United States Patent Office

3,210,287
Patented Oct. 5, 1965

3,210,287

NONSTAINING ALUMINUM CLEANING COMPOSITION AND METHOD

Daniel R. Kelly, Southgate, and Harry G. Wissman, Dearborn, Mich., assignors to Wyandotte Chemicals Corporation, Wyandotte, Mich., a corporation of Michigan

No Drawing. Filed May 6, 1960, Ser. No. 27,251
9 Claims. (Cl. 252—139)

This invention relates to aluminum cleaning compositions and, more particularly, to nonstaining alkaline aluminum cleaners.

It is well known in the prior art to employ aqueous alkaline compositions, inhibited against corrosion, for cleaning aluminum surfaces. Such compositions are disclosed in U.S. Air Force Specification MIL–C–25769 as well as in U.S. Patent No. 2,381,124, Hart, and U.S. Patent No. 2,741,599, McDonald et al. These compositions are, in general, aqueous solutions containing phosphates, silicates and surface active agents. Water-soluble solvents such as the glycol ethers may also be advantageously incorporated in these formulations in order to improve cleaning efficiency. The aluminum cleaning compositions are formulated with an alkaline cleaning agent such as a phosphate or other suitable alkaline material so as to provide an aqueous solution having a pH, in use dilution, in the range of about 10 to 12.5. The silicates function primarily as corrosion inhibitors and, when they are present as ortho or metasilicates, these compounds contribute to the alkalinity of the solution and, thus, augment the cleaning properties of the alkaline cleaning agent. Waterglass, wherein the Na_2O/SiO_2 ratio is 1:3.3, can also be used as the corrosion inhibiting agent. The surface active agents which are effectively employed in these compositions are of the nonionic and anionic types with the nonionic type being preferred because it facilitates removal of oil-type soils from the aluminum surface.

Although the above-described aqueous alkaline compositions are effective cleaners for metal surfaces and painted surfaces, nevertheless, when these compositions are applied to an aluminum surface and allowed to dry before rinsing, they have the undesirable characteristic of leaving unsightly white stains on the aluminum surface which cannot be removed by simply rinsing the surface with water.

Therefore, the principal object of this invention is to provide an aluminum cleaning composition which, when applied to an aluminum surface and allowed to dry, will not leave unsightly, tenaciously held white stains thereon.

In accordance with this invention, it has now been discovered that by incorporating sucrose in the aforementioned alkaline cleaning compositions there is obtained a nonstaining alkaline aluminum cleaner. Although proportions with respect to this additive are not unduly critical, the aqueous alkaline aluminum cleaners should contain sucrose in an amount of at least about 0.2 weight percent in order to eliminate staining.

Thus, according to one of its aspects, this invention relates to nonstaining aqueous alkaline cleaners for aluminum surfaces which comprises alkaline material in an amount to provide a pH in the range of about 9 to 13, an alkali metal silicate corrosion inhibitor, a water-soluble, alkali-stable surface active agent, sucrose in an amount from about 0.2 to 10 weight percent and water.

The alkaline cleaning agents or alkaline materials which are employed in aluminum cleaning compositions include, for example, alkali metal hydroxides, alkali metal silicates, alkali metal phosphates, alkali metal carbonates and mixtures thereof. These alkaline materials are present in an amount to provide the aqueous cleaning solution with a pH in the range of about 9 to 13 and, preferably, with a pH in the range of about 10 to 12.5. Typical examples of alkaline cleaning agents which may be present in these cleaning compositions are alkali metal hydroxides such as sodium and potassium hydroxides; sodium silicates such as sodium orthosilicate and sodium metasilicate; alkali metal phosphates such as trisodium phosphate, disodium phosphate and where hard water is encountered it is advantageous to use sequestering phosphates such as sodium tripolyphosphate or tetrasodium pyrophosphate; and alkali metal carbonates such as sodium carbonate.

In view of the fact that high alkalinity corrodes aluminum, corrosion inhibitors are incorporated into detergent formulations used for cleaning aluminum surfaces. The alkali metal silicates are effective corrosion inhibitors for this purpose and include sodium orthosilicate, sodium metasilicate and waterglass in which the SiO_2/Na_2O ratio is from 5:1 to 2:1. The alkali metal silicate is generally present in an amount to provide an SiO_2 concentration from about 0.25 to 2.0 weight percent.

