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Corrosion Characterization of Aluminium 7075 / Beryl Metal Matrix Composites in Mixture of Sodium Chloride and Sodium Hydroxide

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ABSTRACT

Composite materials are finding their usage broadly in the field of mechanical and automobile engineering. They are manufactured by different methods. Their properties can be tailored with respect mechanical and corrosion studies. In this paper metal matrix composites containingAluminium 7075 as matrix alloy and beryl particulates as reinforcement are manufactured by stir casting method and subjected to corrosion behaviour test by static weight loss method in three different concentrated solution mixtures containing sodium chloride and sodium hydroxide. The results indicated that the composite materials exhibit improved corrosion behaviour when compared to matrix alloy. Hence it is recommended that the composite materials are more suitable for the applications instead of matrix alloy.

KEY WORDS:Aluminium 7075, Beryl, Stir casting, Static weight loss.

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INTRODUCTION

Metal Matrix composites with decreased density are in demand in recent days due to their improved mechanical and corrosion resistance. By selecting suitable cheap reinforcements the density and weight of composite materials can be reduced and applications with respect to automobile and air craft industries can be recommended. Aluminium alloys with various compositions are very much in demand due to their exploration with respect to various mechanical propertoies.[1] many researchers have tried basalt fibre in the manufacture of polymer matrix composites and obtained good results in mechanical properties determinations.[2-4] HosurNanjireddy Reddappa[5] et al studied the mechanical properties and wear behaviour of Aluminium 6061 metal matrix composites reinforced with beryl particulates. Improved results were obtained by them with respect to the properties mentioned above. H V Jayaprakash[6] et al studied the stress corrosion behaviour of Aluminium 7075 / Beryl metal matrix composites in hydrochloric acid medium with different concentration at various time of exposure at different temperature. They report that in all the concentrations of hydrochloric acid the corrosion resistance of the composites were very high when compared to matrix alloy at various temperature and exposure time. Extensive literature survey reveal that static weight loss corrosion test of Aluminium 7075 alloy reinforced with beryl particulates in different concentrations of mixtures of sodium chloride and sodium hydroxide have not been studied so far.

EXPERIMENTAL PROCEDURE

Material selection

The matrix selected is AL7075 alloy; it is an important alloy of aluminium available commercially. Its composition is given in table 1.

Table 1: Composition (%) of Aluminium 7075 alloy

Element	Cu	Cr	Mn	Mg	Si	Ti	Zn	Fe	Al
Percentage	1.8	0.2	0.4	1.9	0.5	0.15	3.25	0.5	Bal

Beryl particulates which is naturally occurring mineral and having the formula $[Be_2Al_2(SiO_3)_6]$ is used as reinforcement. They have a density of 2.6 - 2.8 g/mm3 which is almost on par with that of Aluminium 7075 and has hardness of 7.5 to 8 on Mho's scale and a hexagonal structure.50-80 μm size beryl particulates are used in this study. The chemical composition of beryl particulates is given in table2.

Table 2: Composition of beryl particulates

SiO_2	Al_2O_3	BeO	Fe_2O_3	CaO	MgO	Na_2O	K_2O	MnO
65.4	17.9	12.3	0.8	1.34	0.48	0.55	0.004	0.05

Both matrix alloy and reinforcement are available commercially.

Preparation of composites

The liquid metallurgy route using vortex technique used by P.V Krupakara[7] is employed to prepare the composites. A mechanical stirrer was used to create the vortex. The reinforcement material used was red mud particulates of size varying 50-80 µm. The weight percentage of beryl used was 2-6 weight percentage in steps 2%. Addition of beryl particulates in to the molten Aluminium 7075 alloy melt is carried out by creating a vortex in the melt using a mechanical stainless steel stirrer coated with aluminite (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 beryl particles were pre heated to 200°C and added in to the vortex of liquid melt at a rate of 120 g/m[8]. 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. Matrix alloy was also casted in the same way for comparison.

Specimen preparation

Bar castings of composites and matrix alloy obtained from the manufacture of composites are subjected to machining in order to get cylindrical specimens of size 20mm x 20mm.

Test conducted

Static weight loss corrosion tests were conducted in 0.025, 0.05 and 0.1 molar solutions of mixtures of sodium chloride and sodium hydroxide.

Static weight loss corrosion test

The corrosion behaviour of Al7075 alloy and its composites reinforced with beryl particulates was studied by immersion test. The specimens were suspended in the corrosive medium for different time intervals up to 96 hours in steps of 24 hours. To minimize the contamination of the aqueous solution and loss due to evaporation, the containers 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. Then corrosion rate is calculated using the formula given below

Corrosion rate: 534W/DAT mpy[9]

Where w is the difference between the initial weight and final weight i.e., weight loss, D is the density of the alloy, A is the area exposed in square inch and T is time of exposure in hours.

