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ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)

Vol 2, Issue 11,November 2017

Investigation of Aluminium Based Composite Material Using Fly Ash

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Abstract:- **This research work deals with the experimental investigation of the composite material of aluminium with fly ash. Aluminium material grade 6063 is chosen for this investigation of metal matrix composites. There has been an increasing interest in composites containing low density and low cost reinforcements. Fly ash is low-cost material available in large quantities which are obtained from the combustion of coal in power plants. Hence, composites with fly ash as reinforcement are likely to overcome the cost barrier for widespread applications in automotive and small engine applications. By using stir casting method, the composite can be obtained with aluminium. We used the composite material to make a much effective prototype or mechanical structure having very good mechanical properties. Properties of composite materials completely depend on the method used to produce it. Aluminium with Fly ash materials were fabricated using Stir casting method. After composite matrix, the materials are observed and investigated. Dry sliding wear behaviour of the composites in the cast conditions is studied at different loads with the help of Pin-On-Disc wear test machine. Finally, mechanical properties such as hardness and tensile strength have been investigated.**

INTRODUCTION

Materials are frequently chosen for structural applications because they have desirable combinations of mechanical characteristics. Development of hybrid metal matrix composites has become an important area of research interest in Materials Science. The present experiment investigation is aimed at evaluating the physical properties of Aluminium 6063 in the presence of fly ash and its combinations. Consequently aluminium metal matrix composite combines the strength of the reinforcement with the toughness of the matrix to achieve a combination of desirable properties not available in any single conventional. Aluminium alloys with a wide range of properties are used in engineering structures. Alloy systems are classified by a number system (ANSI) or by names indicating their main alloying constituents (DIN and ISO). Selecting the right alloy for a given application entails considerations of its tensile Strength, density, ductility, formability, workability, weldability and corrosion resistance, to name a few. A brief historical overview of alloys and manufacturing technologies is given in Ref. Aluminium alloys are used extensively in aircraft due to their high strength-to-weight ratio. On the other hand, pure aluminium metal is much too soft for such uses, and it does not have the high tensile strength that is needed for airplanes and helicopters.

2.1 MATERIAL SELECTION

Al 6063 is the most common alloy used for aluminium extrusion. It allows complex shapes to be formed with very smooth surfaces fit for anodizing and so is popular for visible architectural applications such as window frames, door frames, roofs, and sign frames. Applications requiring higher strength typically use 6061 or 6082 instead. A property of Al-6063 is shown in below table.

Table 2.1 Properties of Al-6063

Chemical composition	Weight (%)	Chemical composition	Weight (%)
Silicon (Si)	0.57	Zinc (Zn)	0.01
Iron (Fe)	0.21	Titanium	0.02
Copper (Cu)	0.05	Cadmium (Cd)	0.00
Manganese (Mn)	0.04	Lead (Pb)	0.0
Magnesium (Mg)	0.48	Stannum (Sn)	0.00
Chromium	0.02	Aluminiu	98.59

2.2 COMPOSITE MATERIAL (FLY ASH)

ISSN (Online) 2456-1290

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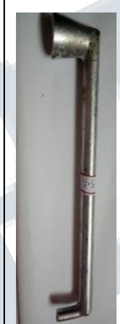
Fly ash and pulverized coal ash are the two names of the same thing. It is also known as pulverized fuel ash. Table 2.2 Properties of Fly ash

Fly ash compound	**(%)**	**Fly ash compound**	**(%)**
SiO_2	55.9	TiO_2	1.6
AL_2O_3	30.2	Na_2O	0.2
Fe_2O_3	5.4	P_2O_3	0.4
K_2O	2.7	Mn_2O_3	0.1
CaO	1.3	SrO	0.1

3.1 EXPERIMENTATION

770 gm of commercially pure aluminium was melted in a resistance heated muffle furnace and casted in a clay graphite crucible. For this the melt temperature was raised to 880K and it was degassed by purging hexachloro ethane tablets. Then the aluminium-fly ash (5%, 10% and 15%) composites were prepared by stir casting route. The fly ash particles were preheated to 373K for two hours to remove the moisture. Commercially pure aluminium was melted by raising its temperature to 880K and it was degassed by purging hexachloro ethane tablets. Then the melt was stirred using a mild steel stirrer. Fly-ash particles were added to the melt at the time of formation of vortex in the melt due to stirring. The melt temperature was maintained at 880K- 990K during the addition of the particles. Then the melt was casted in a clay graphite crucible. The particle size analysis and chemical composition analysis was done for fly ash. The hardness testing and density measurement was carried out Al-(5, 10 and 15) wt% fly ash composites. The hardness of the samples was determined by Brinell hardness testing machine with 750 kg load and 5 mm diameter steel ball indenter. The detention time for the hardness measurement was 15 seconds. The wear characteristics of Al-fly ash composites were evaluated using wear testing machine. For this, cylindrical specimens of 2.0 cm diameter and 2.0 cm length were prepared from the cast. Al- fly ash composites. Test was performed at under different loads and rpm for 10 minutes. The following figures shows the arrangement of out coming of metal matrix composite material. The fly ash also pre heated up to 600°c to eliminate the impurities and water content.

