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INHIBITOR FOR ALUMINUM IN ALKALINE SOLUTIONS

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2 Claims

ABSTRACT OF THE DISCLOSURE

A method of inhibiting the corrosion of metallic aluminum during its treatment with alkaline solutions. As the inhibitor in the alkaline solution, according to the invention polyacrylic acids having a specific viscosity in the range of 0.07 to 0.90, preferably 0.09 to 0.20, are used in a preferred amount of 0.05 to 0.5% by weight, based on the weight of the alkaline solution. Instead of the polyacrylic acids their water-soluble alkali salts can be used.

By the present invention the undesired side effects of alkali silicate inhibitors, such as incrustation of the aluminum, can be avoided.

This invention relates to the inhibition of metallic aluminum in alkaline solutions by the action of polyacrylic acids and/or their water-soluble salts.

It has been known to inhibit aluminum metal in alkaline solutions by the action of oxidizing agents, e.g. permanganates or chromates, which are active in the alkaline range. However, the efficiency of these oxidizing agents is limited and relatively high amounts thereof must be used. In view of the physiological labor conditions and reasons connected with waste-water purification, chromates cannot be used in practice at present any more. The use of waterglass as an inhibitor for aluminum has also been known. It yields good results if it is applied in the necessary high proportions.

It has been found that the addition of water glass in the necessary high proportions, to alkaline solutions frequently results in unpleasant side effects, for example in crust-formation or incrustation on the parts or objects treated with said solutions, particularly if said parts or objects are after-treated with acid, in order to remove the excess of alkali. Such incrustations do not react with solutions conventionally used for their removal. They can be removed with hydrofluoric acid only, the use of which, however, raises physiological problems.

It has now been found that these difficulties can be eliminated if—instead of water-glass-polyacrylic acids having a specific viscosity of 0.07 to 0.90 are added to the alkaline solutions as inhibitors for aluminum. It has been found preferable to use polyacrylic acids having a specific viscosity in the range of 0.90 to 0.20. The inhibiting effect decreases in general if the specific viscosity is higher than 0.2. In some cases, for example in pickling aluminum, a not too strong reduction of the attack on aluminum is desirable. The "specific viscosity" η of a substance is calculated from the viscosity of the solution according to the following formula:

$$\eta = \frac{\text{viscosity of the solution}}{\text{viscosity of the solvent}} - 1$$

In the present case, always the viscosity of a 0.7% solution of the respective polyacrylic acid in 2 N sodium hydroxide solution in water is measured.

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It has been found that the polyacrylic acids are particularly efficient at relatively low inhibitor concentrations and preferably 0.05 to 0.05% by weight, based on the weight of the alkaline solution. Equal amounts of alkali silicate have no inhibiting effect and they even intensify the corrosion of metal caused by the alkali and a satisfactory degree of inhibition can be attained in this case by essentially higher alkali silicate concentrations only.

Instead of the free polyacrylic acids, water-soluble salts thereof can also be used, particularly the sodium, potassium and ammonium salt.

The alkaline solutions used in the treatment of aluminum in carrying out the present invention, contain particularly sodium hydroxide or potassium hydroxide. However, other substances of strongly alkaline reaction, such as alkali carbonates and alkali phosphates can also be used, either alone or in mixture with alkali hydroxides.

It has been found that by using the above described polyacrylic acids and/or their water-soluble salts, a retardation of the attack by the alkaline solution on the aluminum metal takes place, which is particularly suitable for commercial practice. At the same time, crust formation or the formation of coatings, which cause difficulties in the application of the hitherto used alkali silicate inhibitors, is avoided.

The following examples describe some embodiments of the invention, to which the invention is not limited.

EXAMPLE 1

Three aqueous solutions were prepared

- (a) from water and 1% by weight of NaOH;
- (b) from water, 1% by weight of NaOH and 0.2% by weight of polyacrylic acid having a specific viscosity of 0.15;
- (c) from water and 1% by weight of NaOH and 0.2% by weight of sodium-silicate, in which the mol-ratio $\text{SiO}_2:\text{Na}_2\text{O}$ was 3.3:1.

