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PROCESS FOR PREPARING ALUMINUM ALLOYS

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4 Claims. (Cl. 164—57)

This invention relates to aluminum alloy fabrications and more particularly is concerned with an improved process for preparing aluminum alloy casting exhibiting a high electrochemical efficiency and an oxidation potential in the range particularly suitable for use as sacrificial anodes with ferrous structures in saline water applications.

Aluminum which has alloyed therewith small amounts of mercury, for example, from about 0.001 to about 0.2 weight percent and usually from about 0.005 to about 0.08 weight percent, as well as up to about 35 weight percent zinc and/or from less than 1 percent up to 20 weight percent of one or more certain other alloying components such as for example magnesium, calcium, manganese, copper, silver, cadmium, tin, gold, antimony, beryllium, silicon, barium, strontium, gallium, bismuth, indium and lead has been found unexpectedly to be cathodic protection of ferrous based installations and objects operated in or in contact with sea water and other saline or brackish waters.

These mercury containing alloys when cast or otherwise fabricated into anode structures and employed as sacrificial galvanic anodes as set forth hereinbefore exhibit an operating oxidation potential of from about 0.9 to about 1.2 volts (as measured in closed circuit at either about 250 or about 1000 milliamperes per square foot in a synthetic sea water electrolyte with a standard saturated KCl calomel cell as reference). Additionally, anodes prepared from the majority of these compositions exhibit a satisfactory, relatively smooth corrosion pattern throughout the operating life of the anode and a high efficiency (actual electrical output in ampere-hours per pound of metal consumed as compared to theoretical) ranging from 70 percent to 98 percent or higher.

Anodes from these mercury containing aluminum alloy compositions usually are prepared by alloying and castting following conventional aluminum metal handling procedures. Generally, as is well understood in the metal fabrication art, aluminum alloys are cast while employing melt temperatures between about 1220° F. and 1350° F. Within this range, good melt fluidity and castability results. Those skilled in the aluminum casting art normally do not employ higher casting temperatures because it is universally understood that nothing is gained by casting at higher temperatures.

With anodes from aluminum alloys containing mercury cast under such conventional procedures which are stored prior to use, undesirable surface oxidation, usually in the form of large "blooms," is commonplace. This is surface oxidation and contamination serves to make the anode less appealing to potential customers as well as can actually reduce the effectiveness of the product during operation. Much effort has been extended in the past to overcome or minimize this problem primarily by incorporating additives into the alloy system.

Now unexpectedly, it has been found in accordance with the present invention that this undersirable surface oxidation can be markedly reduced and even eliminated on such mercury containing alloy anodes during storage.

In the practice of the present invention a mercury containing aluminum alloy composition which exhibits an electrochemical potential of from about 0.9 to about 1.2 volts and a high efficiency when utilized as a sacrificial

anode with a ferrous structure in saline water applications is melted at a temperature of at least about 1400° F. and generally at from about 1400 to about 1800° F., preferably at from about 1500 to about 1800° F. and cast while at this melt temperature. Cast anodes prepared by this treatment exhibit markedly reduced surface oxidation during storage as compared to those anodes cast using conventional aluminum melting and casting temperatures. Further, in the practice of the present invention the melt and casting temperature is predetermined with respect to the mercury content of the alloy. Higher melt temperatures within the disclosed range are employed for the higher mercury containing alloys. To illustrate: for those alloys commonly utilized as sacrificial anodes and having a mercury concentration of from about 0.02 to about 0.08 weight percent it was found that with those alloys having a mercury concentration of from about 0.02 to about 0.025 percent virtually no surface oxidation was observed on storage when these were melt and cast at a temperature of from about 1400 to 1500° F. Those alloys which approached 0.08 percent mercury showed some reduction in oxidation resistance when cast at this temperature range as compared to those cast using conventional aluminum casting temperatures (i.e. up to about 1350° F.) but showed substantially no surface oxidation on storage when these were melted and cast at about 1800° F. Temperatures higher than 1800° F. can be employed but substantially no additional advantage with regards to reduction in the surface oxidation is realized. For temperatures above about 1800° F., it is preferred that an inert atmosphere be held over the molten melt to prevent oxide scum formation from forming on the melt surface during the melting and casting operation.