The surface active agents which are employed in aluminum cleaning compositions include the nonionics, anionics and mixtures thereof. Nonionics are particularly advantageous because they facilitate the removal of oil-type soils from aluminum surfaces. The nonionics which are effective in these compositions are generally the ethylene oxide adducts of hydrophobic bases and the alkylated and aralkylated ethers thereof. Thus, typical examples of the nonionics include the ethylene oxide adducts of alkyl phenols such as octyl and nonyl phenol, ethylene oxide adducts of fatty acids and fatty alcohols and the ethylene oxide adducts of polyoxypropylene terminated bases. An excellent review on nonionic surfactants can be found in the text entitled "Surface Active Agents and Detergents," vol. II, 1958, by A. N. Schwartz, J. W. Perry and J. Birch at pages 120–172. The anionics which are advantageously employed in the aluminum cleaning compositions are generally alkanesulfates and alkylarylsulfonates. A typical anionic is sodium dodecyl benzene sulfonate. For an extended review of anionic surfactants, see the above-identified text by Schwartz et al. at pages 25 to 102. The surface active agent or agents are generally present in the aqueous cleaning solutions at a concentration from about 0.1 to 5 weight percent and, preferably, from about 1 to 4 weight percent.

The essence of the present invention resides in the use of sucrose in an aqueous alkaline aluminum cleaner such that when the solution is applied to an aluminum surface and permitted to dry before rinsing no unsightly, tenaciously held, white stains are deposited thereon. The sucrose is present in the aqueous solution in an amount of at least about 0.2 weight percent and the concentration of this additive generally does not exceed more than about 10 weight percent. It should be noted, however, that the upper limit is primarily dictated by good formulating practice. A preferred concentration for sucrose is from about 2 to 6 weight percent.

Water-soluble solvents such as the glycol ethers are advantageously, but optionally, included within the formulation and, when present, enhance the cleaning efficiency of the composition. Typical glycol ethers are the lower alkyl ethers of ethylene and propylene glycols and the lower alkyl ethers of diethylene and dipropylene glycols wherein the lower alkyl radical contains from about 1 to 4 carbon atoms. The glycol ether solvent is present in an amount from about 0.5 to 10 weight percent and preferably in an amount from about 1 to 5 weight percent.

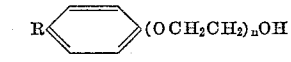
The balance of the aqueous composition is, of course, water. The solids content of the aqueous solution including solvents, if any, is generally from about 2 to 37 parts by weight and, preferably, from about 8 to 20 parts

by weight. Consequently, the water content is generally from about 63 parts by weight for a highly concentrated solution to about 98 parts by weight for a highly dilute solution and, preferably, from about 92 to 80 parts by weight.

In accordance with a second aspect, this invention relates to a non-staining, dry aluminum cleaner adapted for use in an aqueous medium. Thus, according to this aspect of the invention there is provided an aluminum cleaning composition comprising an alkaline cleaning agent, the amount thereof being sufficient to provide an aqueous solution of the dry composition with a pH in the range of about 9 to 13, an alkali metal silicate corrosion inhibitor in an amount to inhibit corrosion due to said alkalinity, a water-soluble, alkali-stable surface active agent, sucrose and, optionally but advantageously, included within the formulation a water-soluble, glycol ether solvent. The nonstaining, dry aluminum cleaner is employed in an aqueous medium at a concentration from about 1 to 10 weight percent and, preferably, from about 3 to 6 weight percent.

The alkaline materials which are used in the dry compositions include alkali metal hydroxides, silicates, carbonates and phosphates, and mixtures thereof in an amount from about 30 to 70 weight percent and, preferably, 40 to 60 weight percent such that the aqueous solution of the detergent composition will have a pH in the range of about 9 to 13 or, preferably, a pH in the range of about 10 to 12.5. The alkali metal silicate corrosion inhibitor is present in an amount from about 2 to 10 weight percent and, preferably 3 to 7 weight percent such that an aqueous solution of the dry aluminum cleaner will have an SiO_2 concentration from about 0.25 to 2.0 weight percent.

