Study of Mechanical Properties of AL (6061) with FLYASH and Sic to Prepare Different Compositions of Metal Matrix Composite by Stirring Solidification in Die Casting Process

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Abstract- *Metal matrix composites (MMCs) are amongst different classes of composites. MMCs offer a unique balance of physical and mechanical properties. Aluminum based MMCs have received increasing attention in recent decades as engineering materials with most of them possessing the advantages of high strength, hardness and wear resistance. The experimental investigation of the Study of mechanical properties of AL (6061) with FLYASH and Sic to prepare different compositions of metal matrix composite by stirring solidification in die casting process are reported in this paper. In this case we are taken the casted components are machined to specimen dimensions and different material testing had been conducted to obtain the material properties and characteristics. We are varying mass fraction of and fly ash (5%, 10%, & 15%) and keeping 3%, 6%, 8% sic. We had got well advancements in mechanical properties like tensile, impact strength and hardness with the increase in wt % of reinforcement.*

Keywords- Aluminum Alloy (Al 6061), Fly ash, Die-Casting, Mechanical properties.

I. INTRODUCTION

Composites are just a combination of different materials in such a way that the resulting materials have desired/required properties. Nowadays composite materials are widely used for many no of applications like engineering structures, aerospace, marine Application, sports and so on. The Metal matrix composites are especially aluminum matrix and articulate reinforced composites are getting most applications in present days. The fly ash is extracted from power plant and also mixes sic and among the various methods of producing MMC we had selected die-casting technique by using stirrer as it appears to be the best technique to introduce particles by forming vortex.

II. LITERATURE REVIEW

Anil et al. [2011] investigated the mechanical properties like compressive strength, ductility and hardness using aluminium fly ash composites. By increasing the weight fraction of the fly ash particles the above mentioned properties were found to be improved. Different composition needed to be added in the fly ash composites to enhance their properties further.

Vivekananda et al. [2013] have fabricated the aluminum fly ash composite by stir casting process. The addition of fly ash acts as a barrier to the movement of dislocations and thereby increases the hardness of the composite. And also by adding fly ash to the aluminum in molten state increases the abrasive wear resistance due to solid solution strengthening, dispersion strengthening and particle reinforcement.

Garg et al. [2012] have prepared a composite by using aluminum 6061 as the matrix and Sic, fly ash as the reinforcement. The composite is produced by stir casting technique in which the weight fraction of the silicon carbide is varied (from 2.5%, 5%, 7.5%. 10%) by fixing the fly ash weight fraction (5%). From the analysis, it is clear that increase in weight fraction of Sic improves the tensile strength and hardness of the composite.

Prasad et al. [2013] have investigated the mechanical properties of hardness and wear rate of Al-fly ash using different casting techniques. In this, Al –fly ash with 7.5% weight fraction has high hardness and wear rate when compared to the aluminium alloy produced by squeeze casting and gravity casting. The sample produced in this gravity casting has low hardness and high wear rate.

Prasad et al. [2013] have used eutectic -Al - Si -alloy as a matrix material with increasing fly ash (in wt. %) as a reinforcement and prepared a composite using squeeze casting by applying pressure. By increasing the weight percentage of fly ash the sliding wear resistance of the composite gets improved. The results further revealed that the porosity in composite has been minimized due to the squeeze casting method.

Anandhamoorthy et al. [2012] have produced Al/fly ash/graphite metal matrix composite using stir casting by fixing wt. % of graphite (3%) and varying the composition of fly ash (3 to 9%). It has been observed that the sliding wear rate depends on the load and hardness of the hybrid metal matrix composite is more when compared to Al 6061.

Mahindra et al. [2007] fabricated the metal matrix composite using Al-4.5% Cu as the matrix material and fly ash with varying weight fraction (5 to 15%) as the reinforcement material. The composite is produced by stir casting method in which the impact strength, compressive strength, tensile strength and hardness increases with increase in fly ash content. But the density and corrosion resistance decreases.

