ISSN: 2456 - 4664
International Journal of Advanced Trends in Engineering and Technology
Impact Factor 5.965, Special Issue, October - 2019
6th National Conference on Advancements in Mechanical, Environmental, Safety and Health Engineering (AMESHE) On 11th May 2019 Organized By
Department of Mechanical Engineering, Knowledge Institute of Technology, Salem, Tamilnadu


# EXPERIMENTAL STUDY ON CHANGE IN PROPERTIES OF A16061 REINFORCED WITH FLYASH

**G. Gunalan*, V. Kirupa Shankar**, N. Thilak**, C. Chennakrishnan**** & R. Prakash*******

Mechanical Department, Knowledge Institute of Technology, Salem

**Cite This Article:** G. Gunalan, V. Kirupa Shankar, N. Thilak, C. Chennakrishnan & R. Prakash, "Experimental Study on Change in Properties of A16061 Reinforced with Flyash", International Journal of Advanced Trends in Engineering and Technology, Special Issue, October, Page Number 1-4, 2019.

**Abstract:**

Metal matrix composites (MMCs) possess significantly improved properties including high specific strength; specific modulus, damping capacity and good wear resistance compared to unreinforced alloys. There has been an increasing interest in composites containing low density and low cost reinforcements. Among various discontinuous dispersoids used, fly ash is one of the most inexpensive and low density reinforcement available in large quantities as solid waste byproduct during combustion of coal in thermal power plants. Hence, composites with fly ash as reinforcement are likely to overcome the cost barrier for wide spread applications in automotive and small engine applications. It is therefore expected that the incorporation of fly ash particles in aluminium alloy will promote yet another use of this low-cost waste by-product and, at the same time, has the potential for conserving energy intensive aluminium and thereby, reducing the cost of aluminium products. Now a days the particulate reinforced aluminium matrix composite are gaining importance because of their low cost with advantages like isotropic properties and the possibility of secondary processing facilitating fabrication of secondary components. The present investigation has been focused on the utilization of abundantly available industrial waste fly-ash in useful manner by dispersing it into aluminium to produce composites by stir casting method.

**Key Words:** Aluminium, Chemical Analysis, Fly Ash, Mechanical Properties & Stir Casting

## 1. Introduction:

Aluminium fly ash metal matrix composite is strengthen composite in which soft and ductile aluminium matrix is strengthen by the hard and brittle fly ash particles. Discontinuously reinforced aluminium based metal matrix composites are improving their high strength, high isotropic and good wear resistance. Discontinuously reinforcement aluminium composites have been developed in the various fields like aerospace, automotive and many other engineering applications. Fly ash particles are low cost, low density and available in large quantities of waste by-product in thermal power plants and industries. In this study, fly ash particles are generated in the combustion of coal is chosen to reinforcement material. In India coal produces about 1100 lacks tons of fly ash per year from burning about 2500 lacks tons coal for power generation. Present days fly ash utilization improved and reduces the pollution in environment, now in present day's fly ash is focusing and improving their investigating in various fields like MMCs, bricks, agricultural and etc. By adding fly ash reinforcement with commercially aluminium to make aluminium fly ash composite is improving their properties in strength and hardness and reduces the weight of the commercially aluminium. Hence, composites with fly ash reinforcement are overcome the cost barrier for wide applications. By adding of commercially aluminium with fly as his decreases the need of intensive energy-aluminium, by resulting in energy savings. By mixing the aluminium fly ash composites by using stir casting process method, in stir casting process is mixing conventionally in directly furnace it will reduce the time for mixing the aluminium and fly ash. Mixing the aluminium with fly ash particles in the ratio of 5% to 20% of weight in the commercially aluminium. To studied on commercially aluminium and fly ash chemical analysis in testing Laborites. Hence, studied before and after physical and mechanical properties of aluminium fly ash metal matrix composite and also comparing with pure commercially aluminium. The aluminium fly ash composite are mainly used in aerospace, industries and other engineering application.

