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METHOD AND COMPOSITION FOR CHEMICAL POLISHING OF STAINLESS STEEL SURFACES

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ABSTRACT OF THE DISCLOSURE

Stainless steel surfaces are treated with an aqueous solution containing phosphate ions equivalent to 145–580 g./litre of phosphoric acid, nitrate ions equivalent to 17–85 g./litre of nitric acid, chlorine ions equivalent to 16–80 g./litre of hydrochloric acid, sulfosalicylate ions equivalent to 1–10 g./litre of sulfosalicylic acid and small amounts of optional compounds selected from the group of water soluble polymer, aromatic amino compounds, surfactant, ligninsulfonic acid and salts thereof, sulfuric acid and acids having equivalent concentration of 4.0 N–18 N.

BACKGROUND OF THE INVENTION

This invention relates to a method of chemical treatment for stainless steel to polish its surface and more particularly to a chemical polishing for stainless steels having ferrite, austenite or pearlite structure, for example, for chromium-iron alloys and chromium-nickel-iron alloys.

BRIEF DISCUSSION OF THE PRIOR ART

Mechanical polishing like buffing and electrolytic polishing have long been employed for stainless steel treatment. However, buffing is difficult to apply to complicated goods and in electrolytic polishing having anode surfaces, it is difficult to gain a sufficient cathode area which is needed for the electrolytic treatment since this area must be more than twice as large as the polished surface of the goods. Also, it is impossible particularly when large and complicated goods are treated, to maintain the same current densities on all surfaces in order to perform uniform polishing. In recent years, it has been attempted to treat stainless steel by chemical polishing, and, aqueous solutions containing some mineral acids and organic acids or salts of mineral acids have been put on the market for stainless steel having pearlite structure. However, the temperature of the treatment is very high and moreover the effects of polishing for stainless steels having ferrite or austenite structure such as 18 chromium-iron alloys or 18 chromium-8 nickel-iron alloys is not sufficient to be commercially practical.

OBJECTS OF THE INVENTION

Accordingly, it is an object of the invention to overcome the aforementioned problems and disadvantages.

Another object of the invention is to provide a method by which all kinds of stainless steel structures can be treated.

Another object of the invention is to provide a method in which large and complicated goods can be treated

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to gain a sufficiently uniform polish having a smooth metallic luster and a near-mirror finish.

Another object of the invention is to provide a method in which stainless steel surfaces are polished at a low cost.

SUMMARY OF THE INVENTION

In our invention, stainless steel surfaces are treated with an aqueous solution containing phosphate ions equivalent to 145–580 g./litre of phosphoric acid, nitrate ions equivalent to 17–85 g./litre of nitric acid, chlorine ions equivalent to 16–80 g./litre of hydrochloric acid, sulfosalicylate ions equivalent to 1–10 g./litre of sulfosalicylic acid and small amounts of optional compounds selected from the group of water soluble polymer, aromatic amino compounds, surfactant, ligninsulfonic acid and salts thereof, sulfuric acid and having acid equivalent concentration of 4.0 N–18 N.

Acid equivalent concentrations are defined as the numeral equivalent of sodium hydroxide required to neutralize the aqueous solution to the end point of the indicator phenolphthalein.

DETAILED DESCRIPTION

The solution preferably contains about 10–100 g./litre of water soluble polymer; e.g. polyethylene glycol, polypropylene glycol, polyvinyl alcohol, about 5–20 g./litre of ligninsulfonic acid or salt thereof; e.g., sodium ligninsulfonate, potassium ligninsulfonate, about 1–5 g./litre of surfactant; e.g., alkali metal salts of alkyl sulfate, alkyl benzene sulfonate, alkylnaphthalene sulfonate, alkylpyridinium chloride, condensation product of amines and formaldehyde, stearo chromic chloride, polyoxyethylene alkyl phenol ether, polyoxyethylene sorbitan monofatty acid ester, polyoxyethylene alkyl carboxylate, polyoxyethylene alkyl amine, about 9–36 g./litre of sulfuric acid, about 0.5–5 g./litre of aromatic amino compounds more preferably aromatic amino compounds having dimethyl amino radical; e.g., dimethyl aminoaniline, dimethyl amino azobenzene, dimethylamino benzaldehyde, dimethylamino methyl phenol, crystal violet, auramine, malachite green. Water soluble polymer increases the viscosity of the aqueous solution and inhibits a diffusion of metal ions which are corroded by the aqueous solution and make the corrosion more uniform.

