Corrosion Studies on Al-10Si-TiB_2 Composites Produced through Stir Casting Method

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Abstract—*The present work deals with the corrosion test that demonstrates the effect of immersion time on weight loss of Al-10Si-TiB_2 composites. The weight losses were recorded at regular intervals of 2, 4, 6, 8, and 10 hrs in standard solutions of 5% HCl and 95% water, 10% HCl and 90% water and 15% HCl and 85% water. Increasing concentration of HCl has increased the corrosion rate, Composites exhibit better corrosion resistance than the alloy of similar composition. Increased severity of the media enhances the corrosion attack on the alloy to a greater extent than the composite of similar composition.*

Keywords— Al-10Si alloy, TiB_2, Corrosion, HCl solution.

I. INTRODUCTION

Corrosion is defined as destruction and consequent loss of a material either by chemical or electrochemical or metallurgical reaction of material with the environment. Corrosion is one of the most serious problems of the industry and causes heavy economic losses. Worldwide studies have shown that the overall cost of corrosion amounts to at least 4 –5% of the gross national product and that 20 – 25% of this cost could be avoided by using appropriate corrosion control methods [1]. In general corrosion products exist as a thin adherent film which merely stains or tarnishes the metal and may act as a retardant to further corrosive action. In other cases, the products of corrosion are bulky and porous in character, offering no protection. Corrosion is a complex problem about which a great deal of information is known. Despite extensive research and experimentation, there is still a lot to learn. In some cases, such as direct chemical attack, corrosion is highly obvious, but in other cases, such as inter granular corrosion, it is less obvious but just as damaging. The basic cause of corrosion is the instability of metals in their refined forms. The metals tend to revert to their natural states through the processes of corrosion. Extensive studies have been carried out on corrosion behaviour of aluminium base metal matrix composites with different types of reinforcements in the last two decades. Madhusudan. S et al [2] Corrosion studies of Al-Cu particulate composites produced through liquid metallurgy route is comparable to that of Al-Cu alloy and is superior to the base alloy. J Bienias et al [3] has studied the corrosion behavior of aluminium flyash composites in NaCl environment. Results show that flyash particles lead to an enhanced pitting corrosion of the AK12-9% flyash composite in comparison with unreinforced matrix, AK12 alloy. Marko et al [4] reported the investigations on the corrosion resistance of Al / SiC composites. The results of the investigation show that the conventional unreinforced AlSi7Mg1 alloy has a better corrosion in both H_2O aired and 3.5% NaCl corrosion media. The best corrosion resistance is obtained in a 3.5% water solution of NaCl, a corrosion medium that is comparable with aggressive sea water. Investigations showed that corrosion cracking did not occur as a result of stress corrosion. S Das [5] have studied the erosive-corrosive wear of Al-SiC composite using rotating sample test method in three different slurries namely 3.5% Nacl, 3.5% NaOH and synthetic mine water. Reports reveal that the corrosion resistance of the composite is comparable to the base alloy irrespective of the corrosive media. As the erosive corrosive wear is dominated by erosive wear; rate of the composite is noted to be less than that of alloy. VG Grechanyuk et al [6] studied the corrosion resistance of Copper-Molybdenum composites by gravimetric method. Results have shown that in Copper–Molybdenum condensate materials in neutral medium, the corrosion processes take place according to the electrochemical mechanism. Condensates where Mo concentration does not exceed 5% feature better corrosion resistance. The thermal stability decreases when Mo is introduced into the copper matrix, and large variations are noticed with Mo concentration over 5%. M Ramachandra and K Radhakrishna [7] investigated the corrosive wear of Al-SiC composite. It was reported that addition of SiC particles decreased the corrosion resistance and pitting corrosion was the dominant mechanism. Mykloas Gladkovas et al [8] investigated on corrosion aspects of nickel with B_4C, Al_2O_3 and SiC in neutral and acid salt fog. The present report deals with the Al-10Si-TiB_2 composites and the influence of TiB_2 reinforcement on corrosion properties of the Al-10Si alloy.

