IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 11, Issue 6 Ver. III (Nov- Dec. 2014), PP 38-41
www.iosrjournals.org

Aluminum Composite with Fly Ash – A Review

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Abstract: *In our present stage, metal matrix composite is more acceptable because they are suitable for applications requiring combined strength and thermal conductivity, damping properties, lower density. The properties of MMCs enhance their usage in automotive and many applications. In the field of automobile, MMCs are used for pistons, brake drum, cylinder block because of better corrosion resistance and wear resistance. Fly ash is used as the reinforcement to produce the composite by stir casting. Fly ash is chosen because of it is least expensive and low density reinforcement available in large quantities as solid waste by-product during combustion of coal in thermal power plants. Due to low weight it can be applied in automobile and thus improving its life. The review reveals that increase in mechanical properties up to 20% of fly ash in the matrix material. But the corrosion resistance decreases with the fly ash addition.*
Keywords: *Metal matrix composite, fly ash, stir casting, aluminum alloy*

I. Introduction

Metal composite materials have found application in many areas of day to day life for quite some time. In traffic engineering, especially in the automotive industry, MMCs have been used commercially in fibre reinforced pistons and aluminum crank cases with strengthened cylinder surfaces as well as particle-strengthened brake disks.Aluminium is a chemical element in the boron group with symbol Al and atomic number is 13. It is silvery white, and it is insoluble in water under normal circumstances. Aluminium alloys are alloys in which aluminium (Al) is the strongest metal. The typical alloying elements are silicon and zinc. There are two divisions, namely casting alloys and wrought alloys. Fly ash is one of the residues generated in the combustion of coal. It is an industrial by-product recovered from the flue gas of coal burning electric power plants. Based on the source and makeup of the coal being burned, the fly ash components produced changes considerably. In general, fly ash contains Fe_2O_3, Al_2O_3, SiO_2, as major proportion and oxides of Ca, Na, Mg etc., as minor proportion. Fly ash particles are mostly spherical in shape and range from less than 1 μm to 100 μm with a upper area, between 250 and 600 m^2/kg. The specific gravity varies between 0.6-2.8 g/cc. Physical properties of fly ash mainly depend on the type of coal burned and the conditions of burning. Class F type fly ash is produced from burning high rank (containing high carbon content) coals such as anthracite and bituminous coals, whereas, Class C fly ash is produced from low rank coals.

II. Literature Review

Anil et al. [1] investigated the mechanical properties like compressive strength, ductility, and hardness by using aluminium fly ash composites. By increasing the weight fraction of the fly ash particles the above mentioned properties gets improved. Different composition needed to be added in the fly ash composites to enhance their properties further.

Vivekanandan et al. [2] have fabricated the aluminium fly ash composite by stir casting process. The addition of fly ash acts as a barrier to the movement of dislocations and there by increases the hardness of the composite. And also by adding fly ash to the aluminium in molten state increases the abrasive wear resistance. This strengthening of the composite is because of the solid solution strengthening, dispersion strengthening and particle reinforcement.

Garg et al. [3] have prepared a composite by using aluminium 6061 as the matrix and SiC, fly ash as the matrix material. 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 by increasing the weight fraction of SiC the tensile strength and hardness of the composite gets improved.

Prasad et al. [4] have investigated the mechanical properties of hardness and wear rate by 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. And also the sample produced in this gravity casting has low hardness and high wear rate.

Prasad et al.[5] 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. And also by employing squeeze casting the porosity in composite has been removed.

Anandhamoorthy et al. [6] 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 also the hardness of the hybrid metal matrix composite is more when compared to Al 6061.Mahendra et al.

Mahendra et al. [7] fabricated the metal matrix composite by 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.

Bienias et al. [8] investigated the pitting corrosion behavior and corrosion kinetics of Al alloy. In this method, they have used AK12 as the matrix material and fly ash as the reinforcement to produce the composite by gravity casting and squeeze casting. Fly ash particles lead to an enhanced pitting corrosion of the AK12/9% fly ash composite in comparison with unreinforced matrix.

Motgi et al. [9] 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 analyzing this sample, the tensile strength and hardness gets increased with increase in % wt of aluminium oxide. But the major issue is the ductility and impact strength gets reduced.

Arunkumar et al. [10] 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. And also the samples were tested using ultrasonic flow detector to identify the defects.

Umashankar et al. [11] 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. But the problem is, after 9% wt of bottom ash the tensile strength and micro hardness decreases.

Uthayakumar et al. [12] 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. From the result it is clear that the composite does not wear at low loads. And the result shows that the applied load has the greatest effect on dry sliding wear.

Bharat et al. [13] have utilized eutectic Al-Si-alloy LM6 containing 12.2491% Si as the matrix and the cenosphere 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 higher for type-B fly ash because of its micro structural differences and presence of small amount of carbon.

Sreenivasareddy et al. [14] have opted Al 7075 alloy as the matrix material and e-glass fibre with fly ash by varying the weight percentage to produce the composite .The hardness and tensile strength of the heat treated specimen is higher when compared to the cast specimen. The percentage of e-glass fibre and fly ash can be varied to enhance the mechanical properties further.

Anilkumar et al. [15] have chosen Al 6061 alloy as the matrix material and fly ash with varying weight percentage (10%, 15%, 20%) with particle size [of 4-25, 45-50, 75-100 μm] as the reinforcement to produce the composite by stir casting. By analyzing the sample, the hardness, tensile strength, compressive strength increases with increase in weight fraction of fly ash.