The wetting agents which are effectively employed in the dry cleaner are nonionic and anionic surfactants. Although a wide variety of nonionic surfactants can be incorporated into the compositions described herein, it is generally preferred to employ the ethylene oxide adducts of hydrophobic bases and alkylated and aralkylated ethers thereof because of the ready availability of such compositions. Typical nonionics are illustrated by the following formula:



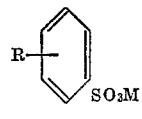
wherein R is an alkyl group of 8 to 15 carbon atoms and n is an integer from 12 to 40 and wherein the terminal hydrogen in the oxyethylene chain can be substituted with an alkyl or aralkyl radical such as methyl, ethyl or benzyl radicals; see, for example, U.S. Patent No. 2,856,434. Other nonionics are illustrated by the formulas:

$$HO—(C_2H_4O)_x(C_3H_6O)_y(C_2H_4O)_{x'}—H$$

wherein y is at least 15 and $(C_2H_4O)_{x+x'}$ equals 20 to 90 percent of the total weight of the compound; and

$$Y(C_3H_6O)_n(C_2H_4O)_mH$$

wherein Y is the residue of organic compound containing at least one active hydrogen atom, n has a value of at least about 6.4 and m is 25 to 95 percent of the total weight of the compound; for more complete disclosures as to the aforementioned nonionics see U.S. Patents Nos. 2,674,619 and 2,677,700. The anionic wetting agents are illustrated by the following formula:



wherein R is an alkyl radical containing from about 9 to 15 carbon atoms, preferably about 12 carbon atoms, and M is an alkali metal salt such as sodium or potassium. The wetting agents or surface active agents are employed in the dry compositions in an amount from about 1 to 10 weight percent and, preferably, from 3 to 8 weight percent.

In order to prevent staining, the dry composition should be formulated with at least about 11 weight percent sucrose and, for optimum results, the dry formulation should contain from about 15 to 25 weight percent of sucrose. The upper limit is dictated by good formulating practices and generally does not exceed about 40 weight percent.

In accordance with a third aspect, this invention relates to a process for cleaning aluminum surfaces which comprises applying to such surface an aqueous solution of a composition containing an alkaline cleaning agent selected from the group consisting of alkali metal hydroxides, carbonates, silicates, phosphates and mixtures thereof in an amount to provide the solution with a pH in the range of 9 to 13, an alkali metal silicate corrosion inhibitor in an amount to provide said solution with an SiO_2 content from about 0.25 to 2.0 weight percent, a water-soluble, alkali-stable surface active agent selected from the group consisting of nonionic and anionic surfactants in an amount from about 0.1 to 5 weight percent, sucrose in an amount from about 0.25 to 2.0 weight percent and, optionally, a glycol ether solvent in an amount from about 0.5 to 10 weight percent and the balance water, whereby, if the cleaning solution is permitted to dry on the surface prior to rinsing, no unsightly, tenaciously held white stains form on the surface.

The following examples further illustrate the invention.

In each of the examples, the procedure employed was similar to the procedure described in USAF MIL–C–25769B, July 22, 1959, par. 4.4.10, Residue Rinsability. This procedure is substantially as follows: Aluminum dishes (similar to Cenco Catalog No. 12720) shall be cleaned in a solution of 21 grams chromic acid and 36 grams phosphoric acid per liter, rinsed, dried, and weighed. Ten millimeters of a 10% solution of the cleaning compound shall be placed in the precleaned dishes and tested as follows:

Evaporate to constant weight in a mechanical convection oven at 65.6° C. (150° F.) with full draft. Cool in a desiccator and weigh. Rinse with running distilled water for one minute. Brush with brush containing long fiber bristles for one minute using distilled water. Rinse for 15 to 30 seconds with running distilled water. Dry in oven, cool and inspect for white residue or stains.

EXAMPLE 1

The following aqueous alkaline aluminum cleaning compositions were evaluated for staining properties in accordance with the procedure outlined above.

Table I

Composition	Parts by Weight	
	I	II
Tetrasodium pyrophosphate	1.00	1.00
Caustic soda	0.58	0.58
Sodium silicate, 42° Be.[1]	4.80	4.80
Nonionic surfactant [2]	1.50	1.50
Sucrose		1.00
n-Butyl ether of ethylene glycol	4.60	4.60
Water	87.52	86.52
	100.00	100.00
Results	Heavy white stains	No stains

[1] Na_2O/SiO_2 ratio of 1:3.3.
[2] Nonylphenol condensed with about 10 mols of ethylene oxide.

It will be noted that the aluminum specimen treated with Composition I, containing no sucrose, had heavy white stains whereas the aluminum specimen treated with Composition II, formulated with sucrose, had no stains whatsoever.

