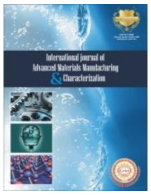

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Dry Sand Abrasion Wear of Aluminium-Graphite Composite Synthesized in Open Hearth Furnace with Manually Controlled Stirring Method

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Aluminium alloys are known to have very good mechanical properties but they lack good resistant to wear. By adding solid lubricant particles like graphite into the Aluminium alloy the material shows better tribological properties. The distribution of graphite particles was improved by adding elements like magnesium in the Aluminium matrix. Stir casting is generally used for synthesis of composite due to its simplicity and low cost.
In the present work, Aluminium based composite containing graphite particles (5% by weight) and magnesium (5% by weight) in the commercially pure Aluminium alloy was synthesized. The stir casting method was used to synthesize the composite. For the stir casting, the open hearth furnace with a hand-driven stirring arrangement was used.
The present work aims to understand the abrasion wear characteristics of the casted composite.

Introduction

In industries, MMC materials are sometimes used to provide higher abrasive resistance and longer service life. Aluminium based discontinuously reinforced MMCs are very popular due to their better strength, higher modulus and increased wear resistance over conventional Aluminium alloys.
The graphite particle reinforced Aluminium matrix composite has shown good potential for a variety of anti-friction applications [1-3].The graphite particles present in the Aluminium based composite acts as a lubricating agent.The homogeneous distribution of graphite particles is required for better mechanical and tribological properties of compositeThe type of production method adopted has a large influence on the mechanical and tribological properties of the composite due to its effect on the matrix grain size, porosity, the distribution of graphite particles [4] and the interfacial properties of the Al-Gr couple [5]. Presently, stir casting is the most economical method, but it is associated with problems caused due to the apparent non-wettability of graphite by liquid Aluminium alloys [6-8] and the density differences between the two materials [9, 10].The addition of Mg into the commercially pure Al causes an increase in the viscosity of melt thus preventing the graphite particles from clustering [11]. In the present study, 5 % (by weight) graphite particles were added in the molten commercially pure Aluminium. Also, 5 % (by weight) Mg was added to the melt for obtaining uniform distribution of graphite particles in the melt. Stir casting method was employed, using open hearth furnace and a self made hand-driven stirring arrangement.

Experiment

Materials and Processing

The weighed quantity (1200 gm) of pure Aluminium was melted to desired superheating temperature of around 750^0 C in a graphite crucible in an open hearth furnace. After melting was over, the required quantity of graphite (5% by weight) powder preheated to around 400^0 C were then added to the molten metal at a rate of about 0.5 gm/sec and stirred continuously by using mechanical stirrer. For the stirring purpose, a completely new, hand driven stirring arrangement, employing a set of bevel gears was used. The stirring time was maintained between 6 to 8 minutes at an impeller speed of around 300 rpm. To improve the wettability, small quantities of Mg (5% by weight) was added to the melt. The melt with the reinforced particulates was then quickly poured to a cylindrical sand mould. After pouring is over, the melt solidified in the mould.

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Abrasive wear testing

Abrasive wear tests were performed on dry sand abrasion wear tester TR-50 machine. The rotating wheel was made of chlorobutyl rubber and rounded quartz grain sand was used as abrasive. Care was taken to ensure that abrading surface of specimens remains flat so that the complete contact occurs in each test. Various test run were conducted with varying wheel speed at constant load of 80 N. Also, tests were performed with varying load at constant wheel speed of 212 rpm. In order to calculate weight loss, samples were weighed before and after the test.

Results and discussion

Fig. 1 shows a plot between mass loss and rubber wheel speed at constant load and constant abrading distance. It is evident from the graph that the mass loss in case of composite is the least at all speeds. This indicates better wear resistance property of the composite due to the addition of graphite particles which reduces the coefficient of friction. In other words, the better wear resistance of the composite can be accounted for the reason that a lubricating film gets formed at abrading surface of the composite.