In each said solutions (a), (b) and (c) a weighed 99.5% sheet aluminum of 1 mm. thickness was immersed and left immersed for 60 minutes. The test pieces were then removed from the solution, rinsed with water and weighed in order to determine the weight of aluminum removed from the test piece during said 60 minutes. The weight of aluminum removed during immersion from the test pieces amounted in grams, per square meter, and per minute

in test (a), i.e. treatment with NaOH only, to 0.17 gram
in test (c), i.e. treatment with solution (c), to 0.26 gram
in test (b), i.e. according to the invention, to 0.024 gram

If the treatment is carried out in the above described manner, but with solutions (a), (b), and (c), which contain now in each case 3% of NaOH in solution, the weight of aluminum removed during immersion from test pieces amounted in grams per square meter, and per minute

in test (a'), i.e. treatment with solution of NaOH only, to 0.45 gram
in test (c'), treatment with solution of NaOH and water-glass to 0.75 gram
in test (b'), i.e. treatment according to the invention to 0.09 gram

EXAMPLE 2

In 3 series (a), (b), (c) of tests aluminum sheet pieces of 99.5% by weight of aluminum, having a thickness of 1 mm. and dimensions of 5×10 cm., were exposed by immersion to the action of aqueous NaOH solutions of different NaOH concentrations at 65° C. for 15 minutes.

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In series (a) the NaOH solution contained no inhibitor; in series (b) the NaOH solution contained 0.2% by weight (based on the weight of the solution) of polyacrylic acid having a specific viscosity of 0.15; in series (c) the NaOH solution contained 0.2% by weight (based on the weight of the solution) of water-glass of a mol-ratio of $\text{SiO}_2:\text{Na}_2\text{O}=3.3:1$. Subsequently the test pieces were removed from the solutions, rinsed and dried.

The following Table 1 shows the weight of the aluminum removed in each case from the test pieces during immersion under the above described conditions, at different NaOH concentrations. In using instead of polyacrylic acid a water-soluble alkali salt thereof, substantially equal results are obtained.

TABLE 1

Percent by weight of NaOH	Weight of aluminum removed in grams per square meter and per minute		
	Solution a	Solution b	Solution c
0.5.....	3.62	0.86	2.08
1.0.....	4.49	0.58	5.21
2.0.....	6.65	0.79	11.20
3.0.....	9.35	0.92	13.65

EXAMPLE 3

Aluminum sheet pieces of the dimensions 0.1 x 5 x 10 cm. were exposed to the action of aqueous solutions containing 1% by weight of NaOH and 0.1% by weight of polyacrylic acid of varying specific viscosity. Said test pieces were immersed in said solutions of 20° C. for 60 minutes.

The following Table 2 shows the weight of aluminum removed in each case from the test pieces during immersion under the above described conditions, in dependence on the specific viscosity of the polyacrylic acids used.

TABLE 2

Specific viscosity of the polyacrylic acid:	Weight of aluminum removed in grams per square and per minute
0.09	0.017
0.12	0.014
0.15	0.020
0.34	0.030
0.68	0.028
0.90	0.037

It will be understood from the above that this invention is not limited to the specific details and conditions disclosed above and can be carried out with various modifications. Thus—as already mentioned above—in the alkaline solutions for the treatment of aluminum according to the invention, other substances of strong alkaline reaction may be used, alone or in mixture with alkali hydroxides. As examples of such solutions, the following are mentioned: an aqueous solution containing 0.1 to 10% by weight of Na_2CO_3 ; an aqueous solution containing 1 to 5% by weight of NaOH and 0.05 to 0.5% by

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weight of K_3PO_4 . Such solutions are used for the treatment of aluminum in a manner substantially analogous to that described above in the case of solutions, in which the alkali consists of alkali hydroxide.

The term "inhibitor" is used herein to denote compounds or compositions having the effect of slowing down corrosion of aluminum in alkaline solution. The term "polyacrylic acids" is used herein to denote products obtainable by polymerization of acrylic acid ($\text{CH}_2=\text{CH}\cdot\text{COOH}$). The test described in the above Example 1 was carried out at ordinary room temperature of about 20° C. The percent and parts stated herein are by weight, if not otherwise stated.

What is claimed is:

1. A process for inhibiting the corrosion of metallic aluminum in the presence of a strong alkaline solution selected from the group consisting of aqueous sodium hydroxide and aqueous potassium hydroxide which consists of the addition of from 0.05 to 0.5% by weight, based on the weight of said alkaline solution, to said solution of a compound having a specific viscosity in the range of from 0.09 to 0.90 and selected from the group consisting of polyacrylic acids and water-soluble salts of said acids selected from the group consisting of the sodium salt, the potassium salt and the ammonium salt, said specific viscosity η being determined according to the formula

$$\eta = \frac{\text{viscosity of the solution}}{\text{viscosity of the solvent}} - 1$$

where the viscosity is determined of a 0.7% solution of said polyacrylic acid in a 2 N sodium hydroxide solution in water.

2. The process of claim 1 wherein said compound has a specific viscosity in the range of from 0.09 to 0.20.

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