GOVERNMENT OF INDIA : THE PATENT OFFICE, 214, ACHARYA JAGADISH BOSE ROAD, CALCUTTA-17.

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"IMPROVEMENTS IN OR RELATING TO THE DEVELOPMENT OF ANODES BASED ON ALUMINIUM AND ITS ALLOYS FOR CATHODIC PROTECTION"

COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH, RAFI MARG, NEW DELHI-1, INDIA, AN INDIAN REGISTERED BODY INCORPORATED UNDER THE REGISTRATION OF SOCIETIES ACT (ACT XXI OF 1860).

This is an invention by Venkataraman Balasubramanian, Junior Scientific Assistant, Pattarakalam Luka Joseph' Scientist, Balkunje Anantha Shenoi, Scientist, Narayanaswami Subramanyan, Scientist and Vasudeva Sastri Kapali, Junior Scientific Assistant, all are employed in the Central Electrochemical Research Institute, Karaikudi-3 and all are Indian Nationals.

The following specification describes and ascertainsh the nature of this invention :—

This invention relates to improvements in or relating to the development of anodes based on the aluminium and its alloys for cathodic protection.

Hitherto it has been proposed to employ aluminium and aluminium alloys as anodes for giving cathodic protection to submerged and buried steel structures, either by the impressed current or by the sacrificial method.

This is open to the objection that there is likelihood of the aluminium getting passivated in neutral media and thereby becoming ineffective as anode for cathodic protection. In the case of alloys, reported in literature, the methods of making the alloys are covered by patents in foreign countries.

The object of this invention is to obviate these disadvantages by developing alloys of aluminium, which will help in the utilisation of aluminium which is available in large quantities in our country and which will not get passivated in neutral media like brine or sea water or alkaline or acidic soil, when used as anode for cathodic protection of steel structures.

To these ends, the invention broadly consists in making aluminium useful as anode for cathodic protection by alloying it with small amounts of zinc, and/or mercury and/or tin having the following range of compositions and cast in the form of sheets or rods of any shape :

(a)	Mercury :	0.01—0.1%
	Aluminium :	Balance
(b)	Mercury :	0.01—0.1%
	Zinc :	0.5—5.0%
	Aluminium :	Balance
(c)	Zinc :	0.5—5.0%
	Tin :	0.1—2.0%
	Aluminium :	Balance
(d)	Zinc :	0.5—5.0%
	Aluminium :	Balance
(e)	Tin :	0.1—2.0%
	Aluminium :	Balance

The alloys are made by the conventional method of melting together the constituents.

In the preparation of alloys containing mercury, the addition of mercury is brought either by first amalgamating zinc or aluminium and then adding the amalgam to the rest of the constituents in the molten state, or by passing vapours of mercury into the molten metals and stirred well and cast at about 700°C in moulds of cast iron or graphite.

The follhwing typical examples are given to illustrate the invention ;

EXAMPLE I

Anode Efficiency :

Anode efficiency experiment was carried out with the aluminium alloy having the following composition : zinc 2%, mercury 0.04% and rest aluminium.

In an electrolytic cell made up of the aluminium alloy anode (rod of 1 cm. dia. and 10 sq. cm. area) and a platinum cathode foil of 6.25 sq. cm. area) dipping in 250 ml. of 3% NaCl solution or synthetic sea water in a glass beaker, a current of 100 mA was passed for three hours. From the weight loss of the anode, the anode efficiency was found to be 70-80%.

EXAMPLE 2

In a H-type glass cell with a sintered glass partition, containing 3% NaCl solution, a mild steel specimen of 2.5 cm×2.5 cm was coupled to an anode of aluminium alloy (zinc 2%, mercury 0.04% and rest aluminium) and the potential of the steel specimen was merasured and the duration for which the steel remained free from corrosion was noted. It was found that the potential of steel was raised to −1.02 volts versus saturated calomel electrode and that it received complete cathodic protection for the entire duration of the experiment, namely, for two months. The potential of the aluminium alloy anode remained steady at —1.06 volts with respect to saturated calomel electrode thereby showing negligible polarisation of the anode.

The following are the main advantages of the invention :

1. Aluminium of which India has large resources, can be employed for making anodes for cathodic protection of submerged or buried steel structures.
2. By alloying aluminium with zinc, tin or mercury or with all or either of these metals, anodes giving good anode efficiency can be made.
3. The anodes of the aluminium alloys mentioned in this patent are free from getting passivated in brine or sea water and hence can deliver current for cathodic protection continuously till the anodes last.
4. The anodes of the aluminium alloys show steady negative potentials in brine or sea water and hence will maintain a constant driving voltage for cathodic protection of steel.

Sd. Illegible
PATENTS OFFICER,
Council of Scientific and Industrial Research.

Dated this 24th day of October, 1970.

Price : TWO RUPEES

COMPLETE SPECIFICATION

COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH, RAFI MARG, NEW DELHI-1, INDIA, AN INDIAN REGISTERED BODY INCORPORATED UNDER THE REGISTRATION OF SOCIETIES ACT (ACT XXI OF 1860).

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The following Specification particularly describes and ascertains the nature of this invention and the manner in which it is to be performed:—

This invention relates to improvements in or relating to the develoment of anodes based on aluminium and its alloys for cathodic protection.