If desired, the molds can be preheated to a temperature of from several hundred degrees Fahrenheit up to 1000° F. or more prior to casting the high temperature melt therein. In actual foundry operations, it has been found that the initial casting heats the mold sufficiently such that the mold is still at an elevated temperature of several hundred degrees Fahrenheit or more when subsequent castings are made therein.

The cast anode is removed from the mold after it has solidified in accordance with standard casting and handling techniques. After the casting has been removed from the mold, it can be stored, adapted for use as an anode or otherwise employed.

Since iron molds ordinarily are used in casting aluminum, if desired these can be coated with a thin film of mold wash (a thin graphite suspension in water) or can be coated with acetylene black from an acetylene flame prior to casting the aluminum melt therein. This coating although very thin prevents iron contaminant from the mold wall from being absorbed into the casting as it solidifies.

The preparation of the alloy itself is carried out in a conventional manner. Since mercury has a low solubility in aluminum and because of its physical state, it is harder to alloy with other higher melting metals. Conveniently the mercury can be prealloyed with other of the other alloying ingredients, for example zinc, and the prealloy be submerged into the molten aluminum at a temperature slightly above the melting point of the aluminum. The prealloy is then dispersed in the melt and the melt heated and cast in accordance with the practice of the present invention.

The melting of the alloy can be carried out using induction furnaces, gas fired furnaces and the like heating apparatus. Ordinarily, some type of agitation is employed to assure that the alloying components are substantially homogenously blended throughout the melt. With induction type furnaces, no external agitation is needed while

with gas fired furnaces generally these are stirred to mix the alloying components throughout the melt.

The following examples will serve to further illustrate the present invention but are not meant to limit it thereto.

Example 1.—Aluminum alloy melts having zinc and mercury as the alloying components were prepared in an induction furnace. In this study, a number of alloys were prepared wherein mercury was first prealloyed with zinc in predetermined quantities and the prealloy then added to the molten aluminum. Total melt weights ran from about 10 to about 16 pounds. The base aluminum metal employed was a commercially available aluminum of about 99.85 percent purity, the main impurities being iron and silicon. The melts were heated to either 1400° or 1800° F. and then each melt was cast into a mold which was at a temperature of about 550° F. The cast ingots after solidifying and cooling were removed from the mold and placed in an environment of 100 percent relative humidity at room temperature (i.e., about 80° F.) for two hours. After this period the ingots were examined to determine the extent of surface oxidation. Prior to placing the ingots in the high humidity test chamber, they were sampled and elemental chemical analysis run to determine the alloy composition. The data and results for these studies are presented in Table I.

TABLE I

Run No.	Analysis		Temperature of melt, ° F.	Surface oxidation
	Percent Hg	Percent Zn		
1	0.049	0.4	1,400	Yes.
2	0.052	0.4	1,400	Yes.
3	0.055	0.4	1,400	Yes.
4	0.052	0.5	1,800	No.
5	0.059	0.6	1,800	No.
6	0.060	0.7	1,800	No.

Example 2.—Using 99.9 percent purity aluminum as a base metal and following the procedure described in Example 1 a number of mercury-zinc-aluminum alloys were melted and cast at a predetermined melt temperature. For this study, the amount of surface oxidation was determined quantitatively. The data and results of this study are presented in Table II. For purposes of comparison, a number of controls wherein the melt temperature was below that employed in the practice of the present invention also are included in Table II.

TABLE II

Run No.	Analysis		Temperature of melt, ° F.	Percent of surface oxidation
	Percent Hg	Percent Zn		
Control	0.046	0.57	1,382	16
Do	0.045	0.62	1,382	19
1	0.040	0.53	1,688	1
2	0.046	0.60	1,688	1
3	0.039	0.54	1,796	0

