, and further a rust-preventing agent has been painted onto the surface of the metallic material after the removal of the rust; however, according to the rust removing/preventing agent of the invention, a rusted metallic material is merely immersed into a single liquid which is the rust removing/preventing agent of the invention or is merely coated with the liquid, whereby the rust can be completely removed. Thus, it is not necessary to wash the metallic material taken off from the liquid with water or the like as in the prior art. Only by volatilizing the liquid naturally or wiping away the liquid, the effect of preventing rust is exhibited over a long term whether the metallic material is present indoors or outdoors.

[0147] For reference, conventional rust-removing agents need to be washed away from a metal with water since the agents have toxicity. Moreover, unless the metal is immediately subjected to rust-preventing treatment after the washing with water, the metal rusts at once. Even if the metal is subjected to rust-preventing treatment, there is caused a problem that rust is generated outdoors in a short term.

[0148] As illustrated in FIG. 3, it is possible to omit many steps, such as an acid-removing step, a neutralizing step, a
The rust-prevention treating step, and a rust-preventing liquid removing step, as compared with the case shown in FIG. 25. Accordingly, the present metal-treating process can be smoothly shifted to a plating step or a painting step immediately after the liquid is volatilized or wiped away after the rust-removing step. Before this plating step or painting step, the acid-removing step, the neutralizing step, the rust-prevention treating step and the rust-preventing liquid removing step can be made unnecessary; thereby simplifying the production line. For this reason, costs and time can be decreased, thereby improving the work efficiency greatly.

[0149] It is sufficient to prepare only a bath wherein a metallic material is to be immersed. Both treatments of rust-removal and rust-prevention can be simultaneously attained only by using a simple facility made only of a bath. Costs for the facility in the production line can be decreased.

[0150] In the rust-removing or rust-preventing treatment with the rust removing/preventing agent of the invention, it is unnecessary to heat (the liquid of) the rust removing/preventing agent, and the treatment can be conducted at an ordinary temperature. Accordingly, a zero energy operation, wherein no energy is consumed, can be attained.

[0151] In ordinary steps of painting onto a metal material, painting is repeated at least two or three times. However, the metal treated with the rust removing/preventing agent of the invention exhibits a remarkable rust-preventing effect; therefore, it is unnecessary to paint a rust inhibiting paint or a primer coating.

[0152] For reference, when rust is removed by shot blast or a chafoplet operation in conventional rust-removing methods, rust certainly remains partially on the metal; therefore, there is a risk that rust is generated even if a rust inhibiting paint or a primer coating is repeatedly painted.

[0153] As illustrated in FIG. 1, the material of the rust removing/preventing agent of the invention contains orthophosphoric acid, DL-malic acid, sodium dihydrogen phosphate dihydrate and water; and ½ or more of the total weight thereof is made of the water; therefore, the rust removing/preventing agent itself can be provided at low costs.

[0154] Moreover, the rust removing/preventing agent is made of a single product having the effect of removing rust and the effect of preventing rust; therefore, the use thereof makes it possible to attain rust-removing and rust-preventing treatments at lower costs than the use of two agents of a rust-removing agent and a rust-preventing agent as in the prior art. Furthermore, only single stack management is required, and the stock management is easily attained.

[0155] When rusted pliers are immersed in a solution wherein 4 parts by weight of the rust removing/preventing agent are blended with 10 parts by weight of 45°C hot water (ratio by weight of 4/10) for 35 minutes, rust of uncovered metallic portions of the pliers can be completely removed. Simultaneously, it is possible to remove dirt from the hand and other stains adhering on the surface of a polyvinyl sheet for electric insulation which covers handle portions of the pliers.

[0156] Even if the pliers are left as they are outdoors in the state that the pliers may be exposed to rain for 3 months, the metallic portions never rust. This results from a matter that a phosphate coating spreads over the surface of the metal as described, so that the rust-preventing effect based on this coating is exhibited. In this way, the life spans of tools such as pliers can be prolonged.