Biennials et al. [2003] investigated the pitting corrosion behavior and corrosion kinetics of Al alloy. In this method, AK12 is used as the matrix material and fly ash as the reinforcement to produce the composite by gravity casting and squeeze casting. Addition of Fly ash particles resulted in enhanced pitting corrosion.

Motgi et al.[2013] have used LM25 aluminium alloy as the matrix material and constant weight fraction of fly ash (3%) with varying weight fraction of aluminium oxide (5%,10%,15%) as the reinforcement to produce the composite by stir casting. By analysing this sample, the tensile strength and hardness seemed to be increased with increase in % wt. of aluminium oxide. But the major issue is the reduction of ductility and impact strength.

Arunkumar et al. [2011] have chosen Al6061 alloy as the matrix material and 2 to 8wt% of fly ash with 2 and 6wt% of e-glass fibre as the reinforcement to produce the composite by stir casting. The hardness, tensile strength and compressive strength increases as the wt. % of fly ash increases. The samples were tested in ultrasonic flow detector to identify the defects.

Uma Shankar et al. [2010] have opted Al6061 alloy as the matrix and bottom ash as the reinforcement to produce the composite by stir casting. Micro hardness and tensile strength of the composite increases with increase in wt. % of bottom ash particles. The tensile strength and micro hardness decrease when the wt. % of fly ash increases beyond 9%.

Uthayakumar et al. [2012] have used aluminium alloy 6351 as the matrix material and fly ash with weight percentage (5 to 15%) as the reinforcement to produce the composite by stir casting. The result shows that the applied load has the greatest effect on dry sliding wear and the composite did not wear at low loads.

Bharat et al. [2014] have utilized eutectic Al-Si-alloy LM6 containing 12.2491% Si as the matrix and the chemosphere of two different types (fly ash type- A and type -B) as the reinforcement to produce the composite by stir casting. The micro hardness, tensile strength, impact strength and hardness were high for type-B fly ash because of its micro structural differences and presence of a small amount of carbon.

III. EXPERIMENTATION

In this work, Al6061 material is used as the matrix element, and silicon carbide and fly ash as reinforcement

Table.1 Chemical composition of Aluminum 6061

Chemical properties:- Pure AL(6061) Test Method: OES-ASTM E-1251-11						
Fe%	Si%	Mn%	Cu%	Ni%	Cr%	Ti%
0.304	0.790	0.086	0.215	<0.005	0.113	0.015
Sn%	V%	Co%	Zn%	Pb%	Mg%	#Al%
<0.003	0.007	<0.005	<0.005	0.005	0.820	97.677

- **SILICON CARBIDE:**

Silicon carbide is the only chemical compound of carbon and silicon. It is an excellent abrasive. It is having low density, high strength, high elastic modulus, high thermal conductivity, excellent thermal shock resistance. Elevated temperature Performance and the fact that they reported only a 35% loss of strength at 1350ºC are their best qualities. And its melting point is 2700 ºC.

- **FLY ASH:**

Fly ash is one of the most in expensive and low density reinforcement available in large quantities as solid waste by-product during combustion of coal in thermal power plants. They constitute mostly of silicon dioxide (sio2), aluminum oxide/alumina (al2o3) and iron oxide (fe2o3). Fly ash particles are mostly spherical in shape and range from less than 1µm to 100 µm. It is having high electrical resistivity, low thermal conductivity.

In this work Al-Fa-Sic composites were produced by varying % of fly ash (5, 10 and 15 %) in Die casting process by using of stirrer.

1. Required amount of fly ash of by weight should be measured and kept aside.
2. Then the fly-ash were heated to 450-600 degree Celsius and maintained at that temperature for about 20 minutes to remove the moisture content.
3. Then weighed quantity of aluminum was melted in a crucible at 600-750 degree centigrade

4. The molten metal should be degassed at a temperature of 780 degree Celsius using solid dry hexachloroethane tablets. (<.5% weight age)
5. Then the molten metal was stirred to create a vortex and the weighed quantity of pre heated fly ash particle were slowly added to the molten metal maintained at >720 degree Celsius with continuous stirring at a speed of 400-500 rpm to a time of 6-8 minutes
6. During stirring magnesium about >2% should be added to ensure good wettability.
7. Then the melt with the reinforced particles were poured in to moulds the poring temperature should be maintained. At 680 degree Celsius.

