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Corrosion inhibition study of sodium dodecyl benzene sulphonate to zinc-aluminium alloys in 1N HCl solution

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ABSTRACT

The corrosion inhibition of Zn-Al alloys are the subject of tremendous technological importance due to the increased industrial applications of these materials. This paper reports the results of weight loss measurements on the corrosion inhibition of Zn-Al, [(Zn-Al+2%Si) (Zn-Al+4%Si) (Zn-Al+6%Si)] alloys in 1.0 M HCl in the lab temperature using sodium dodecyl benzene sulphonate as an anionic surfactant (AS) inhibitor. The results showed that the addition of the surfactant inhibits the hydrochloric acid corrosion of the FourZn- Al samples. The inhibition occurs through adsorption of the surfactant on the metal surface without modifying the mechanism of corrosion process. The surfactant acts predominately as cathodic inhibitor. The inhibition efficiency increases with an increase in the surfactant concentration. Maximum inhibition is observed around its critical micelle concentration (CMC). The inhibition efficiency for the FourZn- Al samples decreases in the order: (Zn-Al+6%Si)> (Zn-Al+4%Si)> (Zn-Al+2%Si) >Zn-Al. (Al+6%Si)>(Al+6%Cu)>Al.. Results obtained from the this method are in good agreement.

KEYWORDS

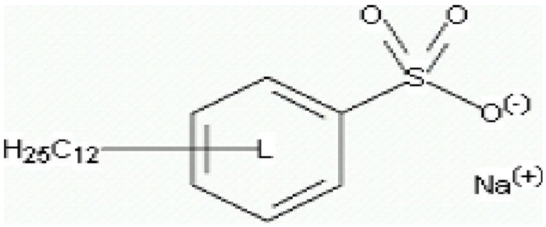
Corrosion;
Inhibition;
Weight loss;
Zinc-Aluminium samples;
Anionic surfactant.

INTRODUCTION

Designers get many advanced benefits in designing the components for automobile and aircraft industry through metal matrix composites (MMCs). These materials maintain good strength at high temperature, good structural rigidity, dimensional stability and light weight. The trend is towards safe usage of the MMC parts in the automobile engine which work particularly at high temperature and pressure environments. For the last two decades particulates reinforced MMCs has been the most popular.

Zinc-Aluminium alloy MMCs have most popular families being represented by ZA-27 alloy reinforced with ceramic particulates. By the addition of second phase into matrix material enhances not only physical and mechanical properties, but also change the corrosion behaviour significantly. In industries Zn-Aluminium alloys are used extensively with respect to their excellent fluidity, castability and mechanical properties. For the past few years Zn-Aluminium family of alloys has been used widely among zinc based foundry alloys. Zn-Aluminium alloys have got many advantages over the aluminium based ones, especially with respect to high strength with a low casting temperature. These alloys have very good tribological properties.

Structure of sodium dodecyl benzene sulphonate



EXPERIMENTAL PROCEDURE

Materials selection

Zn-Al alloy, which exhibits excellent casting properties and reasonable strength, was used as base alloy. This alloy is best suited for mass production of lightweight metal casting. The chemical composition of Zn-Al alloy is given in TABLE 1.

TABLE 1 : Composition of ZA-27.

Zinc	Copper	Magnesium	Aluminium
Balance	2-205%	0.01-0.02%	26-27%

SiC is used as reinforcement in the form of particulates.. It has got a layered structure. It has a specific gravity of 2.55, with hardness of 6.0 on the Mohr's scale.

Composite preparation

The liquid metallurgy route using vortex technique is employed to prepare the composites. A mechanical stirrer was used to create the vortex. The reinforcement material used was SiC particulates of size varying 50-80 μm. The weight percentage of SiC used was 2-6 weight percentage in steps 2%. Addition of SiC in to the molten Zn-Al alloy melt was carried out by creating a vortex in the melt using a mechanical stainless steel stirrer coated with alumina (to prevent migration of ferrous ions from the stirrer material to the zinc alloy). The stirrer was rotated at a speed of 450 rpm in order to create the necessary vortex. The SiC particles were pre heated to 200°C and added in to the vortex of liquid melt at a rate of 120 g/m. The composite melt was thoroughly stirred and subsequently degassed by passing nitrogen through the melt at a rate 2-3 l/min for three to four minutes. Castings were produced in permanent moulds in the form of cylindrical rods. [Diameter 30mm and length 150mm] The material was cut into 20x20mm pieces using an abrasive cutting wheel. The matrix alloy also cast under identical conditions for comparison.