100% Al	***Al 6063 + Fly ash 5%***	***Al 6063 + Fly ash 10%***	***Al 6063 + Fly ash 15%***
			

4.TESTING AND RESULT

4.1.WEAR TEST

Aluminium and composite specimen were prepared in the size of 12mm diameter and 15mm length and loaded in a computer interfaced pin on –disc wear testing machine. The test piece were secured to in the instrument at the normal loads of 5, 10, 15 and 20N with sliding speeds were 0.5, 1.0, 1.5 m/s. wear test carried out at room temperature.

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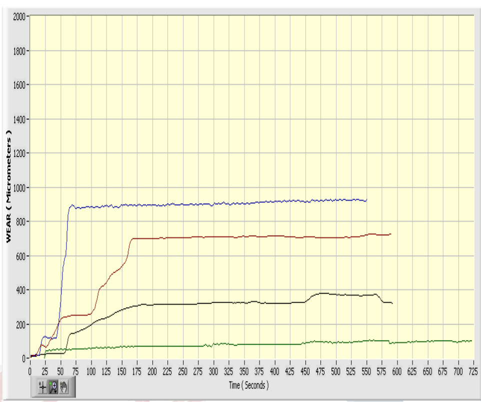

4.2.HARDNESS TEST

Hardness tests were performed for the composite specimens at micro lab. The hardness values of the specimen were measured using Brinell hardness testing system with 10mm diameter ball at a load of 250 kg. The detention time was 30 seconds. Three tests were taken on each specimen of aluminium composite fly ash material to eliminate possibility of segregation and mean value was considered. Figure 3.7 is shown hardness testing workpiece.

Type	Composite Material	Hardness Test(HRA)
Sample 1	Pure Aluminium	50
Sample 2	(Aluminium 95% + Fly ash 5%)	53
Sample 3	(Aluminium 90% + Fly ash 10%)	56.2
Sample 4	(Aluminium 85% + Fly ash 15%)	60.5

4.3.TENSILE TEST

Tensile strength test were carried out on composites using universal testing machine. Specimens were machined with standard dimensions. Samples were tested for composition and value was taken. Figure 3.8 is shown tensile testing workpiece.

Type	Composite Material	Testing Result		
		Yield Strength (N/mm2)	Ultimate Tensile Strength	% Elongation in 4D GL

			h (N/mm 2)	
Sample 1	Pure Aluminium	90	125	15
Sample 2	(Aluminium 95% + Fly ash 5%)	94.49	128	15.5
Sample 3	(Aluminium 90% + Fly ash 10%)	97.27	131	16.1
Sample 4	(Aluminium 85% + Fly ash 15%)	99.08	132	16.8

4.4. IMPACT TEST

The Charpy impact test, also known as the Charpy v-notch test, is a standardized high strain rate test which determines the amount of energy absorbed by a material during fracture. This absorbed energy is measure of given materials toughness.

Type	Composit e Material	Test Temperatu re	Notch Type	Specime n size (mm)	Impa ct test (Joule s or N-M)
Sampl e 1	Pure Aluminiu m	240°C	Un Notche d	10x10x5 5	12.67
Sampl e 2	(Aluminiu m 95% + Fly ash 5%)	240°C	Un Notche d	10x10x5 5	12.5
Sampl e 3	(Aluminiu m 90% + Fly ash 10%)	240°C	Un Notche d	10x10x5 5	11.96
Sampl e 4	(Aluminiu m 85% + Fly ash 15%)	240°C	Un Notche d	10x10x5 5	11.7

CONCLUSION

Development of lightweight materials has provided the automotive industry with numerous possibilities for vehicle weight reduction. Generally the selection of materials in automobiles plays a vital role in it. Al –fly ash composites were successfully fabricated by stir casting process with homogenous distribution of fly ash particles in the Al matrix. We have drawn various conclusions from the various calculations based on the diff. experimental testes; the following is the conclusion for this experimental investigation.

Hardness, tensile strength and impact test were determined for the test materials. Increasing fly ash content resulted in increase in the tensile strength of the Al. However. Wear resistance of the commercial Al was considerably enhanced by the addition of fly ash particles and the wear resistance of the composites was much superior to the unreinforced aluminium over the entire load range tested under dry sliding conditions. This may be due to the favorable effect of the fly ash particles which is a dominating factor affecting the wear resistance.

Moderate corrosion resistance is seen when the fly ash content is about 15 wt% From the results it can be concluded that the Al-fly ash composites could be considered as an excellent material in sectors where light weight, enhanced mechanical properties and wear resistance are prime consideration especially in automobile applications. Fly ash as filler in Aluminium casting reduces cost, decreases density and increase hardness which are needed in various industries like automotive etc.

From the experimental investigation it is concluded that we can use fly ash for the production of composites and can turn industrial waste into industrial wealth. This can also solve the problem of storage and disposal of fly ash. Also it is found that the overall mechanical properties of the composite material found to be good.

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