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Experimental Investigation of Aluminium7075 Alloy Reinforced with Alumina and E-Glass

Harish R S[1] and Dr. M. Sreenivasa Reddy[2]

Research Scholar, Department of Mechanical Engineering[1]

Guide, Department of Mechanical Engineering[2]

R.L. Jalappa Institute of Technology, Bangalore Rural, India

hariish.1987@gmail.com and sreenivasam123@gmail.com

Abstract: *In this present investigation efforts have been made to study the tensile strength and hardness properties of as cast Al7075 alloy reinforced with Alumina and e-glass. The vortex method of stir casting was employed, in which the reinforcements were introduced into the vortex created by the molten metal by means of mechanical stirrer. Brinell hardness and wear strength samples have been prepared as per the ASTM standards. The results revealed that there will be greater effect of reinforcing different percentage of Alumina and E-glass compared to aluminium alloy matrix composites. An improved wear and hardness properties occurs on reinforced compared to Unreinforced MMCs alloys*

Keywords: Al matrix composites; Alumina, e-glass, wear and hardness.

I. INTRODUCTION

Aluminium hybrid composites are a new generation of metal matrix composites that have the potentials of satisfying the recent demands of advanced engineering applications. These demands are met due to improved mechanical properties and possibility of reducing production cost of aluminium hybrid composites. The performance of these materials is mostly dependent on selection of the right combination of reinforcing materials since some of the processing parameters are associated with the reinforcing particulates [1]. Hybrid MMCs are engineering resources reinforced by a combination of two or more dissimilar material in order to achieve the combined benefits of composites. Alumina (Al_2O_3), Silicon Carbide (SiC), Boron Carbide (B_4C) particles and so on are commonly used non-metallic reinforcements, combined with aluminum alloys to obtain aluminum matrix composites and Al_2O_3/SiC, in the form of particulates, are found to have remarkable compatibility. In a stir casting method, normally the particles reinforced is dispersed into the molten metal by mechanical stirring process [1-8]. Composites with up to 30 wt. % can be used in this process. The major benefits of this process are applicability to mass production. The stir casting process costs very low (up to 1/10th) for mass production of MMCs when compared to powder metallurgical process. Due to this stir casting is the most commonly used viable technique of manufacturing of AMMCs [9-14]. Among other parameters, wt. % of Al_2O_3 and SiCp is reported to be the most operative parameters influencing hardness and other mechanical properties of aluminum matrix composites. Addition of Al_2O_3 to aluminum will shows the increase in its mechanical and tribological properties in composites. Usually, composites have greater compressibility combined with good hardness strength and making them multiuse in a wide range of applications. Information of hardness is very useful in understanding the performance of composites. However, there is no systematic procedure to evaluate the hardness of these composites. The said drawbacks of conventional metallic structure materials have been induced strong interest to find for new possibilities. Studied the influence of Al2O3 and Gr on mechanical and tribological behavior of Al-MMC. Various wt. % of Al_2O_3 (5, 10 & 15%) and constant wt. % of graphite (5%) were used to produce a composite by stir casting process. From the results they have concluded that the hardness in the composites increased with increase in wt. % of Al_2O_3 particles. From the ANOVA, it is observed that Al_2O_3 is the most significant factor that affects the wear rate followed by wt. % of Gr particles and stirring speed [3]. Studied the influence on Mechanical and Tribological Characterization of Al2O3/SiCp Reinforced Aluminum Metal Matrix Composite. Al7075 hybrid metal matrix composite reinforced with the hard ceramics like alumina (2, 4, and 6 wt.% of Al_2O_3) and silicon carbide (3, 6, and 9 wt.% of SiC) is fabricated by using stir casting method. The samples were aging at temperature of 140◦C, 160◦C and 180 C and monitored by hardness test. Taguchi's L_{27} Orthogonal array was used for optimizing the process parameters. Scanning electron microscope (SEM) studies were carried out to evaluate the worn surface. From the analysis of variance (ANOVA), Al2O3 is the significant factor that affects the hardness and wear loss of hybrid composites followed by SiC_p and heat treatment Studied the influence of Al_2O_3 and MoS2 on wear and coefficient of friction properties of AMMCs. The obtained results indicated that the combination of Al+ 5 wt.% Al_2O_3 + 5 wt.% MoS2 has minimum wear rate and coefficient of friction at the sliding speed of 0.5 m/s and sliding distance of 1000 m [15-21].

1.1 OBJECTIVES OF THE PRESENT WORK

The main objective of this project is to develop Al (7075), Alumina and e-glass metal matrix composites. Where the Alumina and E-glass are used as reinforcement materialS & Al 7075 as matrix material. Different weight percentages of Specimens are prepared by vortex stir casting route. Test specimens are prepared to evaluate the ultimate tensile strength and brinell hardness.

II. EXPERIMENTAL DETAILS

Following steps have been carried out in the experimental work:

1. Material selection
2. Composite preparation
3. Testing

2.1 Material selection

The Al 7075 alloy (matrix material), Alumina and e-glass (reinforcement) were used for fabrication of MMCs. The chemical composition of Al7075 is given in the Table 1.the reinforcement percentages are given in Table 2.