Specimen preparation

The samples were successively ground using 240, 320, 400 and 600 SiC paper and were polished according to standard metallographic techniques and dipped in acetone and dried. The samples were weighed up to fourth decimal place using electronic balance and also the specimen dimensions were noted down using Vernier gauze.

Corrosion test

The corrosion behaviour of Zn-Al alloy was studied by immersion test. The static immersion corrosion method was adopted to measure the corrosion loss. Acid chloride corrodent was used to characterize the corrosion behaviour. 1M hydrochloric acid was used for this purpose. 200 ml of the prepared solution was taken in a beaker. Samples were suspended in the corrosive medium for different time intervals up to 96 hours in the steps of 24 hrs. Add sodium dodecyl benzene sulphonate in terms of ppm. To minimize the contamination of the aqueous solution and loss due to evaporation, the beakers were covered with paraffin paper during the entire test period. After the specified time the samples were cleaned mechanically by using a brush in order to remove the heavy corrosion deposits on the surface. The corresponding changes in the weights were noted. At least three samples were tested and average value was taken. Corrosion rates were computed using the equation

Corrosion rate: = 534 W/DAT mpy

where W is the weight loss in gms, D is density of the specimen in gm/cc, A is the area of the specimen (inch^2) and T is the exposure time in hours.

RESULTS AND DISCUSSION

Effect of test duration

The corrosion rate mpy measurement as a function of exposure time in the static immersion test is shown in

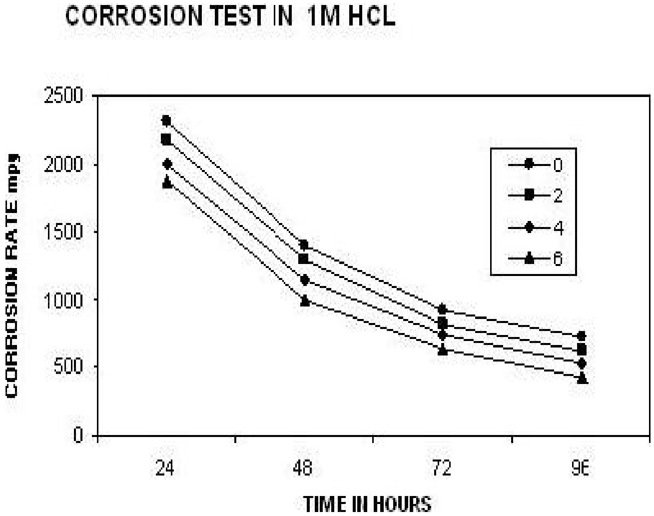


Figure 1 : gives the corrosion rate of composites with different percentage of SiC composites reinforced with SiC particulates

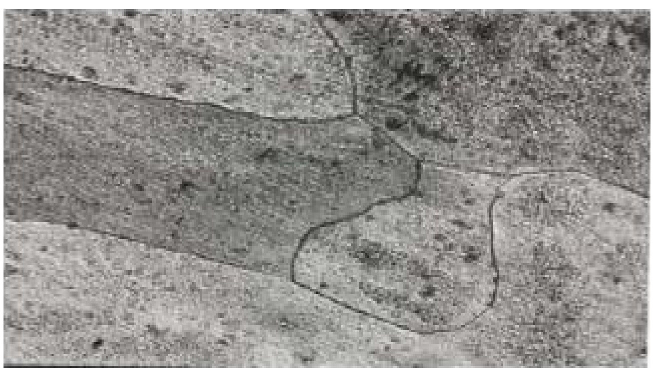


Figure 2 : Micrograph of Zn-Al + 2%SiC After Corrosion test

the Figure 1. The trend observed in all the cases show decrease in corrosion with increase in test duration. It is clear from the graph that the resistance of the composite to corrosion increases as the exposure time increases. This eliminates the possibility of hydrogen bubbles clinging on to the surface of the specimen and forming a permanent layer affecting the corrosion process. The phenomenon of gradually decreasing corrosion rate indicates the possible passivation of the matrix alloy. De Salazar explained that the protective black film consists of hydrogen hydroxy chloride, which retards the forward reaction. Castle et. al. pointed out that the black film consists of aluminium hydroxide compound. This layer protects further corrosion in acid media. But exact chemical nature of such protective film still is not determined.