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II. EXPERIMENTAL PROCEDURE

2.1 Corrosion behaviour

Standard samples of 33 x 22 mm Φ are thoroughly polished to give a uniform smoothness. Samples are thoroughly degreased using mild soap and washed with distilled water. Samples are placed in desiccators. Standard solutions of 5% HCl, 10% HCl and another solution 15% HCl were prepared. Samples were placed for corrosion studies in 250 ml solution, keeping a minimum distance of 1 inch between them; figure 4.1. Samples, taken out at regular intervals of 2 hr, 4hr, 6hr, 8hr and 10hrs were thoroughly washed with distilled water. After through drying and cleaning with alcohol, loss in weight is measured with an electronic balance (Model: Wensar PGB 200 India).

III. RESULT AND DISCUSSION

3.1. Corrosion behaviour

Fig.1shows the effect of immersion time on weight loss in solution having 5% HCl. Both alloy and the composite with same concentration of TiB_2, show a similar trend of dissolution, i.e. a gradual increase in weight loss with time. However, composites show a better resistance towards dissolution than the alloy. Presence of fine Al_2O_3 layer on the overall composite reduces this effect further, resulting in reduced dissolution.

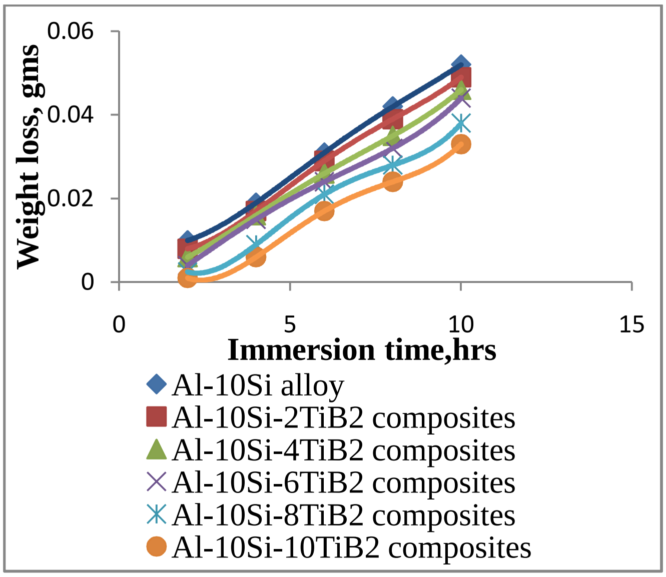

Fig.1 Effect of corrosion time on weight loss, Al-10Si Alloy, TiB_2 composites of 5% concentration of HCl

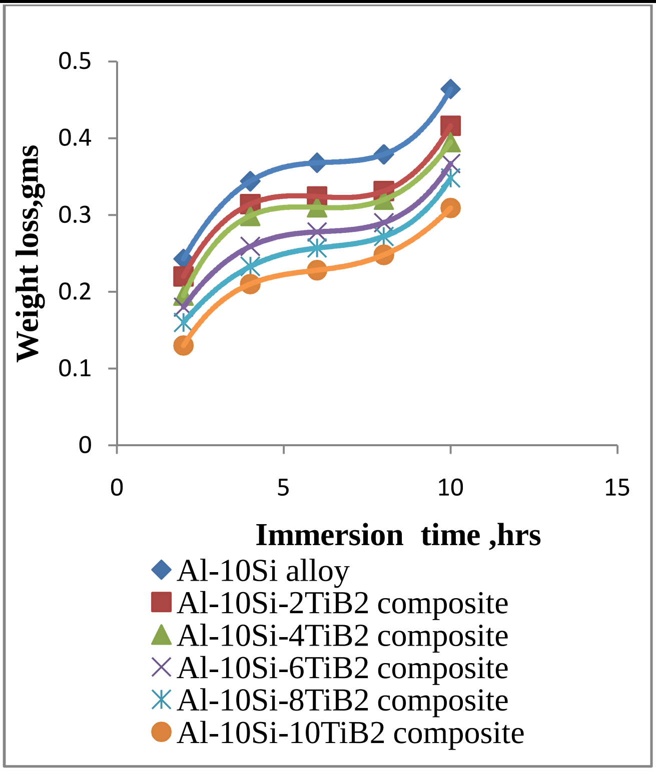

Fig.2 Effect of corrosion time on weight loss, Al-10Si Alloy, TiB_2 composites of 10% concentration of HCl

