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Fabrication and Study of The Effect of Flyash On Aluminium 2024 Composite

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ABSTRACT

Al-alloys are widely used application due to their low density, good mechanical properties, better corrosion resistance, wear resistance as compared to conventional metals and alloys. Fly ash is chosen because of it is least expensive and low density reinforcement available in large quantities as solid waste by-product during manufacturing of bricks. Due to low weight it can be utilized in automobile application and thus improving its life. The present work has been done on Al alloy 2024 Fly ash composite. These were fabricated using Al-2024 alloy as metal matrix and fly ash as reinforcing material. Various weight based composites like (Al 100% - FA 0%), (Al 95% - FA 5%), (Al 90% - FA 10%), (Al 85% - FA 15%) were fabricated by Stir casting technique. The obtained composites were sized into small specimens and tests like hardness test, wear test, tensile test, and microstructure test were carried out.

Keywords: Composite, Fly ash, Al - 2024, Wear, Hardness, Tensile, Microstructure

I. INTRODUCTION

A. Aluminium 2024

Aluminium alloy 2024 has a thickness of 2.78 g/cm³ (0.1 lb/in³). Electrical conductivity of 30% IACS. Young's Modulus of 73 GPa (10.6 Msi) over all tempers. 2024 aluminium amalgam's creation generally incorporates 4.3-4.5% copper, 0.5-0.6% manganese, 1.3-1.5% magnesium and not exactly a large portion of a percent of silicon, zinc, nickel, chromium, lead and bismuth. It has an extreme elasticity of 140– 210 MPa (21– 30 ksi), and most extreme yield quality of close to 97 MPa (14,000 psi).

B. Flyash

Fly ash particles are generally spherical in shape and range in size from 0.5 μm to 300 μm. Fly ash is a heterogeneous material. SiO2, Al2O3, Fe2O3 and occasionally CaO are the main chemical components present in fly ashes. Two classes of fly ash are defined by ASTM C618: Class F fly ash and Class C fly ash. Fly ash can be dark gray, depending on its chemical and mineral constituents. Tan and light colors are typically associated with high lime content. Fly ash color is very consistent for each power plant and coal source.

Table.1 Composition of Flyash

Sl. No.	Composition	Percentage
1	SiO2	60.21
2	Al2O3	26.08
3	Fe2O3	4.80
4	CaO	1.00
5	MgO	0.25
6	Total alkali as Na2O	0.86
7	SO3	0.25
8	Cl	0.005
9	LOI(Loss in Ignition)	1.71

Fig.1 Flyash

C. Rockwell Hardness Test

Rockwell hardness of a Specimen involves application of a minor load followed by major load. The minor load resets to zero position. Major load is applied, then removed while maintaining minor load. Depth of penetration from the zero position is measured on a dial, in which a harder surface gives a much higher hardness number. The advantage of Rockwell hardness is that it displays the hardness values directly. Readings to be taken on a flat surface, as convex surfaces gives error readings.

D. Wear Analysis (Pin-On-Disc)

In a pin-on-disc wear tester, a Specimen is loaded on a flat rotating disc in a way that the circular wear path by the machine is followed. The machine is used to evaluate various wear and friction properties for different materials under pure sliding.

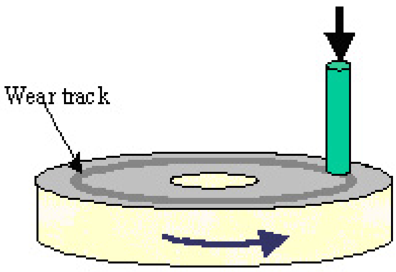


Fig.2 Pin on Disc analysis

E. Tensile Test

This is a fundamental material test in which a sample is subjected to controlled tension until failure, it has maximum elongation and reduction in area. Properties that are directly measured via tensile test are ultimate tensile strength.

Samples were machined and tested as per ASTM E8 standard. Bench tensometer was the device used to test the tensile strength. The electronic Tensometer is a compact and bench model horizontal Tensile Testing Machine of capacity 20 KN. It is a small version of UTM- Universal Testing Machine and is used for testing tension and also compression, shear and flexural properties of different materials.