[0157] The rust removing/preventing agent of the invention is effective also in the case of removing adhesives adhering on the inner face of a pipe of an oil cooler or the like. One end of the pipe is closed, and then (the liquid of) the rust removing/preventing agent, which is colorless and transparent, is poured therein from the other end. After about 10 minutes, the rust removing/preventing agent is discharged. This discharged liquid is discolored into green, and the adhesives are floating in the liquid. Thus, almost all of the adhesives inside the pipe can be removed.

[0158] In the case of a product which cannot be immersed into a bath, such as a large-sized mold having a complicated shape, a column or a ceiling, or in the case that even if the rust removing/preventing agent is painted on a product, the agent volatilizes within a time necessary for the treatment so that the agent cannot exhibit its advantageous effect, rust can be removed by using a piece of paper or nonwoven cloth which has permeability and can hold (the liquid of) the rust removing/preventing agent without drying the agent for a predetermined time.

[0159] This nonwoven cloth may be hygroscopic nonwoven cloth which is excellent in water holding ability and is made mainly of, e.g., vinylon fiber.

[0160] The liquid of the rust removing/preventing agent is first painted onto a large-sized mold having a complicated shape, a column or a ceiling, and then a piece of paper or nonwoven cloth which can hold the rust removing/preventing agent without drying the agent for a predetermined time is caused to adhere onto the painted rust removing/preventing agent (or the piece is wound on the painted agent in the case of the column). Thereafter, the rust removing/preventing agent is further painted thereon, whereby rust which cannot be removed by any conventional method can be removed. Of course, the agent exhibits rust-preventing effect after the removal of the rust.

[0161] It is allowable not to paint the rust removing/preventing agent on the piece of the paper or nonwoven cloth. It is also allowable to: paint (the liquid of) the rust removing/preventing agent onto a mold, a column or a ceiling; cause a piece of paper or nonwoven cloth which can hold the rust removing/preventing agent without drying the agent for a predetermined time to adhere on the painted rust removing/preventing agent (or the piece is wound on the painted agent in the case of the column); and remove rust in this state. In this case also, it is needless to say that after the removal of the rust, the effect of preventing rust is exhibited.

[0162] When the so-called magnetism sheet, which has a magnet effect, is used to cause the nonwoven cloth to be held on a column or a ceiling face, the holding of the nonwoven cloth is made more satisfactory and the rust-removing rate can be made larger. In other words, a magnetism sheet can adsorb a column or a ceiling face made of iron by the magnet effect of the magnetism sheet, and this adsorbing effect of the magnetism sheet toward the column or ceiling face makes it possible to hold the nonwoven cloth. Simultaneously, the magnetism from the magnetism sheet to molecules of the water, which is one of the components of the rust removing/preventing agent, makes it possible to make clusters of the water molecules small and uniform. Thus, the rust-removing rate can be raised.

[0163] When the use of the rust removing/preventing agent as described above is continued so that the amount of the rust removing/preventing agent is decreased in the bath, it is sufficient to pour the agent for replenishment newly into the bath.
Even if the agent is poured for replenishment, the rust-removing effect and the rust-preventing effect are not reduced.

[0164] When in the bath the removed rust precipitates or floats in a large amount, the liquid in the bath is filtered through a filter device, whereby (the liquid) of the rust removing/preventing agent filtrated can be reused.

[0165] If the used rust removing/preventing agent is disposed of, the agent may be neutralized with lime (CaO). In this way, tricalcium phosphate (Ca₃(PO₄)₂), which is a material for fertilizer, is produced. Recycle can be attained without giving any harm.

[0166] Since the ingredients of the rust removing/preventing agent of the invention are each a food additive, no harm is produced. Thus, even if the agent is directly discharged into a drainage channel, no problem is caused.