IV. MECHANICAL PROPERTIES

4.1Tensile and yield strength:

To conduct tensile and the casted specimens are machined to standard IS 1608-2005 dimensions. And tested on universal testing machine.

4.2 Hardness:

Hardness test was carried out on the composite specimens are machined to standards IS 1500-2005 using Brinell hardness testing apparatus with 10mm diameter and load of 500kg. The loading time was 30 secs. Three readings were taken for each specimen and mean value was considered.

4.3 Impact test:

To conduct impact test and the casted specimens are machines to standards IS 1757-1988 dimensions. And tested on Charpy 'V' Notch test.

V. RESULTS AND DISCUSSION

Al-FA-Sic composite was successfully casted using Die casting method.

Table2: Mechanical properties of Al-Fa-SiC composite.

FLY ASH %	SILICON%	TENSILE STRENGTH (MPa)	YIELD STRENGTH (MPa)	HARDNESS (HBW)	IMPACT (JOULES)
0	0	173.49	122.76	56.5	6, 4, 6
5	3	174.25	126.30	51.2	6, 6, 4
10	6	154.29	132.92	55.8	6, 6, 8
15	8	178.90	142.98	47.7	8, 8, 6

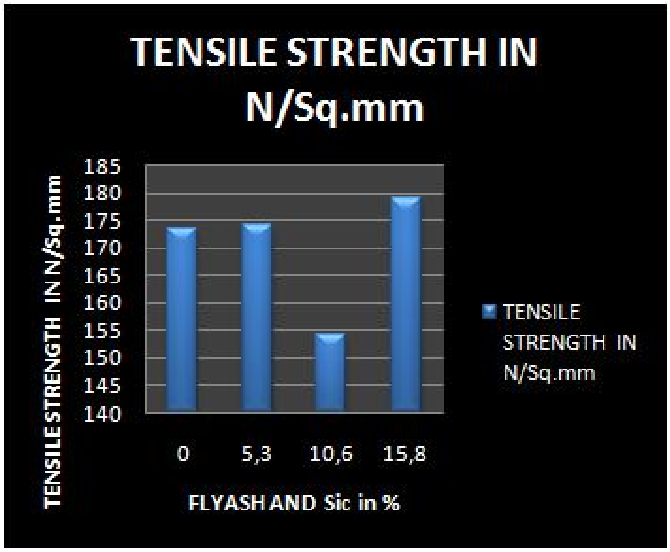

Fig 1: Tensile strength with the weight fraction of Fly ash and Sic

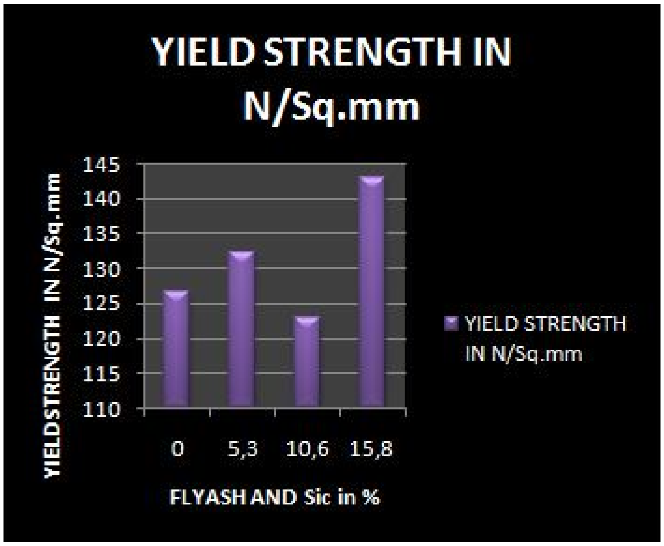

Fig 2: yield strength with the weight fraction of Fly ash and Sic

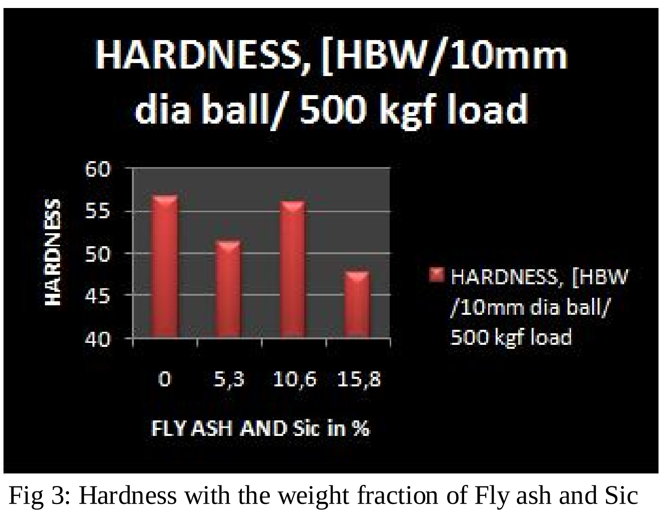

Fig 3: Hardness with the weight fraction of Fly ash and Sic

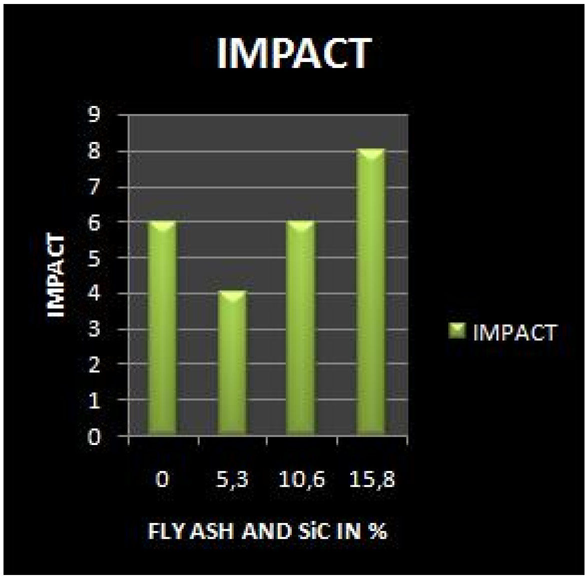

Fig 4: Impact strength with the weight fraction of Fly ash and Sic

Fig 5: Tensile test specimen of pure aluminum 6061

Fig 6: tensile test specimen of Al 6061 with 3% sic and 5% fly ash

