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Study of Abrasive Wear Behaviour of Al-Cu-Mg/Titanium Dioxide Particulate Reinforced Metal Matrix Composite

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Abstract:

In the present investigation, Aluminium based metal matrix composites containing Titanium Dioxide (TiO_2) are synthesized using stir-cast method. Macro structural studies have shown near uniform distribution of Titanium dioxide particulates in the matrix material. Influence of TiO_2 particulate on dry sand rubber wheel abrasion wear characteristics was carried out to explore the feasibility of using this metal matrix composite, developed for abrasion wear resistance application. The details of the results obtained are presented in this paper. Resistance to wear has increased with increase in Titanium dioxide particles; wear has increased with increase in normal load and sliding velocity. Hardness has also increased with increase in weight percentage of TiO2 particles.

Keywords: *Metal matrix composite, Titanium dioxide, Macrostructure, Microstructure.*

I. INTRODUCTION

With new developments and an increase in the common use of composite materials, relevant research has increased. In all this research, investigation of the wear behaviour of composite materials has an important role. Composites with high wear resistance are used in different engineering areas. Aluminium alloys have been widely used in aerospace and automobile industries due to their low densities and good mechanical and corrosion properties [1].

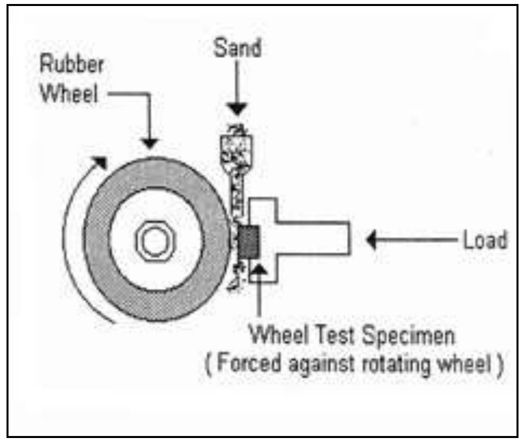
Wear performance,which is one of the important mechanical properties of Metal matrix composite (MMC) materials, varies depending on the material properties of matrix and reinforced elements [7].Research on the friction and wear behaviors of Al metal matrix, it is found that hard reinforced composites resist wear more than alloy matrix. Also parameters such as shear rate of specimen, particle size of abrasive, hardness of composite, applied load, chemical composition of matrix

material and volume and distribution of reinforcing material in the structure affect the wear rate of composites [8–15].

The base metal used in this investigation was Al-2618 alloy. The chemical composition of the base alloy is Cu 2.18 %, Mg 1.43%,Ni 0.93%, Si 0.16%,Ti0.04%,Mn 0.028% and balance is Aluminum. Titanium dioxide (TiO_2) of laboratory grade was used as a reinforcing material. The TiO_2 content in the composite was varied from 2 to 8 Wt % and four types of composites were produced. TiO_2 reinforced Al2618 alloy composite were produced using stir casting technique, which was used by researcher K.V. Mahindra. K. Radhakrishna et.al. [9].

During this period investigation was carried out to evaluate the effect of heat treatment on hardness of both Base material and the different Wt % of Titanium Dioxide (TiO_2) reinforced composite materials.The cast composites and the base material

Al-Cu-Mg alloy (Al2618) were subjected to solutionizing at a temperature of 529 ^{0}C $\pm$ 1^{0}C for a duration of 2hours and then quenched in three different quenching media Viz. Air, Room temperature water (RT water) and (Ice + Water). Artificial ageing was carried out at 199^{0}C for duration of 4 to 20 hours in steps of 4h.



“Fig.1,” Wheel Abrasive Test Rig.