[0167] The rust removing/preventing agent of the invention can be applied to iron, stainless steel, aluminum, copper, or any other metal in which rust is generated.

Second Embodiment

[0168] With reference to FIGS. 4 and 5, a second embodiment will be described hereinafter. FIG. 4 shows blending proportions (by weight) in 1 kg of (the liquid of) a rust-removing/preventing agent of the invention composed of 5 ingredients, wherein a surfactant is added to the basic proportions shown in FIG. 1. (1) The weight of orthophosphoric acid (H₃PO₄) is set into the range of 50 to 600 g, (2) the weight of DL-malic acid (HOOCCH₂(CH(OH)COOH)) is set into the range of 0.2 to 20 g, (3) the weight of sodium dihydrogen phosphate dihydrate (NaH₂PO₄•2H₂O) is set into the range of 0.2 to 2 g, (4) the weight of a surfactant (for example, propylene glycol: CH₃CHOH(CH₂OH)) is set into the range of 0.1 to 1.5 g, and (5) the weight X (unit: g) of water (H₂O) is a weight obtained by subtracting, from 1,000 g, which is assumed to be the total weight of the rust removing/preventing agent, the total weight of the other components used.

[0169] Propylene glycol as the surfactant is used as a component for food processing (such as a perfume, a colorant solvent, a preservative, or a lubricant). When this surfactant is added to the basic proportions in the rust removing/preventing agent shown in FIG. 1, the permeating power is promoted so that the rust-removing rate can be made larger.

[0170] If the weight of the added surfactant is set to 0.1 g or less, the effect for improving the permeating power or making the rust-removing time short is small. If the weight is set to 1.5 g or more, the effect is gradually exhibited but economical advantages are not very high for the used quantity of the surfactant. Accordingly, the weight added to the basic proportions shown in FIG. 1 is preferably in the above-mentioned range, which is from 0.1 to 1.5 g.

[0171] FIG. 5 shows preferred proportions by weight in the rust removing/preventing agent shown in FIG. 4 when the total weight is assumed to be 1 kg. In this preferred example, the weights of orthophosphoric acid, DL-malic acid, sodium dihydrogen phosphate dihydrate, the surfactant, and water are set to 495 g, 2 g, 2 g, 1 g and 500 g, respectively, so as to set the total weight to 1 kg.

Third Embodiment

[0172] With reference to FIGS. 6 and 7, a third embodiment will be described hereinafter. FIG. 6 shows blending proportions (by weight) in 1 kg of (the liquid of) a rust-removing/preventing agent of the invention composed of 6 ingredients, wherein a surfactant and acetic acid are added to the basic proportions shown in FIG. 1. (1) The weight of orthophosphoric acid (H₃PO₄) is set into the range of 50 to 600 g, (2) the weight of DL-malic acid (HOOCCH₂(CH(OH)COOH)) is set into the range of 0.2 to 20 g, (3) the weight of sodium dihydrogen phosphate dihydrate (NaH₂PO₄•2H₂O) is set into the range of 0.2 to 2 g, (4) the weight of a surfactant (for example, propylene glycol: CH₃CHOH(CH₂OH)) is set into the range of 0.1 to 1.5 g, (5) the weight of acetic acid (CH₃COOH) is set into the range of 0.1 to 5.0 g, and (6) the weight X (unit: g) of water (H₂O) is a weight obtained by subtracting, from 1,000 g, which is assumed to be the total weight of the rust removing/preventing agent, the total weight of the other components used.

[0173] Acetic acid is used in vinegar at a ratio of 3 to 5%. When acetic acid is added to the basic proportions shown in FIG. 1, a metal after subjected to rust-removing treatment can be caused to express its original color and further the metal can be prevented from getting discolored.