Table 1: Chemical Composition of Al 7075

Element	% Composition
Al	88.6
Zn	5.6
Fe	0.5
Mg	2.5
Mn	0.3
Cu	1.6
Si	0.4
Cr	0.23
Ti	0.2

Table 2: Percentages of reinforcements

Model	Reinforcements	
	% of E-Glass	% of Alumina
1	2	3
2	2	6
3	2	9
4	4	3
5	4	6
6	4	9
7	6	3
8	6	6
9	6	9

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2.2 Composite preparation

The Alumina and e-glass were used as the reinforcement and the Alumina content in the composites was varied from 3% to 9% in steps of 3% by weight and E-glass are varied from 2% to 6% in steps of 2% by weight. Stir casting was used to prepare the composite materials in which the Alumina and e-glass particles were introduced into the molten metal pool through a vortex created in the melt by the use of an alumina-coated stainless-steel stirrer. Zirconium coated stirrer used to stir the molten metal. The stirrer was rotated at 200–300 rpm for duration of 15 minutes. The resulting mixture was tilt poured into preheated permanent moulds.

2.3. Wear test

Wear test were conducted at room temperature using Pin on Disc apparatus in accordance with ASTM E9. The wear specimens prepared are of diameter 10 mm and length 70mm.

2.4 Hardness test

Hardness test was conducted by using Brinnel hardness apparatus accordance with ASTM standards. The hardness specimens prepared are of diameter 25 mm and thickness 10mm

III. RESULTS AND DISCUSSION

3.1 **Wear properties**

The results of the *wear tests* of Al7075 MMCs are given in the Figure 3.1, Figure 3.2 respectively.

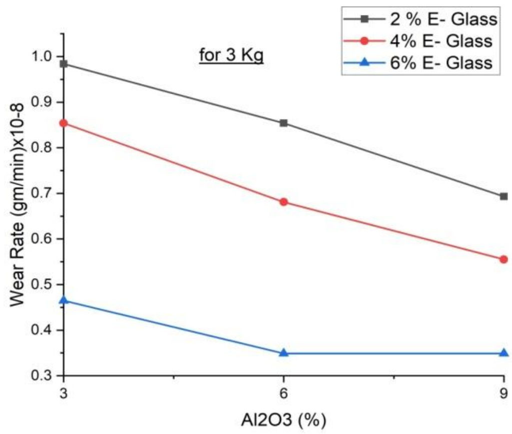

Fig 3.1 Effect of wt. % of reinforcements on Wear Rate of Al7075-Al_2O_3-E-Glass composites

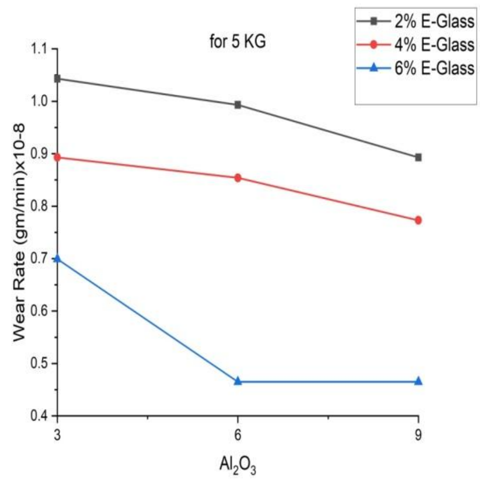

Fig 3.2 Effect of wt. % of reinforcements on Wear Rate of Al7075-Al_2O_3-E-Glass composites

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From the graphs we can observe that significant reduction in wear rate for composites is mainly due the presence of hybrid reinforcements. In addition to this the strong bonding of matrix with reinforcement is the reason for low wear rate of hybrid composites. Wear rate have become constant or the wear resistance is reduced for 9% of reinforcements may be due to increased specimen temperature, the matrix becomes soft. The enhancement of wear resistance (decreasing of wear rate) may be affected by the particle agglomeration.

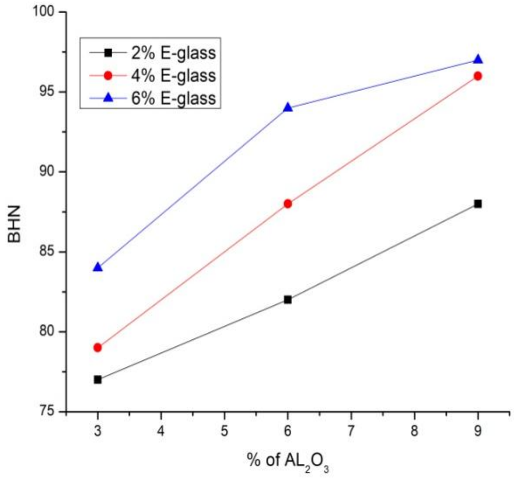

Fig 3.3 Effect of wt. % of reinforcements Hardness of Al7075-Al_2O_3-E-Glass composites

Figure shows the relation between weight percentage of Al_2O_3 -E-glass fiber and hardness of fabricated composites it is evident that the hardness of the composite material is much higher than that of its parent metal. It also shown that the hardness of the composite material increases with wt% of Al_2O_3-E-glass content. This is because of addition of reinforcement makes the ductile Al7075 alloy into more brittle and hard silica content increases. However, there was a drastic improvement in hardness, as compared to the non-reinforced metal matrix. It is also indicates that a further increase in reinforcement material there no significant increase of the hardness.

IV. CONCLUSION

Based on the work carried out the following conclusions have been drawn

- Al7075 based MMCS have been successfully fabricated using the stir casting technique.
- The wear rate of pure aluminum is greater than the composite.
- Hardness increases as the percentage of Al_2O_3 and e- glass increases.

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