## 2. Experimental Procedure:

First of all, 400 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 993K and it was degassed by purging hexachloro ethane tablets. Then the aluminium-fly ash (5%,10%,15%,20%) composites were prepared by stir casting route. For this we took 400 gm of commercially pure aluminum and then (5, 10, 15, 20) wt% of fly ash were added to the Al melt for production of four different composites. 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 993K 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 953K993K 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, 15, 20) wt% fly ash composites. The hardness of the samples was determined by Rockwell 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 1.1 cm diameter and 2.1 cm length were prepared from the cast 24 Al-fly ash composites. Test was performed at under different loads and rpm for 10 minutes. The SEM was done for all the samples.

## 3. Raw Materials:

The matrix material is used in the experiment investigation of commercially aluminium. The fly ash was collected from the Lanco industries. The particle size of the fly as is sieved the range from (0.1-100 μm).

ISSN: 2456 - 4664
International Journal of Advanced Trends in Engineering and Technology
Impact Factor 5.965, Special Issue, October - 2019
6th National Conference on Advancements in Mechanical, Environmental, Safety and Health Engineering (AMESHE) On 11th May 2019 Organized By
Department of Mechanical Engineering, Knowledge Institute of Technology, Salem, Tamilnadu

**4. Melting and Casting:**

First of all, 150gm of commercially aluminium was melted in a resistance heated furnace and casted in a mild steel die. The melt temperature was raised to 720$^0$C. Then the aluminium-fly ash (5%, 10% and 20%) composites were prepared by stir casting method. The 150gm of commercially aluminium and then (5, 10, 20) wt% of fly ash was added to the aluminium melt for production of four different composites. The fly ash particles were preheated to 300$^o$C for three hours to remove the moisture. Commercially aluminium was melted by raising its temperature to 720$^o$C. Then the melt was stirred using a mild steel stirrer blades. 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 680$^0$C to 720$^0$C during the addition of the fly ash particles. Then the melt was casted in a mild steel die. The hardness measurement testing was carried out Al (5, 10, and 20) wt% fly ash composites. The hardness of the samples was determined by Rock well hardness testing machine with 65 kgf load and diamond cone. The detention time for the hardness measurement was 15sec. The tensile strength of the samples was determined by the universal testing machine.

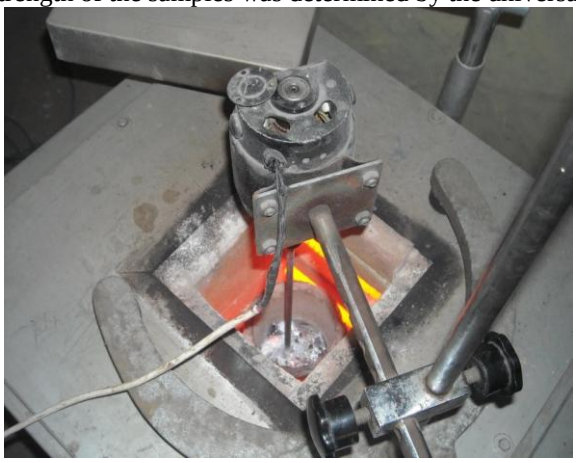


Figure 1: Stir casting Process

**5. Rock Well Hardness Test:**

The Rockwell scale is a hardness scale based on indentation hardness of a material. The Rockwell test determines the hardness by measuring the depth of penetration of an indenter under a large load compared to the penetration made by a preload. There are different scales, denoted by a single letter, that use different loads or indenters. The result is a dimensionless number noted as HRA, HRB, HRC, etc., where the last letter is the respective Rockwell scale. When testing metals, indentation hardness correlates linearly with tensile strength. This important relation permits economically important nondestructive testing of bulk metal deliveries with lightweight, even portable equipment, such as hand-held Rockwell hardness testers.