Example 3.—A series of 249 field size anodes ranging from about 10 to about 75 pounds each were melted and cast using commercial foundry equipment. For these anodes the aluminum base base metal was from about 99.85 to about 99.9 percent pure. Mercury and zinc were prealloyed for addition to the molten aluminum and alloyed with molten aluminum as described in Example 1. Analyses of the cast anodes indicated a mercury concentration of from about 0.048–0.05 percent and a zinc concentration from about 0.5–0.75 percent. The ingots were melted and cast at controlled temperatures ranging from 1300 to about 1800° F. These ingots after casting were stored for seven days under the ambient indoor conditions at the foundry. After this period, the ingots were examined for surface oxidation. The results of this study indicated that those ingots which had been melted and cast under conventional aluminum casting practices, i.e., 1300 to 1350° F., were severely oxidized, i.e., a large number of and extensive "blooms." Ingots melted and cast at from 1350 to 1400° F. still were highly oxidized but somewhat less than those melted and cast under conventional foundry practices. A marked reduction in surface oxidation is found in all ingots melted and cast within a temperature of from 1400 to 1500° F. and ingots melted and cast at above 1500° F. showed virtually no oxidation. Some of the ingots which had been cast at 1800° F. were subjected to 100° relative humidity tests for a period of 48 hours. After this test period, no surface oxidation was apparent on these anodes.

Example 4.—A series of anodes such as in Example 3 were were cast having mercury concentrations of from about 0.02 to 0.025 weight percent and a zinc concentration of from about 0.2 to 0.37 weight percent. These melts were heated over a temperature range of from 1400 to 1500° F. and cast into ingots at this temperature. After storage for a period of 1 year at ambient temperature in the open atmosphere (Texas Gulf Coast, i.e. ~100 percent relative humidity), visual examination showed virtually no surface oxidation on these cast ingots.

Example 5.—A series of about 250 pound castings were prepared from an aluminum-mercury-zinc alloy employing aluminum of about 99.90 percent purity. A prealloy of mercury and zinc was added to the melt and each melt heated to within the temperature range of from about 1400 to 1600° F. The concentration of mercury and zinc in the castings as determined from chemical analysis of samples taken from 100 of such castings was about 0.045 percent mercury and 0.45 percent zinc there being very little variation from these figures from ingot to ingot. The entire batch of 100 castings was exposed for about 2 weeks to ambient outdoor atmosphere on the Texas Gulf Coast (i.e. humidity of about 100 percent). Examination of the cast ingots after this period showed that none of them exhibited any visible surface oxidation.

In a manner similar to that described for the foregoing examples, mercury containing aluminum alloy which may also have other alloying ingredients alloyed therewith as set forth herein can be melted and cast within a temperature range of from about 1400 to about 1800° F. thereby to provide cast structures suitable for use as galvanic anodes in combination with ferrous based structures in saline water which anodes exhibit essentially no surface oxidation during storage.

Various modifications can be made in the present invention without departing from the spirit or scope thereof for it is understood that we limit ourselves as defined in the appended claims.

We claim:

1. I novel process for preparing aluminum alloy castings exhibiting a high electrochemical efficiency and an oxidation potential in the range partcularly suitable for use as sacrificial anodes with ferrous based structures in saline water applications which comprises;
   (a) melting at a temperature of from about 1400 to about 1800° F. a mercury containing aluminum alloy which exhibits an oxidation potential of from about 0.9 to about 1.2 volts,
   (b) maintaining the resulting molten alloy within this temperature range while casting said alloy, and
   (c) casting said alloy into a mold.

2. The process as defined in claim 1 wherein the aluminum alloy is maintained at from about 1500 to about 1800° F. during the melting and casting.

3. The process as defined in claim 1 and including the steps of melting aluminum and alloying said aluminum with a prealloy of mercury and zinc, said prealloy containing mercury and zinc in predetermined quantities so as to provide an aluminum alloy comprising about 0.02 to about 0.08 weight percent mercury and from about 0.1 to about 35 weight percent zinc.

4. The process as defined in claim 1 and including the

step of casting said molten alloy into a mold, said mold being heated to a temperature of from about 500 to about 1000° F.

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UNITED STATES PATENT OFFICE

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 1, line 26, after "be" insert -- effective as a galvanic sacrificial anode in the --. Column 2, line 20, before "1500° F." insert -- about --.

Signed and sealed this 10th day of March 1970.

(SEAL)
Attest:

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