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3,418,230

GALVANIC ANODE AND ALUMINUM ALLOY THEREFOR

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5 Claims. (Cl. 204—197)

This invention relates to aluminous metal galvanic anodes for the cathodic protection of metals and an alloy composition for the same to improve their performance and relates particularly to consumable anodes of an aluminum base alloy for the cathodic protection of non-aluminous metal structures exposed to the corrosive action of aqueous media, and particularly aqueous saline media, and a composition for improving the output of such anodes.

Cathodic protection systems are well known in which a metal article immersed in an electrolyte is protected from corrosion by means of a sacrificial or a consumable anode which is also immersed in the electrolyte and is electrically connected to the metal structure (cathode) which is to be protected. Protection against corrosion is particularly important when the metal article is exposed to the corrosive action of an aqueous saline media. Sacrificial anodes are employed to provide cathodic protection for such structures as steel pipe lines, ship hulls, ship ballast tanks, metal sea walls, and drilling rigs.

Sacrificial or consumable anodes are generally made in any desired shape or size to suit the structure to be protected and must be composed of a metal which is anodic to the metal body to be protected. The anodes may be in wrought or cast form but the latter has generally been preferred. Some convenient means for attaching the anode to the article to be protected is usually necessary such as an embedded metal core strap, rod or cable.

For many applications the expense of replacing exhausted anodes represents a substantial part of the cost of the protective system. For this reason it has been recognized that a long life accompanied by adequate current output is highly desirable for reducing the cost of cathodic protection. This characteristic is referred to as high current efficiency and is generally expressed in terms of ampere hours delivered to the cathode per pound of anode metal consumed. The difference in potential between the anode and cathode must be great enough, of course, to maintain a flow of current. On the other hand, however, too great a difference in potential will shorten the life of the anode without corresponding improvement in cathodic protection.

The object of this invention is to provide an improved aluminum base alloy galvanic anode which has a longer useful life per unit weight of anode material than prior commercial aluminum base alloy anodes.

Another object is to provide an aluminum base alloy galvanic anode having both a high current efficiency and a substantially constant low electrode potential during its life to continuously protect the metal structures with which it is connected.

I have found that greatly improved cathodic protection is achieved by employing aluminum-zinc type alloy anodes which consist essentially of aluminum, 3.5% to 9.0% by weight of zinc, and 0.008% to 0.05% by weight of indium. To obtain the best results I prefer to use from 6.0% to 8.0% by weight of zinc. For some purposes it may be desirable to add 0.05% to 0.2% by weight of tin to assist the action of the indium. All the impurities in the aluminum base alloy, such as for example, iron, silicon and copper, should not exceed a total of 0.50% and more specifically the alloy should not contain over 0.20% iron, 0.20% silicon and 0.02% copper, since in

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greater amounts they reduce the current efficiency of the anodes. All other impurities should not be over 0.05% each.

The zinc component of the alloy is necessary to provide the desired electrode potential for the anode. Smaller amounts than 3.5% do not supply the desired characteristics in the anode while more than 9.0% does not produce any added improvement in performance. The indium component also favorably affects the behavior of the anodes by helping to maintain a high current output over the life of the anode. Smaller amounts than the stated minimums have an insignificant effect upon the performance of the anodes whereas larger quantities have an adverse effect.

The anodes can be made in either cast or wrought form but generally it is most convenient to produce them in the form of castings since the supporting rod or cable can be cast in place. The sand or permanent mold casting procedures are generally most convenient to employ.

The size and shape of the anodes will vary with the type of installation, and anodes for commercial purposes generally weigh between 10 and 50 pounds.

The alloy anodes described above are capable of yielding more ampere hours per pound of metal consumed at a substantially constant potential under the same conditions than anodes of an aluminum—5.5% zinc alloy of the type heretofore used for cathodic protection purposes. My improved aluminum base alloy anodes provide a substantially constant difference of 0.2 to 0.4 volt in electrode potential between the anodes and a steel structure and thus afford adequate protection on the one hand, while on the other hand avoiding what is known as "over protection."