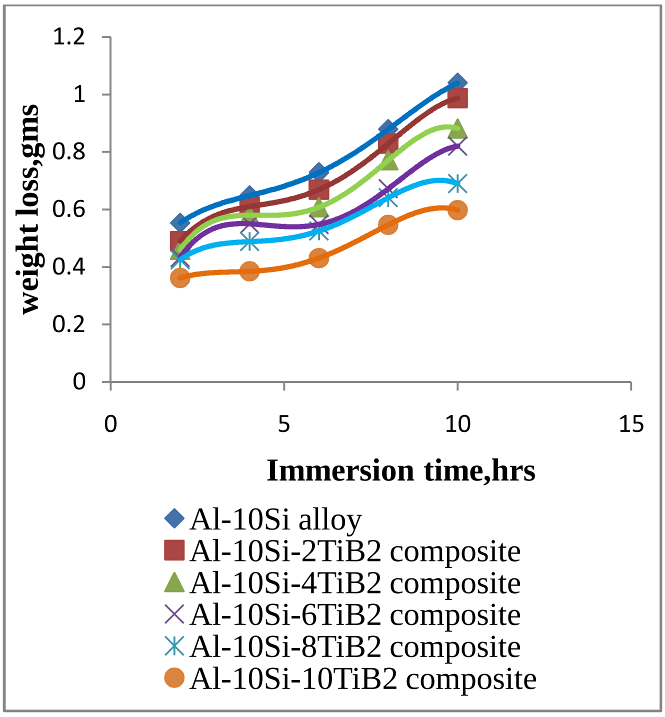

Fig.3 Effect of corrosion time on weight loss, Al-10Si Alloy, TiB_2 composites of 15% concentration of HCl

Further increased in concentration of 10%HCl and increase in TiB_2 contents with the composites has shown increased dissolution amounts, Both alloy and the composite with same concentration of TiB_2, show a similar trend of dissolution, i.e, a gradual increase in weight loss with time. Fig.2 on further increase in TiB_2 contents (Al-10Si-10TiB_2 composite), agglomeration of particles results in formation of Al-10Si rich alloys locally, which in turn enhances localized corrosion. The same can be seen with increased concentration of 15% HCl increased rates of dissolution, Fig.3.

Fig.4 depicts the dissolution behavior of the Al-10Si alloy and the TiB_2 composite having the same composition at different solution concentrations 5% HCl and 10% HCl. The severity of corrosion increases with increase in chloride concentration. Both The Al-10Si alloy and TiB_2 composites respond in a similar fashion. At higher concentration of 10% HCl, the severity of the corrosive attack is more severe with the Al-10Si alloy than the TiB_2 composites.

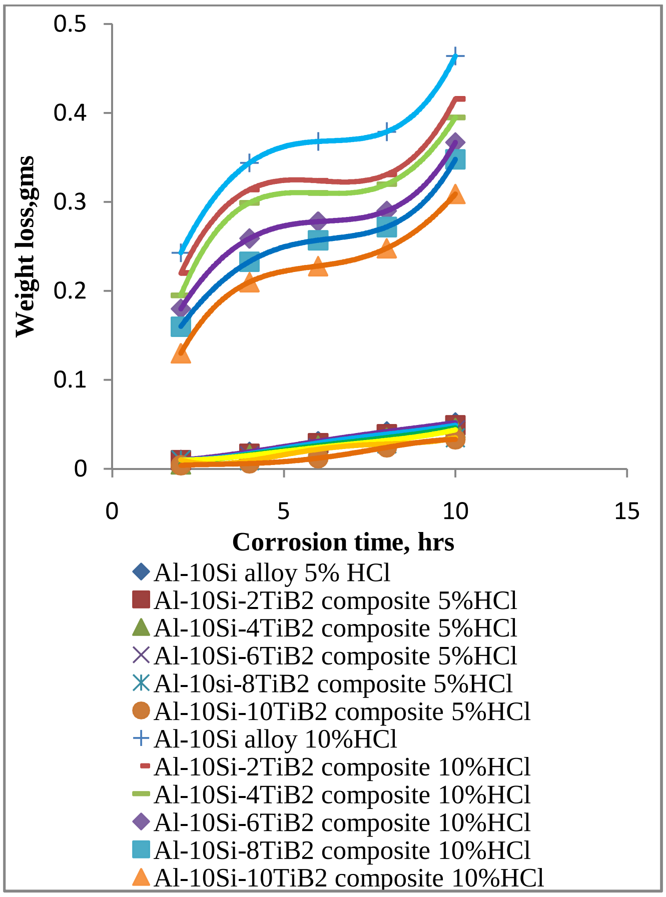

Fig.4 Effect of concentration variation on weight loss, Al-10Si alloy and TiB_2 composites