[0174] If the weight of acetic acid is set to 0.1 g or less, a metal after subjected to rust-removing treatment cannot be caused to express its original color: If the weight is 5.0 g or more, the above-mentioned effects are gradually exhibited but economical advantages are not very high for the used quantity of acetic acid. Accordingly, the weight added to the basic proportions shown in FIG. 1 is preferably in the above-mentioned range, which is from 0.1 to 5.0 g. In the same way as in the second embodiment, the addition of the surfactant to the basic proportions in the rust removing/preventing agent shown in FIG. 1 makes it possible to promote the permeating power and make the rust-removing rate higher.

[0175] FIG. 7 shows preferred proportions by weight in the rust removing/preventing agent shown in FIG. 6 when the total weight is assumed to be 1 kg. In this preferred example, the weights of orthophosphoric acid, DL-malic acid, sodium dihydrogen phosphate dihydrate, the surfactant, acetic acid, and water are set to 495 g, 2 g, 2 g, 1 g, 2 g and 500 g, respectively, so as to set the total weight to 1 kg.

Fourth Embodiment

[0176] With reference to FIGS. 8 and 9, a fourth embodiment will be described hereinafter. FIG. 8 shows blending proportions (by weight) in 1 kg of (the liquid of) a rust-removing/preventing agent of the invention composed of 7 ingredients, wherein a surfactant, acetic acid and an aliphatic acid are added to the basic proportions shown in FIG. 1. (1) The weight of orthophosphoric acid (H₃PO₄) is set into the range of 50 to 600 g, (2) the weight of DL-malic acid (HOOCCH₂(CH(OH)COOH)) is set into the range of 0.2 to 20 g, (3) the weight of sodium dihydrogen phosphate dihydrate (NaH₂PO₄•2H₂O) is set into the range of 0.2 to 2 g, (4) the weight of a surfactant (for example, propylene glycol: CH₃CHOH(CH₂OH)) is set into the range of 0.1 to 1.5 g, (5) the weight of acetic acid (CH₃COOH) is set into the range of 0.1 to 5.0 g, (6) the weight of an aliphatic acid (RCOOH) is set into the range of 1.0 to 10 g, and (7) the weight X (unit: g) of water (H₂O) is a weight obtained by subtracting, from 1,000 g, which is assumed to be the total weight of the rust removing/preventing agent, the total weight of the other components used.

[0177] An aliphatic acid, in particular, a higher aliphatic acid generally exists in a living body. When this aliphatic acid is added to the basic proportions shown in FIG. 1, the rust-preventing effect is further promoted. If the weight of the
aliphatic acid is 1.0 g or less, a significant effect is not obtained very much since the present agent already has the rust-preventing effect of the agent shown in FIG. 1. If the weight is 10 g or more, the advantageous effect is gradually exhibited but economical advantages are not very high for the used quantity of the aliphatic acid. Accordingly, the weight added to the basic proportions shown in FIG. 1 is preferably in the above-mentioned range, which is from 1.0 to 10 g.

[0178] In the same way as in the second embodiment, the addition of the surfactant to the basic proportions in the rust removing/preventing agent shown in FIG. 1 makes it possible to promote the permeating power and make the rust-removing rate higher in addition to the advantageous effects of the first embodiment. In the same way as in the third embodiment, acetic acid is added; therefore, a metal after subjected to rust-removing treatment can be caused to express its original color and further the metal can be prevented from getting discolored.

[0179] FIG. 9 shows preferred proportions by weight in the rust removing/preventing agent shown in FIG. 8 when the total weight is assumed to be 1 kg. In this preferred example, the weights of orthophosphoric acid, DL-malic acid, sodium dihydrogen phosphate dihydrate, the surfactant, acetic acid, the aliphatic acid and water are set to 488 g, 2 g, 2 g, 1 g, 2 g, 5 g and 500 g, respectively, so as to set the total weight to 1 kg.

