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Production and Mechanical Properties of Al-Si Alloy Metal Matrix Composite

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Abstract:

Present study is focused on the fabrication of Aluminium Silicon Alloy, Reinforced with* GBF Slag *by Stir Casting technique. The percentage of reinforcement particulate is varying like 4%, 6%, 8% and 10% composites. The various mechanical tests like Wear test, Impact and Corrosion Test performed on the samples obtained by Stir Casting technique for comparison purpose. The result indicated that the developed method is quite successful, Decreased in Corrosion and Wear Behaviors of Composite also decreased.

Keywords

Aluminium Silicon Alloy, *GBF Slag,* Stir Casting technique

1. Introduction

Aluminium Silicon Composite particulate metal matrix composite has been prepared by stir casting. For preparing Aluminium silicon GBF Slag composite by using stir casting mass basis ratios of 100:4, 100:6, 100:8 and 100:10have been taken. Figure 1 shows the stir casting device used for preparing composite. The raw material for composite preparation has been used in the form of aluminium ingots. These metal ingots have been cleaned and melted to the temperature of 850° C in graphite crucibles. A three-phase electrical resistance furnace with temperature controlling device has been used for melting stirred continuously by a mechanical stirrer at 720° C. The stirring has been carried out for 5 to 8 minutes. During stirring, Magnesium has been added in small quantities to increase the wettability of GBF Slag particles. “Cover all” powder has been added to flux impurities and Degassers tablets have been used for removing air bubbles from molten metal.

2. Materials Methods

Al-sic Alloy Composite and the GBF Slag particles of size 30 microns are used as the reinforcement material. The GBF Slag particles were gathered from Thermal power plant, Visakhapatnam, Andhra Pradesh. aluminum Silicon alloy has been melted in the graphite clay crucible inside an electrical furnace and fly ash particulates were incorporated in different weight fractions like Al-Si +4% GBF Slag, Al-Si+6% GBF Slag, Al-Si+8% GBF Slag and Al-Si+10% GBF Slag. The measured quantity of GBF Slag particles were incorporated to the molten aluminium. The temperature of the thaw was maintained at 850^{0}C.

Figure 1. The granulated blast furnace (GBF) slag powder used for synthesis of Aluminium-granulated blast furnace slag (GBF) slag composites (a) As received condition; (b) After crushing and grinding condition.

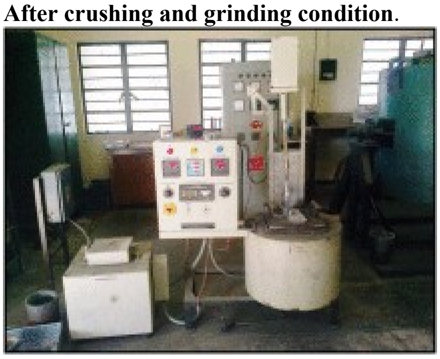

Fig2. Stir Casing Equipment

3. Tests Conducted for Composite Material:

3.1 Impact Test: Charpy impact testing has been used for many years to test the impact toughness of various metals. The advent of modern composites brought about materials with properties that depend on their orientation. Consequently, new test methods had to be found to accurately test the directionally dependent impact resistance of composite materials. Since Charpy impact testing is both cheap and fast, its use was extended to composites. A Charpy impact test machine is shown in the following fig 3and specimens are prepared as per ASTM E:23 as shown in Fig5.

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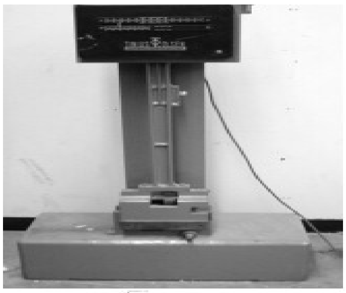

Charpy impact tester.

Fig3. Impact Tester

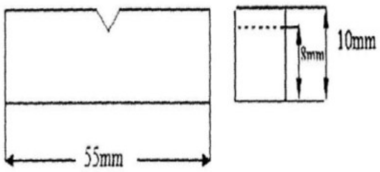

Fig4. ATM Standard Specimen E:23

Fig5. Tested Specimens

3.2 Corrosion Test:

Standard samples are thoroughly polished to give a uniform smoothness. Samples are thoroughly degreased using mild soap and washed with distilled water. Samples are placed in desiccators. Standard solutions of 10% $CUSO_4$ (Copper Sulphate Penta Hydrate) and 90% water were prepared. Samples are placed for corrosion studies in 200 ml solution, keeping a minimum distance of 1 inch between them; Samples, taken out at regular intervals of 2 hr, 6hr. Are thoroughly washed with distilled water. After through drying and cleaning with alcohol, loss in weight is measured with an electronic balance For Corrosion test we have prepared a ASTM STANDARD **ASTM G69-12** Specimen consist is as shown in figure 6.

