INTRODUCTION

Attention in the coastal region has shifted considerably from conventional to newly emerging engineering material in recent years. Aluminum alloys used for seawater applications because of their good combination of mechanical strength, formability, corrosion resistance and cost advantages[1-2]. One major reason that led to intensified research activity was the unprecedented growth of desalination plants in coastal areas, which has the highest population density of desalination plants in the world. Aluminium alloys reinforced with SiC belong to a new generation of metal matrix composites (MMCs) which have been developed for weight-critical functions in aerospace, defense, and structural applications[3-4]. Alloy Al/SiC was developed to obtain more attractive mechanical properties than its competitor Al alloys. Research efforts have largely been concentrated on the physical and mechanical characteristics and thermo-mechanical treatment of the alloy, without any recourse to its corrosion behavior, which is a vital parameter in assessing its application potential as a structural materials [5-6]. However their mechanical property degradation due sea water degradation has not been investigated. Therefore, it is the purpose of this work to investigate mechanical properties of Al/SiC composites after different expose time 3.5% NaCl solution.

EXPERIMENTAL STUDIES

Table. 1 Chemical composition of Al6061 and garnet by wt. %

<table>
<thead>
<tr>
<th>Al6061 alloy</th>
<th>Mg</th>
<th>Si</th>
<th>Fe</th>
<th>Cu</th>
<th>Ti</th>
<th>Cr</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.92</td>
<td>0.76</td>
<td>0.28</td>
<td>0.22</td>
<td>0.10</td>
<td>0.07</td>
</tr>
<tr>
<td>Al6061 alloy</td>
<td>Zn</td>
<td>Mn</td>
<td>Be</td>
<td>V</td>
<td>Al</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.69</td>
<td>0.04</td>
<td>0.003</td>
<td>0.01</td>
<td>Bal.</td>
<td></td>
</tr>
</tbody>
</table>

Al-6061, which exhibits excellent casting properties and reasonable strength, was selected as the base alloy. The chemical composition of the Al-6061 alloy is given in Table 1. SiC of size 30 to 50 μm, was cleaned in distilled water and dried at 90°C. A liquid metallurgy technique was used to fabricate the composite materials in which the SiC were introduced into the molten pool through the vortex created in the molten metal by the use of an alumina-coated stainless steel stirrer. The coating of alumina on the stirrer is essential to prevent the migration of ferrous ions from the stirrer material into the molten metal. The stirrer was rotated at 550 rpm and was immersed to about one-third of depth of the molten metal pool from the bottom of the crucible. The pre-heated (500°C) SiCp were added into the vortex of liquid melt, which was then degassed using pure nitrogen for about 3 to 4 min. The resulting mixture was tilt poured into preheated permanent mould. SiCp was varied from 5 to 15% in steps of 5% by weight.

The tensile specimens of diameter 8.9 mm and gauge length 76mm were machined from the cast composites with the gauge length of the specimen parallel to the longitudinal axis of the castings. Five specimens were tested and the average values of the ultimate tensile strength (UTS) and ductility (in terms of percentage elongation) were measured. Tensile specimens were immersed in 250 ml of 3.5% NaCl solution for durations of 10 and 90 days of interval of 10 days.. After each exposure test, the specimens were then immersed in Clark’s solution for 10 minutes and gently cleaned with a soft brush to remove scales adhered to the surface of the specimens. After exposure the tensile and compression tests were conducted on 20T. Shimadzu universal testing machine. For each of the parameters mentioned at least ten samples were employed to ensure reliable results. Al/SiC MMCs and Al alloy specimens were also tested as a control alloy for comparison. The experimental procedures were identical to those for the composite material.
3. RESULTS AND DISCUSSION

3.1 Corrosion rate

Fig. 1 shows the corrosion wt. loss (% of weight loss) versus the seawater immersion times. In all the cases, however, rate of corrosion loss were seen to increase with immersion time. Overall results in terms of maximum percentage weight loss, over the 90 days period of investigation. The percentage of corrosion wt. loss with time is far greater in case of Al matrix alloy than that of Al/SiC composites. Both types of base alloy and composites showed saturation for corrosion rate. Since the saturated levels of corrosion rate take dictates the property degradations in the materials employed for underwater applications, Al/SiC MMCs proved superiority over based specimens.

3.2 EFFECT OF SEA WATER UP TAKEN ON TENSILE STRENGTH

UTS, MPa

Fig. 2 shows change in UTS of Al and Al/SiC composites with respect to different seawater exposure times. Though all types of specimens showed drop in UTS with respect to immersion time because of corrosion, Al/SiC composites showed lower levels of degradation. Whereas Al matrix and lower percentage Al/SiC specimens showed a drop of 48% in UTS strength for an exposure time of 90 days, the same was 28 % in case of Al/15 wt.% of SiC composites.

In this work, it was found that the corrosion environments reduced the mechanical strength of the alloys and its composites. It is known that the corrosion takes place in three stages including surface pitting, crack formation and crack propagation [7]. The corrosion pits form on the surface of the specimen in the first stage of crack initiated and act as stress concentration sites giving rise to crack formation and propagation [8]. Such cracks were observed on the cylindrical surface of the specimens tested in acid solution.

It is also known that both mechanical and environmental elements act jointly in corrosion tensile and produce a result that is more severe than that obtained by either of these acting alone [9]. This means that crack grows faster in corrosive environments than in air [10]. On the other hand, the corrosion resistance of Al alloys increases with increasing % of reinforcement content. Dissolution of Al results in formation of surface pitting and reduction in the cross sectional area of the fracture specimens. Both effects can greatly reduce the mechanical strength of the alloys. However, no chemical reaction that gives rise to the dissolution of the metal takes place in salt water. Therefore this environment is expected to be less effective on the mechanical behaviour of the alloys. This observation, which shows the sensitivity of Al to these environments, may be explained in terms of free energy change of dissolution of alloying elements. It is known that corrosion rate of metals depends on the free energy change. The change in free energy for dissolution of Al is greater than that for other elements [9]. It is also known that the corrosion rate of metals increases with increasing absolute value of the free energy change [10]. Therefore, high Al content gives rise to high corrosion rate. On the other hand metallographic observations suggest that the cracks initiate and propagate along the interdendritic regions of the alloys. In this work, it was also found that the corrosion degradation factor of the alloys increased as their reinforcement content increased.

4. CONCLUSIONS

The corrosion rate, UTS properties of vinyl Al and Al/SiC composite have been studied. Al/SiC MMCs showed lower values of saturation with respect the percentage of corrosion rate take corresponding to different exposure times than that of Al matrix alloy. The drop in tensile strength in case of MMCs were lower than that of matrix alloy. Tensile strength showed significant degradation followed by stability for the both Al and Al/SiC MMCs as corrosion rate continued toward saturation.

The results showed that the corrosion penetration along the reinforcement/matrix interfaces caused interfacial debonds leading to rupture or degradation of the interface.

REFERENCES

Corrosion of Particulate-Reinforced Aluminum-Matrix Composites and Monolithic Aluminum Alloy Journal of The Electrochemical Society, 156