Fifth Embodiment

[0180] FIGS. 10 and 11 show a fifth embodiment. FIG. 10 shows blending proportions (by weight) in 1 kg of (the liquid of) a rust-preventing/preventing agent of the invention composed of 5 ingredients, wherein acetic acid is added to the basic proportions shown in FIG. 1. (1) The weight of orthophosphoric acid (H$_3$PO$_4$) is set into the range of 50 to 600 g, (2) the weight of DL-malic acid (HOOCC(CH$_2$)$_3$COOH) is set into the range of 0.2 to 20 g, (3) the weight of sodium dihydrogen phosphate dihydrate (NaH$_2$PO$_4$.2H$_2$O) is set into the range of 0.2 to 2 g, (4) the weight of acetic acid (CH$_3$COOH) is set into the range of 0.1 to 5.0 g, and (5) the weight X (unit: g) of water (H$_2$O) is a weight obtained by subtracting, from 1,000 g, which is assumed to be the total weight of the rust removing/preventing agent, the total weight of the other components used.

[0181] In this embodiment, acetic acid is added to the basic proportions shown in FIG. 1; therefore, a metal after subjected to rust-removing treatment can be caused to express its original color and further the metal can be prevented from getting discolored in addition to the advantageous effects of the first embodiment.

[0182] FIG. 11 shows preferred proportions by weight in the rust removing/preventing agent shown in FIG. 10 when the total weight is assumed to be 1 kg. In this preferred example, the weights of orthophosphoric acid, DL-malic acid, sodium dihydrogen phosphate dihydrate, acetic acid, and water are set to 494 g, 2 g, 2 g, 2 g and 500 g, respectively, so as to set the total weight to 1 kg.

Sixth Embodiment

[0183] FIGS. 12 and 13 show a sixth embodiment. FIG. 12 shows blending proportions (by weight) in 1 kg of (the liquid of) a rust removing/preventing agent of the invention composed of 5 ingredients, wherein an aliphatic acid is added to the basic proportions shown in FIG. 1. (1) The weight of orthophosphoric acid (H$_3$PO$_4$) is set into the range of 50 to 600 g, (2) the weight of DL-malic acid (HOOCC(CH$_2$)$_3$COOH) is set into the range of 0.2 to 20 g, (3) the weight of sodium dihydrogen phosphate dihydrate (NaH$_2$PO$_4$.2H$_2$O) is set into the range of 0.2 to 2 g, (4) the weight of an aliphatic acid (RCOOH) is set into the range of 1.0 to 10 g, and (5) the weight X (unit: g) of water (H$_2$O) is a weight obtained by subtracting, from 1,000 g, which is assumed to be the total weight of the rust removing/preventing agent, the total weight of the other components used.

[0184] In this embodiment, the aliphatic acid is added to the basic proportions shown in FIG. 1; therefore, the rust-preventing effect can be further promoted in addition to the advantageous effects of the first embodiment.

[0185] FIG. 13 shows preferred proportions by weight in the rust removing/preventing agent shown in FIG. 12 when the total weight is supposed to be 1 kg. In this preferred example, the weights of orthophosphoric acid, DL-malic acid, sodium dihydrogen phosphate dihydrate, the aliphatic acid, and water are set to 491 g, 2 g, 2 g, 5 g and 500 g, respectively, so as to set the total weight to 1 kg.

Seventh Embodiment

[0186] FIGS. 14 and 15 show a seventh embodiment. FIG. 14 shows blending proportions (by weight) in 1 kg of (the liquid of) a rust-removing/preventing agent of the invention composed of 6 ingredients, wherein a surfactant, and an aliphatic acid are added to the basic proportions shown in FIG. 1. (1) The weight of orthophosphoric acid (H$_3$PO$_4$) is set into the range of 50 to 600 g, (2) the weight of DL-malic acid (HOOCC(CH$_2$)$_3$COOH) is set into the range of 0.2 to 20 g, (3) the weight of sodium dihydrogen phosphate dihydrate (NaH$_2$PO$_4$.2H$_2$O) is set into the range of 0.2 to 2 g, (4) the weight of a surfactant (for example, propylene glycol: CH$_2$CH(OH)CH$_2$OH) is set into the range of 0.1 to 1.5 g, (5) the weight of an aliphatic acid (RCOOH) is set into the range of 1.0 to 10 g, and (6) the weight X (unit: g) of water (H$_2$O) is a weight obtained by subtracting, from 1,000 g, which is assumed to be the total weight of the rust removing/preventing agent, the total weight of the other components used.