RESULTS AND DISCUSSION

Figures 1-3 are the computer simulations of the static weight loss corrosion tests of Aluminium 7075 / Beryl composite materials in 0.025, 0.05 and 0.1 molar solutions of mixture of sodium chloride and sodium hydroxide.

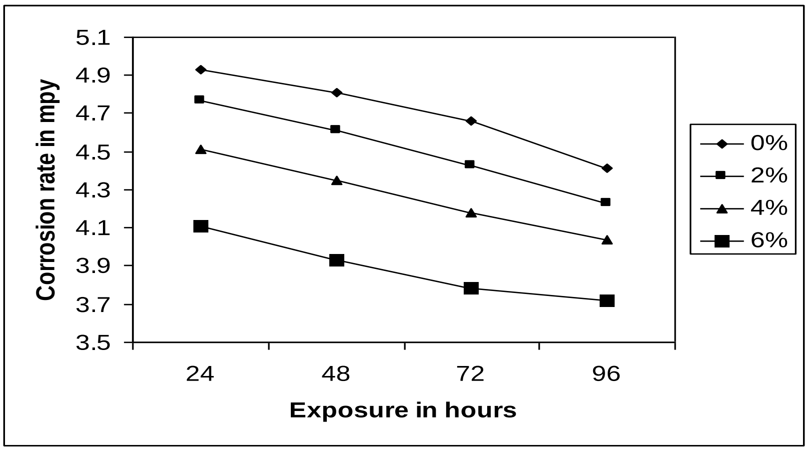
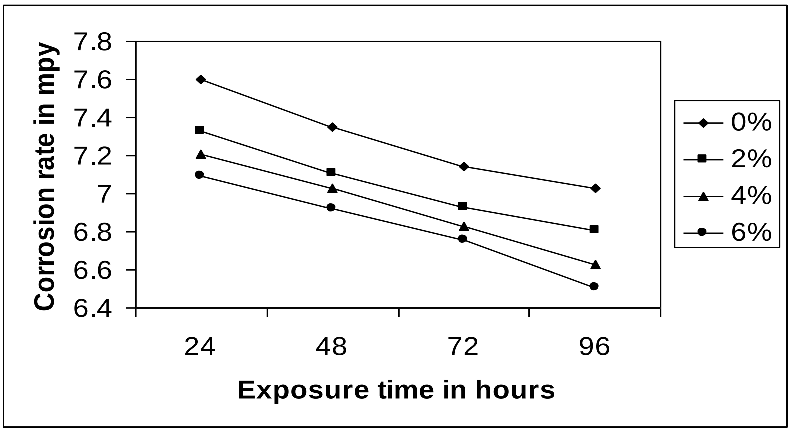


Fig 1:StaticWeightLoss Corrosion Test in 0.025 M NaCl + NaOH



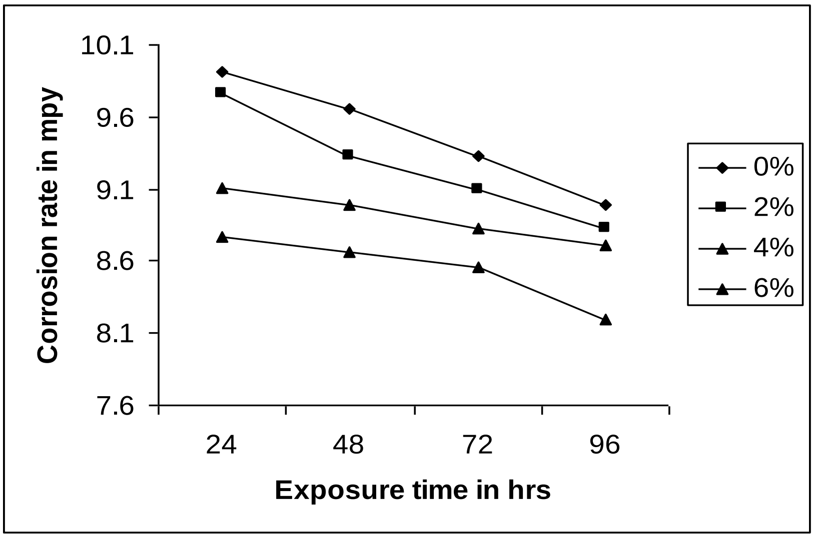


Fig 3: Static Weight Loss Corrosion Test in 0.1 M NaCl + NaOH

From the above graphs it is clearly observed that as the time of exposure goes on increasing the corrosion rate decreases in all the composites and matrix alloy.

EFFECT OF TIME OF EXPOSURE ON THE RATE OF CORROSION

The results shown in the graphs 1 to 3clearly explains that for each composite as well as for unreinforced aluminium 7075 alloy the corrosion rate is found to decrease with increase in time of exposure. The decrease in corrosion rate is due to development of passive nature of the matrix alloy.