It is obvious from the graph that as the wheel speed or abrading velocity increases the wear rate increases. It may be due to the fact that, at the higher speed of abrasion, the energy involved in eroding the material surface doesn't get time to dissipate or spread to the adjoining area, thus major part of the energy is utilized effectively in causing abrasion.

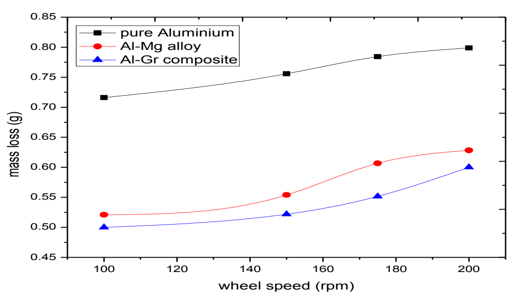

Fig. 1: Mass loss vs. wheel speed in dry sand abrasion test

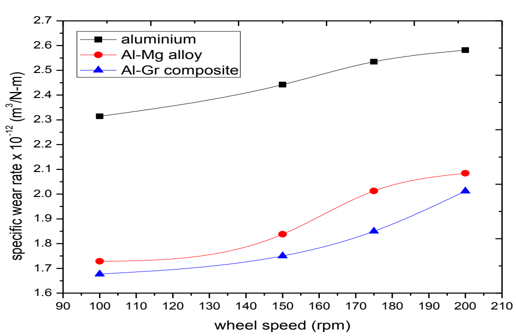

Fig. 2: Specific wear rate vs. wheel speed in dry sand abrasion test

In Fig. 2 a graph between specific wear rate and wheel speed is plotted. Specific wear rate for composite is found to be the least at all speeds.

Fig. 3 shows a plot between mass loss and load applied. Again, wear resistance of composite was found to be the best because of the formation of lubricating film at the tribo-surface. Obviously, on increasing load, wear of the material rises as more energy is imparted to the abrasive sand grains which cause more erosion.

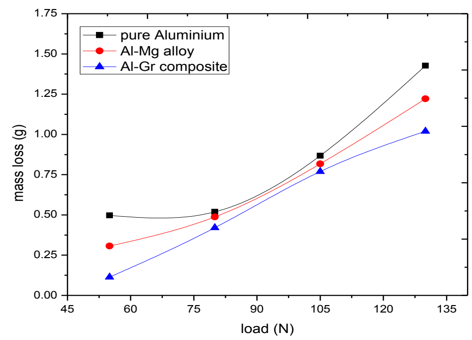

Fig. 3: Mass loss vs. load in dry sand abrasion test

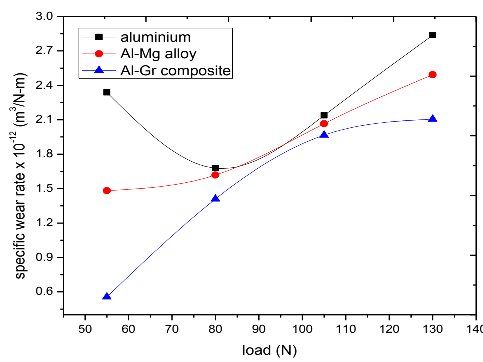

Fig. 4: Specific wear rate vs. load in dry sand abrasion test

Fig. 4 shows a plot of specific wear rate and applied load. The specific wear rate of the composite initially rises at a faster rate but at higher values of load it tends to attain a nearly constant value. It may be due to the fact that at higher loads, a lubricating film forms quickly that reduce friction and promotes sliding between surfaces.

Conclusions:

Aluminium metal matrix composite has been successfully synthesized with fairly uniform distribution of graphite particles, using a completely new method of stir casting that employed the use of open hearth furnace and an indigenously made hand driven stirring arrangement.

The abrasion wear mass loss was significantly reduced for the Aluminium-Graphite composite in comparison to pure Aluminium and Aluminium Magnesium alloy.

The abrasive mass loss was found to be more at higher wheel speed. The abrasive wear increases with the increase in load applied by the abrasive grains.

The specific wear rate of the composite during abrasion with sand grains, increases at lower values of load but at higher load it tends to become constant due to graphite film formation.

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