EXAMPLE 2

Several aqueous alkaline aluminum cleaning compositions were prepared in which different additives were incorporated into the formulations and the solutions were evaluated for stain inhibiting properties. The pH of the cleaning solution was measured upon initial preparation of the composition and after the solution was heated at 140° F. for 60 hours. A drop in pH indicated lack of stability. The following compositions were evaluated for stain inhibiting properties in accordance with the general procedure outlined above.

Table II

Composition	Parts by Weight						
	I	II	III	IV	V	VI	VII
Tetrasodium pyrophosphate	2	2	2	2	2	2	2
Sodium metasilicate.$5H_2O$	3	3	3	3	3	3	3
Nonionic [1]	2	2	2	2	2	2	2
Ethylene glycol monoethyl ether	6	6	6	6	6	6	6
Water	87	82	82	82	82	82	82
Sucrose		5					
Lactose			5				
Polyglycol [2]				5			
Ethylene glycol					5		
Dextrose						5	
Starch							5
pH	12.6	12.6	12.6	12.6	12.6	12.6	12.6
Staining	Heavy Stain	None	None	Stains	Stains	None	Stains
pH after 60 hrs. at 160° F	12.6	12.4	9.0	12.6	12.6	8.8	11.8

[1] Nonylphenol condensed with about 10 mols of ethylene oxide.
[2] Polyoxyethylene having a molecular weight of about 4,000.

It will be observed from the foregoing table that the composition containing sucrose was stable with respect to pH and did not produce any stains on the aluminum surface. On the other hand, it will be noted that although some additives such as lactose and dextrose were effective in preventing the deposition of stains, the compositions containing these additives were, however, unstable with respect to pH.

EXAMPLE 3

The following dry compositions were prepared and 5 weight percent aqueous solutions thereof were evaluated in accordance with the general procedure outlined above.

Table III

Composition	Parts by Weight			
	I	II	III	IV
Tetrasodium pyrophosphate	5	5	5	5
Soda ash	55	50	45	35
Sodium tripolyphosphate	5	5	5	5
Sodium metasilicate.$5H_2O$	5	5	5	5
Nonionic [1]	5	5	5	5
Anionic [2]	10	10	10	10
Sucrose	0	5	10	20
n-Butyl ether of ethylene glycol.	15	15	15	15
Results	Stains	Stains	Stains	No Stains

[1] Nonylphenol condensed with about 10 mols of ethylene oxide.
[2] Sodium dodecyl benzene sulfonate.

It will be observed from Table III that an aqueous solution of Composition IV, wherein the dry formulation contained 20 weight percent sucrose, cleaned an aluminum surface without leaving any white stains thereon whereas aqueous solutions of Compositions I, II and III, wherein the dry formulation contained less than 10 weight percent sugar, when used to clean aluminum surfaces, deposited white stains thereon.

Thus, the principal object of this invention has been accomplished, namely, a composition has been provided for cleaning aluminum surfaces without leaving white stains thereon which comprises, as the principal feature, incorporating sucrose into an alkaline aluminum cleaning composition as more particularly described herein.

What is claimed is:

1. An aqueous alkaline cleaner for aluminum that is substantially noncorrosive to the aluminum and does not leave unsightly tenaciously held white satins on the surface thereof when allowed to dry without rinsing which comprises alkaline material selected from the group consisting of alkali metal hydroxides, carbonates, phosphates and mixture thereof in an amount to provide a pH in the range of about 9 to 13, an alkali metal silicate inhibitor in an amount to inhibit corrosion of said aluminum due to said alkalinity, a water-soluble, alkali-stable surface active agent in an amount from about 0.1 to 5 weight percent and selected from the group consisting of ethylene oxide adducts of hydrophobic bases, the alkylated and aralkylated ethers of said ethylene oxide adducts of hydrophobic bases, alkane sulfates and alkylaryl sulfonates, sucrose in an amount from about 0.2 to 10.0 weight percent and the balance water.

2. An aqueous alkaline cleaner for aluminum that is substantially noncorrosive to the aluminum and does not leave unsightly tenaciously held white stains on the surface thereof when allowed to dry without rinsing which comprises an alkaline material selected from the group consisting of alkali metal hydroxides, carbonates, phosphates and mixtures thereof in an amount to provide a pH in the range of about 10 to 12.5, an alkali metal silicate corrosion inhibitor in an amount to provide an SiO_2 concentration from about 0.25 to 2.0 weight percent, a water-soluble, alkali-stable surface active agent in an amount from about 1 to 4 weight percent and selected from the group consisting of ethylene oxide adducts of hydrophobic bases, the alkylated and aralkylated ethers of said ethylene oxide adducts of hydrophobic bases, alkane sulfates and alkylaryl sulfonates, sucrose in an amount from about 2 to 6 weight percent and the balance water.