[0187] In this embodiment, the surfactant is added to the basic proportions shown in FIG. 1; therefore, the permeating power can be promoted so that the rust-removing rate can be made larger in addition to the advantageous effects of the first embodiment. Moreover, the aliphatic acid is added thereto; therefore, the rust-preventing effect can be further promoted.

[0188] FIG. 15 shows preferred proportions by weight in the rust removing/preventing agent shown in FIG. 14 when the total weight is supposed to be 1 kg. In this preferred example, the weights of orthophosphoric acid, DL-malic acid, sodium dihydrogen phosphate dihydrate, the surfactant, the aliphatic acid, and water are set to 490 g, 2 g, 2 g, 1 g, 5 g and 500 g, respectively, so as to set the total weight to 1 kg.

Eighth Embodiment

[0189] FIGS. 16 and 17 show an eighth embodiment. FIG. 16 shows blending proportions (by weight) in 1 kg of (the liquid of) a rust-removing/preventing agent of the invention composed of 6 ingredients, wherein acetic acid and an aliphatic acid are added to the basic proportions shown in FIG. 1. (1) The weight of orthophosphoric acid (H$_3$PO$_4$) is set into the range of 50 to 600 g, (2) the weight of DL-malic acid (HOOCC(CH$_2$)$_3$COOH) is set into the range of 0.2 to 20
g. (3) the weight of sodium dihydrogen phosphate dihydrate (NaH₂PO₄·2H₂O) is set into the range of 0.2 to 2 g. (4) the weight of acetic acid (CH₃COOH) is set into the range of 0.1 to 5.0 g. (5) the weight of an aliphatic acid (RCOOH) is set into the range of 1.0 to 10 g. (6) the weight X (unit: g) of water (H₂O) is a weight obtained by subtracting, from 1,000 g, which is assumed to be the total weight of the rust removing/preventing agent, the total weight of the other components used.

[0190] In this embodiment, acetic acid is added to the basic proportions shown in FIG. 1; therefore, a metal after subjected to rust removing treatment can be caused to express its original color and further the metal can be prevented from getting discolored in addition to the advantageous effects of the first embodiment. Moreover, the aliphatic acid is added thereto; therefore, the rust-preventing effect can be further promoted.

[0191] FIG. 17 shows preferred proportions by weight in the rust removing/preventing agent shown in FIG. 16 when the total weight is assumed to be 1 kg. In this preferred example, the weights of orthophosphoric acid, DL-malic acid, sodium dihydrogen phosphate dihydrate, acetic acid, the aliphatic acid, and water are set to 489 g, 2 g, 2 g, 2 g, 5 g and 500 g, respectively, so as to set the total weight to 1 kg.

[0192] The method of using each of the rust removing/preventing agents in the second to eighth embodiments is the same method as in the first embodiment.

[0193] In each of the second to eighth embodiments, the rust removing/preventing agent after used may be neutralized with lime, thereby being converted into fertilizer in the same manner as in the first embodiment. Thus, recycable can be attained without giving any harm.

[0194] The ingredients which constitute each of the rust removing/preventing agents are each harmless. Thus, even if the used agent is discharged as it is into a drainage channel, no problem is caused.

[0195] In each of embodiments described above, the above-mentioned advantageous effects can be sufficiently exhibited even if sodium dihydrogen phosphate dihydrate is not added to the other components. Moreover, the water (H₂O) used in each of embodiments may be water of any kind, such as processed water to which magnetism is applied, or water which contains ionized water.