2. EXPERIMENTAL STUDIES

2.1. Study of Abrasive Wear Behaviour

The test equipment consisted of a wheel rubber beading around the circumferential periphery of the wheel as shown in the“Fig.1,”.The specimen was suitably held by means of specimen holder against the rubber wheel by means of lever arrangement. The rubber wheel rotated and the pressure was applied by means of load suspended over the lever arrangement. Sand held in the top of the reservoir was allowed to fall through a nozzle at a constant flow rate between the rotating rubber wheel and the specimen. The specimen was fixed with a locking arrangement against the abrasive medium. The load over the specimen was applied through cantilever mechanism. The wear rates were calculated by weight loss methods. The loss of weight of the specimen, before and after each test, was measured using a microbalance.Test was carried out as per ASTM G-65 standards.

Abrasion resistance of the composite castings was assessed using a dry sand /rubber wheel abrasion test rig. Specimen, measuring 80 mm x25 mm x 6 mm, prepared from test casting was used to evaluate abrasive wear characteristics. Test was conducted for the load of 2N to 10 N in the steps of 2N for the duration of 30 Minutes. Abrasive material used was silica sand grains of 136 micron size. Tests were conducted to obtain the measure of the abrasive wear resistance of the developed material. A surface roughness of 2–3µm was maintained.

3. RESULTS AND DISCUSSIONS

3.1. Abrasive Wear

Effect of load on the wear rate of Al-Cu-Mg alloy and TiO_2 reinforced composite, for un heat treated specimen is shown in “Fig.2,”. “Fig.3, shows the variation of wear rate on heat treated specimens for both base and composite material. It shows that the wear rate of alloy and composites increases with the increase in load. It is noted that the wear rate of Aluminum alloy reduced significantly with the addition of TiO2 particle in Al alloy.

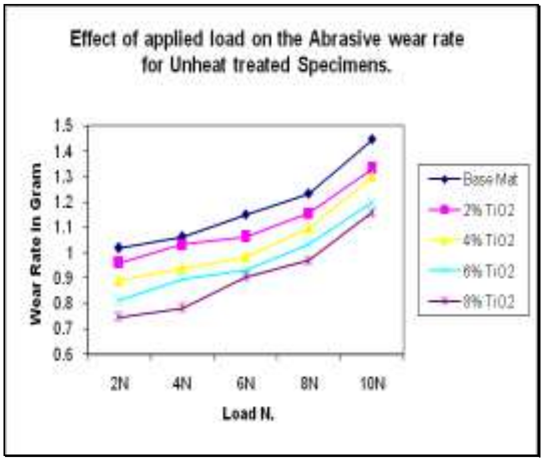


Fig.2. Effect of load on the wear rate of Al-Cu-Mg alloy and TiO_2 reinforced composite, for un heat treated specimen.

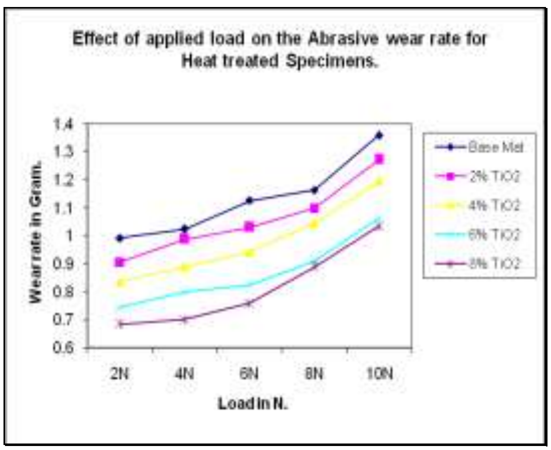


Fig.3.Effect of load on the wear rate of Al-Cu-Mg alloy and TiO_2 reinforced composite, for Heat treated specimen.

4. CONCLUSIONS

Based on the performed study it is evident that in order to improve the abrasive wear resistance of the tool steel by adding hard particles, the matrix–particle interface should be strong enough to prevent the detachment of particle sand the amount of particles should be high enough to compensate the accelerated wear of the matrix because of the hard particle wear debris. Also the reinforcement material should be without internal faults and have a good wear resistance against abrasion.

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