Ligninsulfonic ions depress excess of corrosion by acid and sulfuric acid is added in order to increase corrosive action of the aqueous solution. Aromatic amino compounds prevent formation of smuts on stainless steel surfaces. Particularly when stainless steels, having austenite or ferrite structures, which are more corrosion resistant; e.g., 18 chromium-8 nickel stainless steel is treated, sulfuric acid, water soluble polymer and aromatic amino compounds are preferred.

Surfactant of ionic, nonionic can be employed as usual.

In the treatment of stainless steel, the steel surfaces are contacted with the aqueous solution at an elevated temperature for a period of sufficient time to complete chemical polishing, and ordinarily, a temperature of about 70° C.–100° C. for 1 to 3 minutes is employed. After the polishing, the surfaces are rinsed with water. In operation, various kinds of contacting means may be employed on stainless steel surfaces and the aqueous solution can be practiced, and for example, stainless steel

goods may be dipped in a bath made up of the solution or the solution can be sprayed on the surfaces.

Existence of a small amount of salts or waste material, which is accumulated in progress of the treatment, have substantially no effects. Acid components are wasted and the composition of the aqueous solution changes with the long treatment of polishing and in that case each acid component, particularly hydrochloric acid, which is most readily consumed, is added in order to maintain a fixed bath composition of aqueous solution, and, precipitate waste formed by the reaction is removed.

As for the agents, ordinary grade agents on the market can be employed. In the preferred embodiment of the invention, one litre of the treating aqueous solution is prepared by mixing about 100-400 ml. of 85% aqueous solution of phosphoric acid, about 20-99 ml. of 62% aqueous solution of nitric acid, about 40-200 ml. of 35% aqueous solution of hydrochloric acid, about 1-10 g. of sulfosalicylic acid and optional compounds selected from the group of about 10-100 g. of water soluble polymer, about 5-19 ml. of 98% concentrated sulfuric acid and water balancing the volume of the solution.

For the purpose of giving those skilled in the art a better understanding of the invention, the following illustrative examples are given.

EXAMPLE 1

A basket knitted by two kinds of stainless steel wire having a ferrite structure (18 chromium-iron alloy) and an austenite structure (18 chromium-8 nickel-iron alloy) was dipped in a bath of aqueous solution having the following composition for 3 minutes at 90° C. and then rinsed with water.

Table 1

Composition of the bath (in 1 litre):	G./l.
H ₃ PO ₄ -----	220
HNO ₃ -----	25
HCl -----	40
Polypropylene glycol #500 -----	20
Dimethylaminoaniline -----	1
Sodium sulfosalicylate -----	5
Water balancing.	

The basket had a bright, smooth near-mirror finish.

EXAMPLE 2

Two kinds of stainless steel sheets having 10 cm. in length and 10 cm. in width made by ferrite structure stainless steel (15 chromium-iron alloy) and austenite structure stainless steel (18 chromium-8-nickel-iron alloy) were dipped in a bath of aqueous solution having the following composition for 3 minutes at 95° C. and then rinsed with water.

Table 2

Composition of the bath (in 1 litre):	G./l.
H ₃ PO ₄ -----	220
HNO ₃ -----	25
HCl -----	40
H ₂ SO ₄ -----	35
Polyethylene glycol #400 -----	40
Guineo green B (C ₃₇ H ₃₅ N ₂ O ₆ S ₂ Na) -----	3
Sulfosalicylic acid -----	3
Water balancing.	