**EXAMPLES**

**Comparison Results**

**Measurement Results**

[0196] The following will describe results (measurement results) obtained by comparing an embodiment having the composition recited in claim 1 in the present application (Example 1) and an embodiment having the composition recited in claim 2 therein (Example 2) with the agent in JP-A-9-1090 (Comparative Example 1), and a liquid containing oxalic acid (Comparative Example 2) and a liquid containing citric acid (Comparative Example 3). Oxalic acid and citric acid are each frequently used as a rust-removing agent.

(1) Liquids for Tests

[0197] The above-mentioned five liquids (a rust-removing/preventing agent having the composition recited in claim 1 in the present application (Example 1), a washing solution in JP-A-9-1090 (Comparative Example 1), liquid of Comparative Example 2 and Comparative Example 3, and an rust-removing/preventing agent having the composition recited in claim 2 (Example 2)) for measuring rust-removing effect and/or rust-preventing effect were produced, and tests were made. Details of the five liquids are as follows:

- **[0198]** In Comparative Examples 2 and 3, oxalic acid was used (Comparative Example 2) and citric acid was used (Comparative Example 3) instead of DL-malic acid used in the invention.

- **[0199]** According to this manner, it was verified that advantageous effects based on the use of not oxalic acid or citric acid but DL-malic acid (in the invention) are remarkably exhibited.

A: Example 1 using a rust removing/preventing agent recited in claim 1 of the invention, wherein blending proportions of individual components were those shown in FIG. 2, which shows one of the preferred embodiments of the invention. However, in order to cause the agent to correspond to claim 1, sodium dihydrogen phosphate dihydrate in FIG. 2 was not used, and the agent was prepared so as to have blending proportions (by weight) shown in FIG. 18.

B: Comparative Example 1 using a washing solution having proportions in JP-A-9-1090. As shown in FIG. 19, the blending proportions in this washing solution were adopted from matters described in paragraph [0037] of the specification of JP-A-9-1090.

C: Comparative Example 2 using an agent wherein oxalic acid was used instead of DL-malic acid in the above-mentioned rust removing/preventing agent A (see FIG. 20).

D: Comparative Example 3 using an agent wherein citric acid was used instead of DL-malic acid in the above-mentioned rust removing/preventing agent A (see FIG. 21).

E: Example 2 using a rust removing/preventing agent of the invention wherein sodium dihydrogen phosphate dihydrate was added to the rust removing/preventing agent A. The blending proportions therein are shown in FIG. 2.

(2) Test Method

[0200] An iron piece wherein rust was generated in the whole surfaces was immersed in each of the above-mentioned five rust removing/preventing agents (at 20°C.) for each of times of 10, and 30 minutes, so as to remove the rust. The effect of removing the rust was then measured.

[0201] Thereafter, about only the test pieces immersed for 30 minutes, tests were made according substantially to JIS K 2246 (Humidity Cabinet Test) (at a temperature of 50°C. and a humidity of 100% RH for 2 hours, and at a temperature of 40°C. and a humidity of 100% RH for 24 hours). The rust-preventing effects thereof were observed.

[0202] As a test applicable to only "the liquid of" a rust-preventing agent, JIS K 2246 (Humidity Cabinet Test) described above is prescribed. When a Japanese public organization is asked to make a test in conformity with this JIS regulation, only a result after 24 hours is obtained. Results in the middle (for example, after 2 hours, 4 hours, and . . . ) are not obtained. Moreover, the present invention has, in the form of a single liquid, not a rust-removing function only or a rust-preventing function only but both functions of a rust-removing agent and a rust-preventing agent (a rust removing/preventing agent); no JIS regulations about this rust remov-
ing/preventing agent exits. For the two reasons, the test according substantially to JIS K 2246 was made.