The improvement in anode efficiency resulting from the alloy composition is illustrated in the following two examples:

EXAMPLE I

Two lots of sample anodes were tested. Lot #1 was made up of anodes whose composition consisted essentially of aluminum and 5.5% zinc. Lot #2 was made up of anodes whose composition consisted essentially of aluminum, 7% zinc and 0.02% indium. The anodes in both lots had an impurity content of 0.01% copper, 0.12% iron, and 0.10% silicon, and were cast in the form of cylinders in a permanent mold. Each of the anodes was weighed, the area calculated, and immersed in a separate steel receptacle containing an aqueous solution of 3.5% by weight of sodium chloride. The anodes were placed in circuit with a conventional device for delivering and maintaining a constant current density in which the potential is automatically adjusted to compensate for variations in resistance. In this arrangement the externally applied potential did not exceed a few volts and the current density was maintained at 2 milliamperes per square inch of anode surface. The current values were ascertained by use of milliammeter in the circuit. At the end of the one week testing period, all the anodes were removed, cleaned and weighed to determine the loss of metal. It was found that the anodes of Lot #1 lost 2.8% of their weight and those of Lot #2 lost 1.7% of their weight. The current efficiency, derived by dividing anode weight loss into ampere-hours delivered to the cathode, showed that the anodes of Lot #1 had produced 600 to 700 ampere hours per pound of anode consumed, the average being 650, whereas the anodes in Lot #2 delivered 1067 to 1101 ampere hours per pound of anode consumed, the average being 1085.

EXAMPLE II

Sample cylindrical anodes of aluminum base alloy consisting essentially of aluminum, 7.0% zinc, 0.05% tin,

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and 0.01% indium, with an impurity content of 0.01% copper, 0.12% iron, and 0.10% silicon, were also cast in a permanent mold in the same manner as those referred to in the preceding example. These anodes were exposed to the same corrosion test and for the same period of time as those in Example I. These anodes lost 1.8% of their weight during the one week test period. It was found that these anodes produced 1062 to 1089 ampere hours per pound of anode consumed, the average being 1075.

Having thus described my invention, I claim:

1. A galvanic anode in the non-heat treated condition composed of an aluminum base alloy consisting essentially of aluminum, 3.5% to 9.0% by weight of zinc and 0.008% to 0.05% by weight of indium, the total of all impurities not being over 0.50%, said anode in the as-cast or as-worked condition being characterized by a higher current efficiency than the same anode without indium.

2. A galvanic anode according to claim 1 wherein the zinc content is 6.0% to 8.0% by weight.

3. A galvanic anode in the non-heat treated condition composed of an aluminum base alloy consisting essentially of aluminum, 3.5% to 9.0% by weight of zinc and 0.008% to 0.05% by weight of indium, and containing as impurities a maximum of 0.20% iron, 0.20% silicon, 0.02% copper, and 0.05% each of all other impurities, the total amount of said impurities not exceeding 0.50%, said anode being characterized by a higher current efficiency than the same anode without indium.

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4. A galvanic anode in the non-heat treated condition composed of an aluminum base alloy consisting of aluminum, 3.5% to 9.0% by weight of zinc, 0.008% to 0.05% by weight of indium and 0.05% to 0.2% by weight of tin, and containing as impurities a maximum of 0.20% iron, 0.20% silicon, 0.02% copper and 0.05% each of all other impurities, the total amount of said impurities not exceeding 0.50%.

5. An aluminum alloy for galvanic anodes consisting of less than 0.05 and more than 0.008 weight percent indium; 3.5 to 9.0 weight percent zinc, the balance being aluminum.

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25 RICHARD O. DEAN, *Primary Examiner.*

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75—146; 204—148, 293

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CERTIFICATE OF CORRECTION

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It is certified that error appears in the above identified patent and that said Letters Patent are hereby corrected as shown below:

Column 3, lines 16 and 17, cancel "in the as-cast or as-worked condition".

Signed and sealed this 11th day of November 1969.

(SEAL)

Attest:

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Commissioner of Patents