Effect of SiC content

From the Figure 1 it can be clearly observed that for both as cast and composite, corrosion rate decreases monotonically with increase in SiC content. In the present case, the corrosion rate of the composites as well as the matrix alloy is predominantly due to the formation of pits and cracks on the surface. In the case of base alloy, the strength of the acid used induces crack formation on the surface, which eventually lead to the formation of pits, thereby causing the loss of material. The presence of cracks and pits on the base alloy surface was observed clearly. Since there is no reinforcement provided in any form the base alloy fails to provide any sort of resistance to the acidic medium. Hence the weight loss in case of unreinforced alloy is higher than in the case of composites.

SiC being the ceramic remains inert and is hardly affected by acidic medium during the test and is not expected to affect the corrosion mechanism of the composite. The corrosion result indicates an improvement in corrosion resistance as the percentage of SiC particulates increased in the composite, which shows that the SiC particulates directly or indirectly influence the corrosion property of the composites. B.M.Sathish et.al. who obtained similar results in glass short fiber reinforced Zn-Al alloy composites reported that the corrosion resistance increases with increase in reinforcement.

Wu.Jinaxin et.al in their work on corrosion of aluminium based particulate reinforced MMCs, state that the corrosion is not affected to a significant extent by the presence of SiC particulates in aluminium, where as the particulates definitely play a secondary role as a physical barrier as far as MMC corrosion characteristics are concerned. A particulate acts as a physical barrier to the initiation and development of corrosion pits and also modifies the microstructure of the matrix material and hence reduces the rate of corrosion.

CONCLUSION

The SiC content in Zn-Al alloys plays a significant role in the corrosion resistance of the material. Increase in the Cocentration of sodium dodecyl benzene sulphonate will be advantageous to reduce the density and increase in the strength of the alloy, but the corrosion resistance is thereby significantly reduced.

Zn-Al MMCs when reinforced with SiC of weight percentage from 0 to 6 percent could be successfully produced by liquid melt metallurgy technique.

The rate of corrosion of both the alloy and composite decreased with increase in time duration. The corrosion rate of the composites was lower than that of the corresponding matrix alloy.

REFERENCES

[1] B.M.Girish et.al.; Journal of Mateials Engineering and Performance, **8(3)**, 309-314 **(1999)**.

[2] B.M.Satish et.al.; Material and Design, **17(5/6)**, 245-250 **(1996)**.

[3] P.Reynaud; Composite Science and Technology, **56**, 809-814 **(1996)**.

[4] S.C.Tjong, Z.Y.Ma; Composite Science and Technology, **57**, 697-702 **(1997)**.

[5] H.Akubulut, M.Durman, F.Yilnaaz; Materials Science and Technology, **14**, 299-305.

[6] E.Koya, Y.Hagiwara, S.Miura, T.Hayashi, T.Fujiwara, M.Oneda; Society of Automotive Engines, Inc., 55-64 **(1994)**.

[7] M.K.Aghajanian, G.C.Atland, P.baron-Antolin, A.S.Nagelberg; Society of Automotive Engines, Inc., 77-81 **(1994)**.

[8] M.A.Dellis, J.P.Keusternas, F.Delannay, J.Wergia; Mater.Sci.Engg., 135-253 **(1991)**.

[9] R.J.Barnhurst, K.C.Farge; in Proceedings of international symposium on Zinc-Aluminium, ZA Casting Alloys Ed., G.P.Lewis, R.J.Barnhurst, C.A.Loong, CIM, Toronto, 85 **(1986)**.

[10] S.H.J.Lo, S.Dionne, M.Sahoo, H.M.Hatrone; J.of Mater.Sci., **27**, 5681-5691 **(1992)**.