Fig 6. Samples for 25Days

Fig 7 Samples for 10Days

3.3 Wear Test on Pin on Disc: Dry sliding wear tests have been carried out on a pin- on - disc apparatus (Model: Ducom TR- 20 LE) by sliding a cylindrical pin against the surface of hardened steel disc (with a hardness value of HRC 62) under ambient condition. The Pin-on-disc wear testing experimental set up was shown in fig.6.1.5. The disc was ground to a smooth surface finish and renewed for each test. Standard wear specimens of 33mm length and 6mm ø were retrieved from all the castings through wire cut EDM process from the thoroughly homogenized ingots of base

Al-Si composites, fig 10. Prior to testing, the test samples were polished with emery paper, cleaned in acetone, dried and then weighed using an electronic balance (Model: Wensar PGB 200 India) with a resolution of 0.1 mg. The samples were placed on the wear disc and the sliding wear tests were carried out at various loads, time and sliding distances. The test was conducted in a load range of 10 kg, 20 kg, 30 kg and 40 kg etc. at a sliding velocity of 3.35 m/s and at sliding distances of 2 km, 4 km and 6 km. All the specimens followed a single track of 100 mm diameter with a tangential force. Wear loss and frictional traction experienced by the pin during sliding are Measured continuously by a PC base data logging System .After running through a fixed sliding distance, wear track disc was cleaned with acetone and then dried. After each test, the specimens were removed, cleaned in acetone and weighed with the same electronic balance mentioned above. For each load, the volume loss from the surface of each specimen was determined as a function of sliding distance and applied load. The wear rate (K) was defined as the volume loss (V), divided by the sliding distance (L). Hence, the volumetric wear rate (K) was calculated from the weight loss measurement and expressed in terms of mm^3/km.

For Wear test we have prepared a ASTM STANDARD **ASTM G99-17** Specimen consist is as shown in figure 10.

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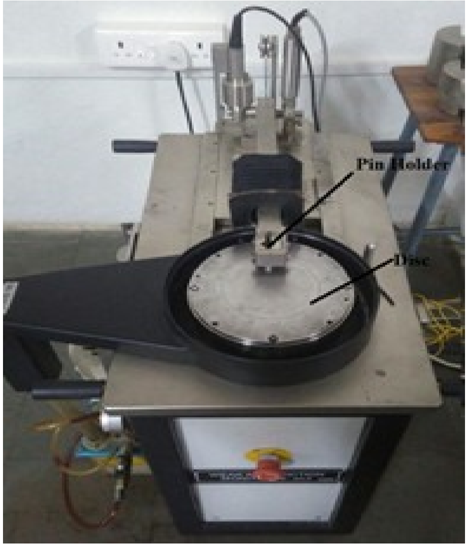

Fig 8 Wear Test rig Setup

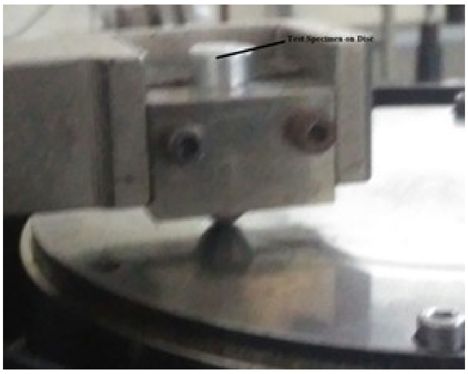

Fig 9 Test Specimen on Disc

Fig 10. Wear Test Specimens

4. Results and Discussion:

4.1 Impact Test: Testing Specimen under room temperature 30^0c and Specimen Placed in holder, In horizontal direction when swing pendulum is released specimen is broken and breaking starts at notched Cross-Section Area. Results are tabulated in Table form as shown in below.