Ferrite structure stainless steel sheet had metallic luster of more than 60% of specular reflectance* and austenite structure stainless steel sheet had metallic luster of more than 75% of specular reflectance.*

*Specular reflectance is measured as compared with a surface of vacuum evaporation coating of aluminum on a plate glass.

EXAMPLE 3

Example 2 was repeated except that an aqueous solution of bath having the following composition, treating temperature of 90° C. and contacting period of 2 minutes were employed.

Almost equivalent results to Example 2 were obtained.

Table 3

Composition of the bath (in 1 litre):	G./l.
H ₃ PO ₄ -----	290
HNO ₃ -----	25
HCl -----	40
H ₂ SO ₄ -----	9
Polyethylene glycol #2000 -----	59
Dimethylaminoaniline -----	0.58
Sulfosalicylic acid -----	5
Water balancing.	

EXAMPLE 4

Example 2 was repeated except that the compositions of the bath shown in following table, temperature of 95° C. and treating period of 90 seconds were employed.

Almost equivalent results to Example 2 were obtained.

Table 4

Composition of the bath (in 1 litre):	G./l.
H ₃ PO ₄ -----	290
HNO ₃ -----	40
HCl -----	20
H ₂ SO ₄ -----	17
Polyethylene glycol #4000 -----	30
Crystal violet -----	5
Sulfosalicylic -----	3
Water balancing.	

EXAMPLE 5

Example 3 was repeated except that dimethylamino aniline was not added in the bath.

Ferrite structure stainless steel sheet had metallic luster of 50% of specular reflectance and austenite structure stainless steel sheet had metallic luster of 70% of specular reflectance.

EXAMPLE 6

Example 3 was repeated except that dimethylamino aniline and polyethylene glycol were not added in the bath.

Ferrite structure stainless steel sheet had metallic luster of 36% and austenite structure stainless steel sheet had metallic luster of 47% of specular reflectance.

When the bath containing only mineral acid in this example without adding sulfosalicylic acid was employed, 15% of metallic luster of specular reflectance for Ferrite structure and 11% of metallic luster of specular reflectance for austenite structure stainless steel sheet were obtained.

EXAMPLE 7

Example 2 was repeated except that an aqueous solution of bath having following composition, treating temperature of 80° C. and contacting period of 2 minutes were employed.

Table 5

Composition of the bath:	G./l.
H ₃ PO ₄ -----	290
HNO ₃ -----	25
HCl -----	40
H ₂ SO ₄ -----	17
Polyethylene glycol #4000 -----	50
Potassium ligninsulfonate -----	5
Sodium sulfosalicylate -----	5
Cationic surfactant -----	3
Water balancing.	

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Ferrite structure stainless steel sheet had about 60% of metallic luster of specular reflectance and austenite structure stainless steel sheet had about 63% metallic luster of specular reflectance.

EXAMPLE 8

Example 2 was repeated except that an aqueous solution of bath having the following composition treating temperature of 90° C. and contacting period of a minute were employed.

Table 6

Composition of the bath:	G./l.
H ₃ PO ₄ -----	580
HNO ₃ -----	80
HCl -----	16
H ₂ SO ₄ -----	9
Polyethylene glycol #4000 -----	50
Ligninsulfonic acid -----	10
Potassium sulfosalicylate -----	5
Cationic surfactant -----	1
Water balancing.	

Almost equivalent results to Example 7 were obtained.

EXAMPLE 9

Example 2 was repeated except that an aqueous solution of bath having the following composition treating temperature of 90° C. and contacting period of 2 minutes were employed.

Table 7

Composition of the bath:	G./l.
H ₃ PO ₄ -----	290
HNO ₃ -----	40
HCl -----	20
H ₂ SO ₄ -----	9
Polyethylene glycol #4000 -----	30
Sodium ligninsulfonate -----	15
Sulfosalicylic acid -----	2
Cationic surfactant -----	1
Water balancing.	