Fig 7: tensile test specimen of Al 6061 with 6% sic and 10% fly ash

Fig 8: tensile test specimen of Al 6061 with 8% sic and 15% fly ash

Fig 9: Hardness test specimens of Al 6061 with fly ash and sic all compositions

Fig 10: impact test specimens of Al 6061 with fly ash and sic all compositions (0%, 5,3%, 10,6%,15,8)

The results of tensile, yield strength, Hardness test and Impact test are as tabulated in table 2 Tensile strength and yield strength of the casted composites is comparatively higher than the un-reinforced material. Its variation is show in fig 1& 2.Thus by observing the above figures and tables we can conclude that, with the addition of fly ash and Sic mechanical properties like tensile strength, hardness and impact strength can be increased up to some extent.

VI. CONCLUSIONS

Based on the observation and results obtained through experiments the following conclusions can be drawn.

- ✓ From the study it is concluded that we can use fly ash for the production of composites and clearing the fly ash storage issues.
- ✓ Fly ash up-to 15% by weight can be successfully added aluminum 6061 alloy by Die casting route to produce composites.
- ✓ Hardness of aluminum (Al6061) is increased from 47 HBW to 55HDW with addition of fly ash and magnesium.
- ✓ The Ultimate tensile strength has improved with increase in fly ash content. Whereas ductility has decreased with increase in fly ash content.
- ✓ Impact strength increases with increase in reinforcement wt%.

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