Fig.5 shows the dissolution behaviour of the Al-10Si alloy and the TiB_2 composites at different solution concentrations 10% HCl and 15% HCl. Both the alloy and the composite respond in a similar trend of dissolution. The same can be seen with increased concentration of 15% HCl i.e increased corrosion rates of dissolution, At higher concentration of 15% HCl, the severity of the corrosive attack is more severe with the Al-10Si alloy and 10% TiB_2 composite showed lower corrosion rate. Localized corrosion occurs between the intermetallic particles, matrix and the interface between them. The earlier discussion holds for this kind of behavior as the corrosive attack on Al-10Si alloy is more severe at higher concentrations than passive Al_2O_3 layer on TiB_2 composites. Both Al-10Si alloy and the TiB_2 composites exhibit a similar behavior at higher concentration of chloride ions.

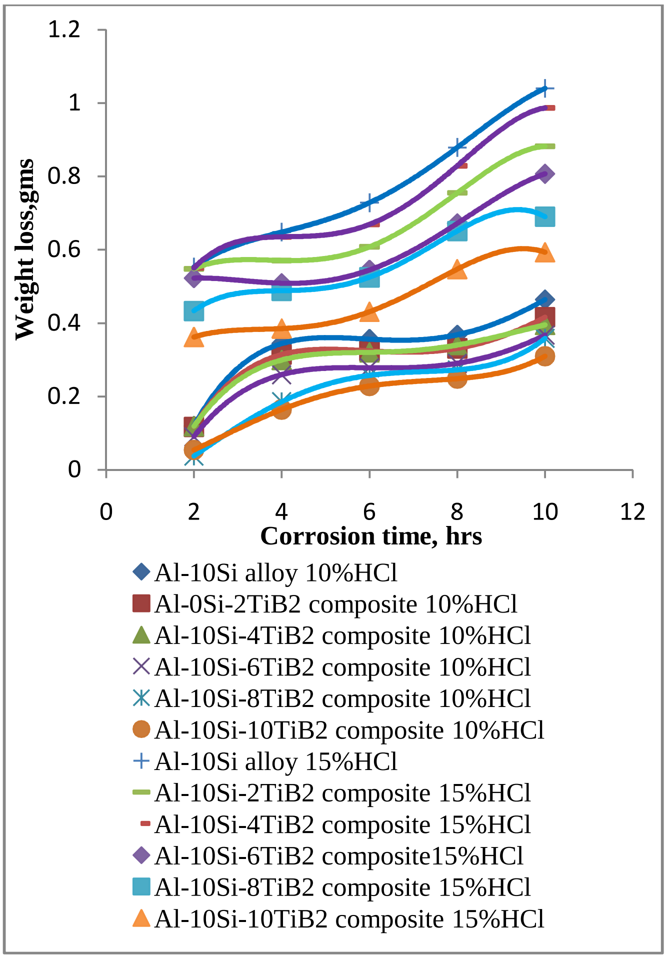

Fig.5 Effect of concentration variation on weight loss, Al-10Si alloy and TiB_2 composites

IV. CONCLUSIONS

1. TiB_2 composites exhibit better corrosion resistance than the base Al-10Si alloy.
2. Al-10Si alloy exhibit higher corrosion rates than the TiB_2 composites, in all the 5% HCl, 10% HCl and 15% HCl solutions.
3. Increasing concentration of HCl has increased the corrosion rate. Hence the alloy and composites are preferred as suitable corrosion resistant materials for 5% HCl solutions.
4. Formation of alumina layer on the surface of the TiB_2 composites enhances the corrosion resistance.
5. Presence of intermetallics is the main reason for the corrosion of the Al-10Si alloy.

6. In case of composites, chances of formation of intermetallics are very much restricted due to thin layer of alloy formation.
7. Agglomeration due to increased particulate TiB_2 contents further decreases the corrosion of the composites.

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