Figure 2: Rockwell Hardness Testing Machine

**6. Universal Testing Machine:**

A universal testing machine (UTM), also known as a universal tester, materials testing machine or materials test frame, is used to test the tensile strength and compressive strength of materials. An earlier name for a tensile testing machine is a tensometer. The "universal" part of the name reflects that it can perform many standard tensile and compression tests on materials, components, and structures.

Figure 3: Universal Testing Machine

ISSN: 2456 - 4664
International Journal of Advanced Trends in Engineering and Technology
Impact Factor 5.965, Special Issue, October - 2019
6th National Conference on Advancements in Mechanical, Environmental, Safety and Health Engineering (AMESHE) On 11th May 2019 Organized By
Department of Mechanical Engineering, Knowledge Institute of Technology, Salem, Tamilnadu

**7. Result and Discussion:**

1. Chemical Analysis of Fly Ash:

| Compounds | Percentage |
|---|---|
| SiO2 | 67.2 |
| Al2O3 | 29.6 |
| $Fe_2O_3$ | 0.1 |
| CaO | 1.4 |
| MgO | 1.7 |

Tabulation 1: Percentage of composition

Fly ash from Rourkel steel plant (India) had a wide particle size distribution. The particle size of the fly as received condition, lies in the range from (0.1-100 μm).The SEM micro-graph of the fly ash is shown in fig4.1. The major components of fly ash as received from the source and used for reinforcement are listed in Table 4.1 in wt%. The fly ash consist mainly $Al_2O_3$ (29.6 wt %) and $SiO_2$ (67.2wt %).

2. Hardness Measurement:

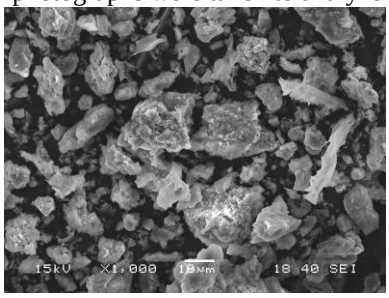
The below table shows that incorporation of fly ash particles in Aluminium matrix causes reasonable increase in hardness. The strengthening of the composite can be due to dispersion strengthening as well as due to particle reinforcement. Thus, fly ash as filler in Al casting reduces cost, decreases density and increase hardness which are needed in various industries like automotive etc.

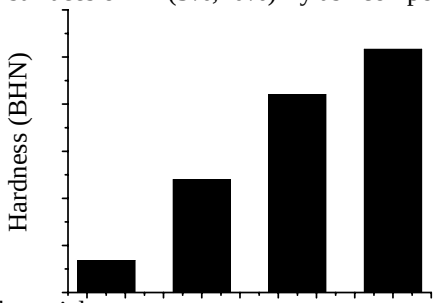
| Composite Sample | Hardness (BHN) |
|---|---|
| Al-5% Fly ash | 49.36 |
| Al-10% Fly ash | 52.8 |
| Al-15% Fly ash | 56.41 |
| Al-20% Fly ash | 58.33 |

Tabulation 2: Hardness value for different composition

3. Sem Analysis:

SEM photographs were taken to analyze the fly ash particles and surfaces of Al-(5%,20%) fly ash composites.




SEM micrograph of Fly ash particles

4. Mechanical Properties of Cast Composites:

The above table shows that incorporation of fly ash particles in Aluminum matrix causes reasonable increase in hardness. The strengthening of the composite can be due to dispersion strengthening as well as due to particle reinforcement. Thus, fly ash as filler in Al casting reduces cost, decreases density and increase hardness which are needed in various industries like automotive etc.