(3) Test Results

[0203] FIG. 22 show a table of the rust-removal results, which are results obtained when each of the test pieces of the rusted iron was immersed in each of the blend liquids for each of times of 10, 20 and 30 minutes.

Rust-Removal Results

[0204] a. In each of the test pieces immersed in each of the rust-removing agents at 20° C. for 10 minutes to remove the rust, in Examples 1 and 2 (agents A and B) a remarkable rust-removing effect was produced ("Good" and "Very good" in the Table) while in Comparative Examples 1 to 3 (agents C to E) a remarkable rust-removing effect was not produced ("Bad" in the Table).

[0205] b. In each of the test pieces immersed in each of the rust-removing agents at 20° C. for 20 minutes to remove the rust, in Examples 1 and 2 (agents A and B) the rust was completely removed ("Very good" in the Table) while in Comparative Examples 1 to 3 (agents C to E) the rust was not completely removed, the situation of the removal being different between the comparative examples ("Bad" and "Allowable" in the Table).

[0206] c. In each of the test pieces immersed in each of the rust-removing agents at 20° C. for 30 minutes to remove the rust, the rust was substantially removed in agents A, B, C, D and E ("Very Good" and "Good" in the Table).

Rust-Prevention Results

[0207] The rust-prevention results are shown in FIGS. 23 and 24. FIG. 23 shows the comparison results obtained by immersing each of the test pieces in each of the rust-removing agents at 20° C. for 30 minutes to remove the rust substantially completely, and then making a humidity cabinet test (at a temperature of 50° C. and a humidity of 100% RH) for 2 hours according substantially to JIS K 2246 about the piece.

[0208] As shown in FIG. 23, in the test pieces treated with agents A and E (Examples 1 and 2), rust was slightly generated in some portions thereof ("very good" in FIG. 23). On the other hand, in the test pieces in Comparative Examples 1, 2 and 3 (treated with agents B, C and D), rust was generated in the substantially entire surface thereof ("Bad" in FIG. 23). In other words, in the test piece treated with agent A (of the invention corresponding to claim 1) and the test piece treated with agent E (of the invention corresponding to claim 2, specifically FIG. 2), the generation rate of rust was extremely smaller than in the test pieces treated with agents B, C and D (Comparative Examples 1 to 3).

[0209] The temperature condition of 50° C. in the above-mentioned JIS is very severe condition in which rust is mostly generated; therefore, as illustrated in FIG. 24, about each of the test pieces immersed in each of the rust-removing agents at 20° C. for 30 minutes to remove rust, a humidity cabinet test was made at a temperature of 40° C. and a humidity of 100% for 24 hours.

[0210] As illustrated in FIG. 24, in the test pieces treated with agents A and E (Examples 1 and 2), the generation of rust was most slightly generated ("Good" in FIG. 24) while in the test pieces treated with agents B, C and D (Comparative Examples 1, 2 and 3), rust was generated in the substantially entire surface thereof ("Bad" in FIG. 24).

[0211] According to the above-mentioned test results, it has been made evident that the rust removing/preventing agent (A and E) of the invention remarkably produces, in the form of a single liquid, more advantageous effects for removing/preventing rust than Comparative Example 1 (washing solution agent B described in JP-A-9-1090, which is one of publications of other patent applications) and Comparative Examples 2 and 3 (agents C and D).
surface of the column or ceiling which is made of iron by means of a magnetic sheet having a magnetic effect.

16: The rust-removing/preventing agent according to claim 1, wherein the water is processed water, molecular clusters of which are substantially uniform.

17: The rust-removing/preventing agent according to claim 16, wherein the water is processed water, to which magnetism is applied.

18: The rust-removing/preventing agent according to claim 2, wherein the water is processed water, molecular clusters of which are substantially uniform.

19: The rust-removing/preventing agent according to claim 18, wherein the water is processed water, to which magnetism is applied.

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