Hitherto it has been proposed to use aluminium alloys containing zinc and mercury as anodes for giving cathodic protection to submerged and buried steel structures by sacrificial methods, but the technique of the preparation of the same is not divulged.

This is open to the objection that the methods of preparation and the desirable composition of aluminium-zinc-mercury alloy are not known in this country, and amalgamation of aluminium by bringing it in contact with mercury or solutions of mercury compounds leads to disintegration of aluminium and stable anodes of rigid form capable of giving steady potential cannot be obtained by this method.

The main object of this invention is to obviate these disadvantages by working out optimum composition for the preparation of aluminium-zinc-mercury alloy using indigenously available aluminium.

The preparation of the aluminium-zinc-mercury alloy involves a special technique by which the addition of mercury into the alloy is brought about *without any loss of mercury during addition* and without affecting the stability of the alloy. For this purpose, a zinc-mercury amalgam containing 3 to 5% mercury is prepared in the first instance. To the molten aluminium which is kept at 700°C, this amalgamated zinc is slowly added and the melt thoroughly stirred to give a uniform alloy composition. The molten alloy is cast in the form of rods or sheet or to the required shape using graphite or cast iron dies.

The aluminium-zinc-mercury alloy thus prepared is stable and will not get passivated in neutral media like brine or sea water or alkaline or acidic soil when used as anode for cathodic protection of steel structures.

The main finding underlying the invention is that by incorporating the optimum amounts of mercury and zinc as mercury-zinc amalgam as described above in the molten aluminium and casting them to the required shape, a stable alloy having high electrode potential and high ampere hour capacity is obtained. Moreover, while incorporating mercury in the alloy as zinc amalgam, there is practically no loss of mercury.

According to the present invention, there is provided a process of making a stable alloy of aluminium, zinc and mercury for use as sacrificial anode for cathodic protection, the process comprising melting of aluminium to 700°C in a cast-iron or graphite crucible wherein a zinc mercury amalgam containing 3 to 5% mercury is added to the molten aluminium so as to incorporate 0.01 to 0.10% of mercury in the alloy and casting the resulting alloy to required shape.

The invention includes within its scope aluminium alloy compositions made by the process and having the ranges of concentrations as indicated below :

Mercury :	0.01-0.1%
Zinc :	0.5-15%
Aluminium :	Balance

The aluminium-zince-mercury alloy compositions described in this patent have open circuit potentials from-0.90 to-1.1 volts versus saturated calomel electode, giving anode effciencies ranging from 70-95% and having ampere hour capacity ranging from 2085 to 2892 ampere hours per kg in 3% sodium chloride.

The present invention thus provides aluminium alloys for use as anode for cathodic protection by alloying aluminium with small amounts of mercury and zinc having the following ranges of compositions and cast in the form of sheets or rods of any shape.

Mercury :	0.01-0.1%
Preferably	0.04 to 0.06% mercury
Zinc :	0.5-15%
Preferably :	1-5%
Aluminium :	Balance

The alloy is made by adding amalgamated zinc containing 3 to 5% mercury to the molten aluminium in a graphite or cast iron crucible and after constant stirring, the alloy is cast at 700°C in moulds of cast iron or graphite to the required shape.

Table 1 illustrates the anodic behaviour of different aluminium alloys including aluminium-zinc-mercury of the present invention and reveals the superiority of the aluminium-zinc-mercury alloy.

Table 1

ANODIC BEHAVIOUR OF ALUMINIUM BASED ALLOYS IN 3% SODIUM CHLORIDE

S.No.	Current density in mA/cm²	Potential of various types of alloys versues saturated calomel electrode in volts			
		Al-Zn-Hg	Al-Zn	Al-Zn-Sn	Al-Sn
1	0	-1.06	-0.98	-1.05	-0.98
2	1	-1.03	-0.97	-0.99	-0.95
3	2	-1.03	-0.97	-0.98	-0.95
4	3	-1.04	-0.965	-0.98	-0.95
5	4	-1.01	-0.95	-0.97	-0.95
6	5	-1.01	-0.945	-0.96	-0.94
7	6	-1.00	-0.94	-0.96	-0.93
8	7	-1.00	-0.925	-0.96	-0.93
9	8	-0.99	-0.925	-0.95	-0.93
10	9	-0.99	-0.925	-0.92	-0.93
11	10	-0.98	-0.92	-0.91	-0.86 to -0.7

SUMMARY

By adding small amounts of zinc and mercury to aluminium, alloys having satisfactory electrode potentials and pola-

risation behaviour suitable for use as galvanic anode for cathodic protection can be obtained. The aluminium-zinc-mercury alloy is prepared by adding amalgamated zinc to the molten aluminium and casting to the required shape.

We Claim :

1. A process of making a stable alloy of aluminium zinc and mercury for use as sacrificial anode for cathodic protection, the process comprising melting of aluminium to 700°C in a castiron or graphite crucible wherein a zinc mercury amalgam containing 3 to 5% mercury is added to the molten aluminium so as to incorporate 0.01 to 0.10% of mercury in the alloy and casting the resulting alloy to required shape.

2. A process for making a stable alloy of aluminium, zinc and mercury for cathodic protection substantially as herein before described.

PATENTS OFFICER,
Council of Scientific and Industrial Research.

Dated this 26th day of July, 1971.

Prabhat Press, Meerut/Patent/73—150.