Physical inspection of the specimens revealed there is a presence of a black film. The composition of the black film was found to be aluminium hydroxidewhich covers the surface of the alloy and composites. Hence aluminium hydroxide layer acts as a passive layer. Since the passive layer acts as a barrier between the fresh metal surface and the corrosive media, it avoids the direct contact between the specimen and the corrosive media, thus further dissolution of the metal alloy would not takes place.[10]

EFFECT OF BERYL PARTICULATES AS REINFORCEMENT

From graphs 1 to 3, it is clear that all the tested specimens' exhibit decreased corrosion rate with increase in reinforcement content. The corrosion rate exhibited by matrix alloy is higher than those in the beryl particulates reinforced composites. This is due to the fact that in alloys there is a direct contact between the alloy surface and the corrosive media, thus alloy dissolution increases, as alloy does not exhibit much resistance to the action of acid medium.

K.N.Chandrashekara[11] et al obtained similar results for the composites made up of Aluminium 6013 / Red mud when static weight loss corrosion tests were conducted in sodium chloride medium. They report that the inert nature of the reinforcement will definitely decrease the exposure of the matrix alloy surface and there by decreases corrosion rate.Vinutha K[12] also report that when titanium diboride reinforced ZA-27 alloy metal matrix composites were subjected to static weight loss corrosion test in sodium chloride medium the corrosion rate of the composites decreases with increase in reinforcement content. Because reinforcement in a ceramic material and is not attacked by any acid, base or salt solutions.

CONCLUSION

- Metal matrix composites of Aluminium 7075 matrix alloy containing 2, 4 and 6 weight percentage of beryl particulates were manufactured by liquid melt metallurgy technique using vortex method.
- Matrix and composites specimen were subjected to static weight loss corrosion test in 0.025, 0.05 and 0.1 molar solutions of mixtures of sodium chloride and sodium hydroxide,
- In all the concentrations of the solution mixtures of sodium chloride and sodium hydroxide the corrosion rate decreased with increase in time of exposure.
- As the reinforcement content increased in the matrix alloy the corrosion rate decreased when compared to matrix alloy.
- Composite materials are more suitable than matrix alloy in applications.

REFERENCES

1. Karthigeyan,R.,Ranganath, G., and Sankaranarayanan,S., Mechanical Properties and Microstructure Studies of Aluminium (7075) Alloy Matrix Composite Reinforced with Short Basalt Fibre,EuropeanJ.l of Sc. Research,2012; 68(4): 606-615
2. S. EzhilVannan and Paul VizhianSimson, Corrosion Behaviour of Short Basalt Fiber Reinforced with Al7075 Metal Matrix Composites in Sodium Chloride Alkaline Medium, J. Chem. Eng. Chem. Res.2014; 1(2): 122-131
3. Jen˝oSándor SZABÓ, Zoltán KOCSIS and Tibor CZIGÁNY, Mechanical Properties of Basalt Fibre Reinforced pp/pa Blends,Periodicapolytechnica ser. Mech. Eng. 2004; 48(2): 119–132.
4. Lopresto,V., Leone,C., De Iorio,I., Mechanical Characterization of Basalt Fibre Reinforced Plastic Composites:,Part B2011; 42: 717–723.
5. HosurNanjireddyReddappa, KitakanurRamareddy Suresh , HollakereBasavarajNiranjan, KesturGundappaSatyanarayana, Studies on Mechanical and Wear Properties of Al6061/Beryl Composites J. of Minerals and Materials Characterization and Engg, 2012; 11: 704-708
6. Jayaprakash,H.V.,Naddoni Sachin Govind, Krupakara,P.V,. Stress Corrosion Behaviour of Aluminium7075/Beryl Composites, International J. for Research in Applied Science &Engg Technology (IJRASET), 2017; 5(XII): 450-454
7. Krupakara, P. V., Corrosion Characterization of Al6061/Red Mud Metal Matrix Composites, PortugaliaeElectrochimicaActa 2013; 31(3): 157-164
8. Wang, A., and Hutchings,I. M., Wear of Alumina Fiber: Aluminum Metal Matrix Composite by Two Body Abrasion, Materials Science and Technology, 1989; 5(1): 71-76.
9. Fontana,M.G., Corrosion Engineering, McGraw Hill Book Company Inc., New York, 1987; 28-115.
10. Trzskoma, “Localized Corrosion of Metal Matrix Composites. Environmental Effects on Advanced Materials”, Ed. By R. H. Jones and R.E Ricker. The Minerals, Metals & Materials Society.1991; 249-265.
11. Chandrashekar,K.N.,Narasimha Murthy,Dr.B.,Krupakara,Dr.P.V., “Studies on Corrosion properties of Aluminium 6013/Red Mud Metal matrix composites in Sodium Chloride and sodium hydroxide Medium”, International journal of Engineering Science and Computing, 2017; 7(5): 11826-11830
12. Vinutha, K,Krupakara P V, Somashekariah, B.V., Radha, H.R.“Electrochemical Studies of ZA-27 / TiO_2 Metal Matrix Composites in Sodium Chloride solutions by weight Loss Corrosion Method” International Journal of Chemical Sciences, 2010; 6(1): 53-60