**8. Conclusion:**

- From the study it's concluded that we can use fly ash for the production of composites and can turn industrial waste.
- Fly ash up to 20% of weight can be successfully added to aluminium by stir casting methods to produce composites.
- The density of aluminium-fly ash is decreased with increase in addition of fly ash and the density will be reduced.
- The hardness of aluminium-fly ash has increased with increase in addition of fly ash the hardness will be increased.
- The tensile strength of aluminium-fly ash is increased up to 15% of fly ash is added in the aluminium

**9. References:**

1. C. Velmurugan, R. Subramanian, S. Thirugnanam, S. S. Ramakrishnan (2010) "Experimental studies on the wear behavior of heat treated Al 6061 hybrid metal matrix composites", ", International Journal of Engineering, Science and Technology vol.3 P87-101.
2. A. R. K. Swamy, A. Ramesha, G. B. Veeresh Kumar, J. N. Prakash (2011) "Effect of Particulate Reinforcements on the Mechanical Properties of Al6061-WC and Al6061-Gr MMCs A. R." , Minerals & Materials Characterization & Engineering vol.10 1141-1152.
3. Sanna Ala-Kleme, Paivi Kivikyto-Reponen, Jari Liimatainen, Jussi Hellman and Simo-Pekka Hannula (2006), "Abrasive wear properties of metal matrix composites produced by hot isostatic pressing" , Proc. Estonian Acad. Sci. Engineering vol.4 445-454.

4. Prakash C. H., Pruthviraj R.D (2011) "Microstructural Studies of Cast Zinc - Aluminum-Sic-Graphite Hybrid Composites", Research Journal of Chemical Sciences vol.6 88-90.
5. M. Sreenivasa Reddy, Soma V. Chetty, Sudheer Premkumar (2012) "Effect of reinforcements and heat treatment on tensile strength of Al-Si-Mg based hybrid composites", Applied Sciences and Engineering Research vol.1 No. 2
6. A. Dolata-Grosz, J. Wieczorek (2007) "Tribological properties of hybrid composites containing two carbide phases", Archives of Materials Science and Engineering vol.28 149-155
7. Vahid Majazi Dalfard (2012) "Effect of Particle Size of Tungsten Carbide on Weight Percent of Carbide in Ni-WC Nano-composite", ELECTROCHEMICAL SCIENCE vol. 3537 – 3542
8. A. Chennakesava Reddy and Essa Zitoun (2010) "Matrix Al-alloys for silicon carbide particle reinforced metal matrix composites", Indian Journal of Science and Technology vol.3 No.12
9. E. Bayraktar, J. Masounave, R. Caplain, C. Bathias (2008) "Manufacturing and damage mechanisms in metal matrix composites", Achievements in Materials and Manufacturing Engineering vol.31 No.2
10. Rajesh Kumar Bhushan (2010) "Effect of machining parameters on surface roughness and tool wear for 7075 Al alloy SiC composite", Int J Adv Manuf Technol vol.50 459–469.
11. Patrick W. Leech, XingS.Li , NazmulAlam (2012)" Comparison of abrasive wear of a complex high alloy hardfacing deposit and WC–Ni based metal matrix composite", CSIRO Earth Science and Resource Engineering vol. 25 P380-386.
12. S.C. Sharma (2001) "The sliding wear behavior of Al6061–garnet particulate composites", Department of Mechanical Engineering, R.V. College of Engineering vol. 249 P1036–1045.
13. T. Miyajima, Y. Iwai (2010) "Effects of reinforcements on sliding wear behavior of aluminum matrix composites", Department of Mechanical Engineering, Fukui University vol. 255 P606-616.
14. A. Mandal , M. Chakraborty, B.S. Murty (2007)" Effect of TiB2 particles on sliding wear behaviour of Al–4Cu alloy", Department of Metallurgical and Materials Engineering vol.262 P160-166.
15. S. Basavarajappa, G. Chandramohan, Arjun Mahadevan, Mukundan Thangavelu (2007)" Influence of sliding speed on the dry sliding wear behaviour and the subsurface deformation on hybrid metal matrix composite", Department of Mechanical Engineering, PSG College of Technology vol.262 P1007-1012.