3. A composition in accordance with claim 2 wherein a water-soluble glycol ether solvent is present in an amount up to about 10 weight percent.

4. An aqueous alkaline cleaner for aluminum that is substantially noncorrosive to the aluminum and does not leave unsightly tenaciously held white stains on the surface thereof when allowed to dry without rinsing comprising the following ingredients in the approximate proportions set forth:

	Weight percent
Tetrasodium pyrophosphate	2.0
Sodium metasilicate	3.0
Nonionic surfactant	2.0
Monoethyl ether of ethylene glycol	6.0
Sucrose	5.0
Water	82.0

5. An aluminum cleaner that is substantially noncorrosive to the aluminum and does not leave unsightly tenaciously held white stains on the surface thereof when allowed to dry without rinsing adapted for use in an aqueous medium comprising 30 to 70 weight percent of an alkaline cleaning agent selected from the group consisting of alkali metal hydroxides, carbonates, phosphates and mixtures thereof, an alkali metal silicate inhibitor in an amount from about 2 to 10 weight percent, a water-soluble, alkali-stable surface active agent selected from the group consisting of ethylene oxide adducts of hydrophobic bases, the alkylated and aralkylated ethers of said ethylene oxide adducts of hydrophobic bases, alkane sulfates and alkylaryl sulfonates in an amount from about 1 to 10 weight percent and sucrose in an amount from about 11 to 40 weight percent.

6. A composition in accordance with claim 5 wherein a glycol ether solvent is present in an amount from about 1 to 10 weight percent.

7. An aluminum cleaner that is substantially noncorrosive to the aluminum and does not leave unsightly tenaciously held white stains on the surface thereof when allowed to dry without rinsing adapted for use in aqueous medium comprising about 40 to 60 weight percent of an alkaline cleaning agent selected from the group consisting of alkali metal hydroxides, carbonates, phosphates and mixtures thereof such that an aqueous solution of said cleaner will have a pH in the range of about 9–13, an alkali metal silicate corrosion inhibitor in an amount from about 3 to 7 weight percent so as to provide in aqueous solution an SiO_2 content of from about 0.25 to 2.0 weight percent, a water-soluble, alkali-stable surface active agent selected from the group consisting of ethylene oxide adducts of hydrophobic bases, the alkylated and aralkylated ethers of said ethylene oxide adducts of hydrophobic bases, alkane sulfates and alkylaryl sulfonates in an amount from about 3 to 8 weight percent and sucrose in an amount from about 15 to 25 weight percent.

8. A process for cleaning aluminum surfaces without depositing unsightly tenaciously held white stains on the surface thereof when allowed to dry without rinsing which comprises applying to said surface an aqueous alkaline cleaning solution containing an alkaline cleaning agent selected from the group consisting of alkali metal hydroxides, carbonates, phosphates and mixtures thereof in an amount to provide a pH in the range from about 9 to 13, an alkali metal silicate corrosion inhibitor in an amount to provide an SiO_2 content from about 0.25 to 2.0 weight percent, a water-soluble, alkali-stable surface active agent selected from the group consisting of ethylene oxide adducts of hydrophobic bases, the alkylated and aralkylated ethers of said ethylene oxide adducts of hydrophobic bases, alkane sulfates and alkylaryl sulfonates in an amount from about 0.1 to 5 weight percent and sucrose in an amount from about 0.2 to 10 weight percent.

9. A process in accordance with claim 8 wherein a glycol ether solvent is present in an amount from about 1 to 10 weight percent.

References Cited by the Examiner

UNITED STATES PATENTS

694,658	3/02	Meurant	252—156 XR
2,314,285	3/43	Morgan et al.	41—42
2,381,124	8/45	Hart	252—135
2,650,875	9/53	Dvorkovitz et al.	252—156 XR
2,741,599	4/56	McDonald et al.	252—38
2,942,955	6/60	Hannah	41—42
2,986,526	5/61	Crowther	252—135

JULIUS GREENWALD, *Primary Examiner.*