Almost equivalent results to Example 7 were obtained.

EXAMPLE 10

A pipe having 50 cm. in length and 2.5 cm. in inside diameter made of Austenite structure stainless steel (18 chromium-8 nickel-iron) alloy were dipped in a bath having the following composition at a temperature of 85° C. for 3 minutes.

Table 8

Composition of the bath (in 1 litre):	G./l.
H ₃ PO ₄ -----	220
HNO ₃ -----	25
HCl -----	40
H ₂ SO ₄ -----	35
Polyethylene glycol #2000 -----	40
Ligninsulfonic acid -----	20
Potassium sulfosalicylate -----	2
Cationic surfactant -----	2
Water balancing.	

Almost equivalent results to Example 7 were obtained. What we claim is:

1. A method of polishing a stainless steel surface comprising the steps of contacting said surface with an aqueous solution consisting essentially of

- phosphate ions equivalent to 145 to 580 g./litre phosphoric acid,
- nitrate ions equivalent to 17 to 85 g./litre nitric acid,

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(c) chlorine ions equivalent to 16 to 80 g./litre hydrochloric acid, and

(d) sulfosalicylate ions equivalent to 1 to 10 g./litre sulfosalicylic acid.

2. A method according to claim 1 wherein the solution additionally contains 0.5 to 5 g./litre of an aromatic amino compound having a dimethyl amino radical and 10 to 100 g./litre of a water soluble polymer selected from the group consisting of polyethylene glycol, polypropylene glycol and polyvinyl alcohol.

3. A method according to claim 2 wherein said solution additionally contains 9 to 36 g./litre of sulfuric acid.

4. A method according to claim 2 wherein said solution additionally contains a small amount of a surfactant selected from the group consisting of alkali metal salts of alkyl sulfate, alkyl benzene sulfonate, alkyl naphthalene sulfonate, alkylpyridinium chloride, condensation product of amines and formaldehyde, stearo chromic chloride, polyoxyethylene alkyl phenol ether, polyoxyethylene sorbitan mono-fatty acid ester, polyoxyethylene alkyl carboxylate, and polyoxyethylene alkyl amine.

5. A method as according to claim 2 wherein said solution additionally contains about 15 g./litre of ligninsulfonic acid or a sodium or potassium salt thereof.

6. An aqueous bath for polishing a stainless steel surface consisting essentially of

(a) phosphate ions equivalent to 145 to 580 g./litre phosphoric acid

(b) nitrate ions equivalent to 17 to 85 g./litre of nitric acid,

(c) chlorine ions equivalent to 16 to 80 g./litre hydrochloric acid, and

(d) sulfosalicylate ions equivalent to 1 to 10 g./litre sulfosalicylic acid.

7. A bath as claimed in claim 6, additionally containing sulfuric ions equivalent to 9 to 36 g./litre sulfuric acid.

8. A bath as claimed in claim 7 additionally containing 10 to 100 g./litre of a water soluble polymer selected from the group consisting of polyethylene glycol, polypropylene glycol and polyvinyl alcohol, and the balance water.

9. A bath as claimed in claim 8 additionally having 0.5 to 5 g./litre of an aromatic amino compound having a dimethyl amino radical.

10. A bath as claimed in claim 8 additionally having a small amount of a surfactant selected from the group consisting of alkali metal salts of alkyl sulfate, alkyl benzene sulfonate, alkyl naphthalene sulfonate, alkylpyridinium chloride, condensation product of amines and formaldehyde, stearo chromic chloride, polyoxyethylene alkyl phenol ether, polyoxyethylene sorbitan mono-fatty acid ester, polyoxyethylene alkyl carboxylate, and polyoxyethylene alkyl amine, and ligninsulfonic acid or a sodium or potassium salt thereof.

11. A bath as claimed in claim 8 additionally having a 0.5 to 5 g./litre of an aromatic amino compound having a dimethyl amino radical.

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