Table.2 Specimen Composition

Specimen	Aluminium 2024 (wt %)	Flyash (wt %)
Specimen 1	100%	0%
Specimen 2	95%	5%
Specimen 3	90%	10%
Specimen 4	85%	15%

II. EXPERIMENTAL RESULTS AND DISCUSSION

A. Wear Test

Table 3 Wear test results

COMPOSITION	SPEED (RPM)	LOAD (N)	TIME (min)	WEIGHT (gm)			WEAR RATE (gm/mm)
				INITIAL	FINAL	WT. LOSS	
0%	600	9.81	5	3.2638	3.2614	0.0024	$2.4047*10^{-6}$
	500	19.613	5	3.2614	3.2535	0.0079	$9.4940*10^{-6}$
5%	600	9.81	5	2.5267	2.5140	0.0127	$1.2718*10^{-5}$
	500	19.613	5	2.5140	2.5042	0.0098	$1.1777*10^{-5}$
10%	500	19.613	5	2.5829	2.5076	0.0753	$4.2920*10^{-7}$
	500	19.613	5	2.5076	2.5058	0.0018	$8.0969*10^{-5}$
15%	500	19.613	5	3.0202	3.0032	0.0017	$2.060*10^{-6}$
	500	19.613	5	3.0032	2.9859	0.0173	$1.4571*10^{-5}$

B. Tensile Test

Table 4 Tensile Test Results

Sl.no	PARAMETERS	SPECIMEN			
		1	2	3	4
1	Initial area, (mm^2)	32.68	32.68	32.68	32.68
2	Initial gauge length, (mm)	25	25	25	25
3	Peak load, (N)	5555.8	5065.4	5845.8	6119.8
4	Engineering Ultimate Tensile strength, (MPa)	174.2	160.7	185.8	190.8
5	True Ultimate Tensile strength, (MPa)	210.9	182.00	222.8	284.1

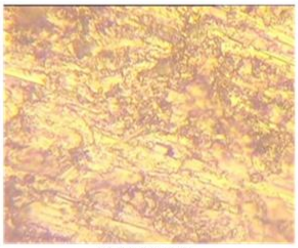
C. Hardness Test

Table 5 Hardness Test Results

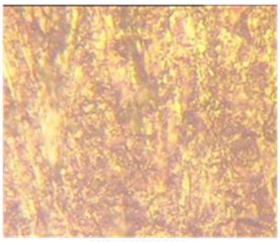
COMPOSITION (Flyash)	APPLIED LOAD (Kg)	BRINELL HARDNESS NUMBER
0%	100	90.59
5%	100	113.162
10%	100	143.41
15%	100	153.162

D. Microstructure Examination

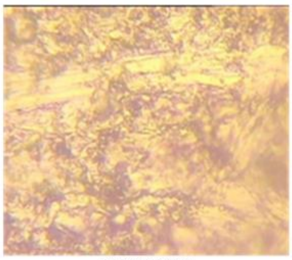
The microstructure observations of the casted specimens are as shown below. The microstructures show the distribution of Flyash particles. The grain boundaries are visible and no porosity is seen.



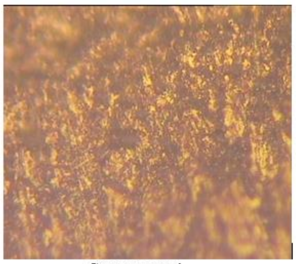
SPECIMEN 1



SPECIMEN 2



SPECIMEN 3



SPECIMEN 4

III. CONCLUSION

Al 2024 with flyash composite was synthesized successfully by using stir casting technique. By adding flyash the strength of al 2024 alloy gets improved. This is due to the presence of hardened fly ash particles and oxides. The reinforced Al2024 exhibits higher tensile strength. The hardness values increased compared to the pure alloy without reinforcement and specimen 4 was found to have the highest hardness number. The reinforced composites were found to have less wear loss compared to the base alloy. Microstructure evaluation showed dispersion of the reinforcements in the specimens.

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