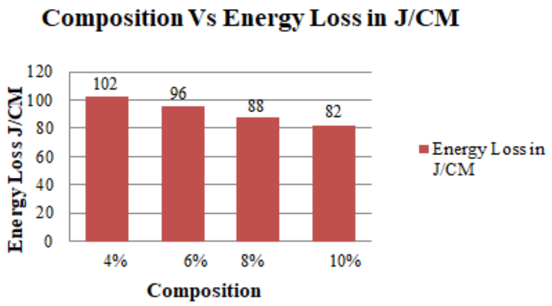

Fig11. Impact Test Results on Bar Graph

Table 1. Impact Test Results

S.no	Composition Al-Si + GBF Slag%	Energy loss J/cm
1	4%	102
2	6%	96
3	8%	88
4	10%	82

4.2. Corrosion Results:

By immersing Test specimen in Solution, then we need to maintain the time for calculating weight loss after cleaning the specimen with Distilled Water**.** Results are tabulated in Table form as shown in below.

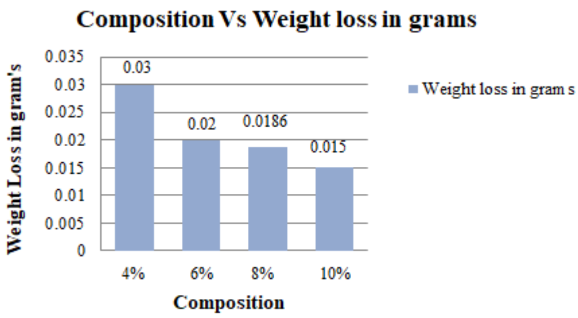

Fig 12. Corrosion Behavior at 2hr's

Table2. Corrosion Value in 2hr's

S.no	Composition Al-Si + GBF Slag%	Weight loss in grams
1	4%	0.03
2	6%	0.02
3	8%	0.0186
4	10%	0.015

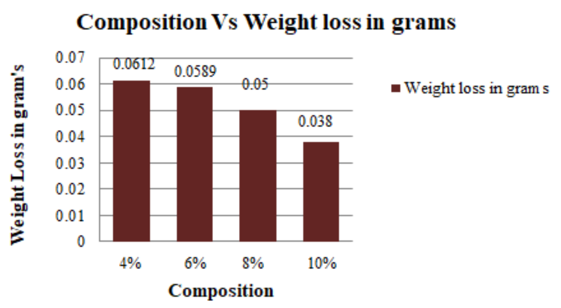

Fig13. Corrosion Behavior at 4hr's

Table3. Corrosion Value in 4hr's

S.no	Composition Al-Si + GBF Slag%	Weight loss in grams
1	4%	0.0612
2	6%	0.0589
3	8%	0.05
4	10%	0.038

4.3 Wear Test pin on Disc:

Test Specimen is at room Temperature 30^{0}c when holder holds the specimen then by varying Speed in RPM, Load in Kg and Sliding Distances we are going Obtain Weight loss and weight loss is calculated by using Simple Balancing machine.

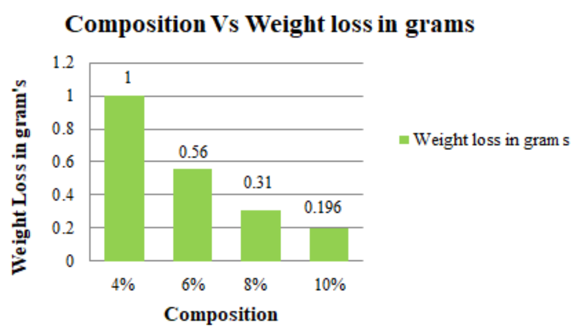

Fig2. Wear Behavior Graph.

Table3. Wear Test Results

S.no	Composition Al-Si + GBF Slag%	Weight loss in grams
1	4%	1
2	6%	0.56
3	8%	0.31
6	10%	0.196

5. Conclusion:

It can be concluded from observations and graphs: a. the value of wear rate found very low in case of 6% and 8% Compositions, When compared to other materials.

b. 6% and8% Compositions constant low wear rate compared to other when tested under similar working conditions.
c. There is no fluctuation of wear rate in case of 6% and8% Compositions and it is almost constant as compared to other materials.
d. Al-Si Metal matrix composites reinforced with up to 4%,6%,8% and10% with GBF slag and measured by Charpy impact tests, as a function of the Composition is observed and Energy Consumption is Decreased when we increase the Reinforcement.
e. Al-Si Metal Matrix composites reinforced with upto4%,6%,8% and10% with GBF slag Composition is observed and Weight Loss is Decreased when we increase the Reinforcement.

5.1 Future Scope: Further the work can be extended for different lining materials as well as for different abrasives.

6. Acknowledgment

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