Mani et al. [16] have investigated the hardness, tensile strength, and the wear resistance of the composite by suitable testing methods. They have used AL 6063 as the matrix material with fly ash as the reinforcement to produce the composite by stir casting. From the analysis it is clear that the tensile strength, hardness and wear resistance increases with the incorporation of fly ash

Prabhu et al. [17] have utilized aluminium as the matrix material and fly ash as the reinforcement to produce the composite by stir casting. The electro chemical machining is used to find out the minimum overcut and optimum metal removal rate. From the result, the hardness of al-fly ash increases with increase in addition of fly ash.

Lokesh et al. [18] have investigated the tensile, compressive, hardness and impact properties of the base alloy as well as the composite by stir, squeeze and gravity casting. In this the weight fraction of fly ash is varied from 3% to12% which increases the above properties. The base alloy prepared by squeeze casting has lower porosity when compared to the base alloy prepared by gravity casting.

Prashant Kumar Suragimath et al. [19] carried out the mechanical properties of Aluminium alloy (LM6) reinforced with SiC and fly ash to find that the wear resistance tends to raise with addition of Fly Ash in LM6/SiC Hybrid composite.

Selvi et al. [20] investigated the mechanical properties of AL MMCs theoretically and experimentally and also concluded that the fly ash particles improve the wear resistance of the Al MMC and the presence of

SiO2 in fly ash increase wear resistance of Al MMC and that changes of wear rates are observed in the sliding wear test.

Shanmughasundaram et al. [21] Revealed that by adding fly ash particles the compressive strength gets improved. Compressive Strength of the composites tends to drop when the fly ash content is raised from 20 % to 25 wt%. But beyond20 wt%, the fly ash particles interact with each other due to clustering of particles which reduces the strength.

Prabhakar Kammer et al. [22] Carried experimental investigation of Al7075 with Fly ash & Eglass fibers. The metal matrix composite is produced by stir casting. The e glass fibre percentage is fixed as 1% with varying fly ash (2 to 8%) Compression strength and tensile strength tends to improve when compared to Al 7075 alloy.

Mahendra Boopathi et al. [23] Mentioned a increase in hardness was observed with increase in weight fraction of SiC & fly ash. Maximum hardness is observed at Al/ (10%SiC+10%fly ash). Incorporation of fly ash particles improves the hardness and also the deformation of the Al matrix. It is observed that the fact that the combination of SiC with fly ash particles possess higher hardness than the aluminum alloy.

Shivaprasad et al. [24] have used the aluminium alloy AA2024 as the matrix material and fly ash as the reinforcement with 10% weight fraction, the composite is produced by stir casting. The hat treated AA2024+10% fly ash composite has improved were characteristics when compared to non-hate treated ones. The specific wear rate for water cooled condition is low when compared to air cooled condition.

Arun et al. [25] investigated the characteristics of aluminium –fly ash – alumina composite with the stir casting process .Al 6061 is chosen as the matrix material and fly ash as the reinforcement. The reinforcement particulates are equally distributed in Al6061 alloys which is shown in SEM analyses .

III. Conclusion

This paper reviews that the metal matrix composites are very much useful in automobile. Fly ash plays a key role in enhancing the mechanical property. The previous result shows 10 to 20% increase in mechanical properties. The tensile strength, compression strength and hardness get improved by adding fly ash. The usage of aluminum can be minimized by enforcing the fly ash. SEM analysis is done to know the distribution of fly ash with the composite.

References

[1]. H.C.Anilkumar, H.S.Hebbar and K.S.Ravishankar, "Mechanical properties Of Fly Ash Reinforced Aluminium Alloy (al6061) Composites", IJMME, 2011, Vol.6, Issue.1, pp. 41-45.

[2]. Vivekanandan.P, Arunachalam.V.P, "The Experimental Analysis of Stir Casting Method on Aluminium-Fly Ash Composites", IJCET, 2013, Vol.3.

[3]. Sandeep Kumar Ravesh, Dr. T. K. Garg, "Preparation & Analysis for Some Mechanical Property of Aluminium Based Metal Matrix Composite Reinforced with Sic & Fly Ash", IJERA, 2012, vol.2, issue6, pp.727-731.

[4]. K.N.P.Prasad, M.Ramachandra, "Effect of Squeeze Pressure on The Hardness and Wear Resistance of Aluminium Fly Ash Composite Manufactured by Stir-Squeeze Casting", IJEI, 2013, vol.3, issue 4, pp.01-08.

[5]. K.N.P. Prasad, M. Ramachandra, "Evaluation Of Factors Affecting Sliding Wear Behaviour Of Al-Fly Ash Metal Matrix Composites By Using Design Of Experiments", IJMER, 2013, Vol.3, Issue 5, pp 2591-2599.

[6]. A. AnandhaMoorthy, Dr. N. Natarajan, R. Siva Kumar, M. Manoj Kumar, M. Suresh, " Dry Sliding Wear and Mechanical Behaviour of Aluminium/Fly ash/Graphite Hybrid Metal Matrix Composite Using Taguchi Method", IJMER, 2012, Vol.2, Issue.3, pp-1224-1230.

[7]. K.V.Mahendra, K.Radhakrishna, "Fabrication of Al–4.5% Cu Alloy with Fly Ash Metal Matrix Composites and its Characterization", material science, 2007, vol.25.

[8]. J. Bienia, M. Walczak, B. Surowska, J. Sobczaka, "Microstructure and Corrosion Behaviour of Aluminium Fly Ash Composites", Journal of Optoelectronics and Advanced Materials, Vol. 5, No. 2, 2003, pp. 493 – 502.

[9]. B.S.Motgi, R Patil, "A Study on Mechanical Properties of Fly Ash and Alumina Reinforced Aluminium Alloy (LM25) Composites", IOSR,Vol. 7, Issue 6, 2013, pp.41-46.

[10]. Arun Kumar M. B. and R. P.Swamy, "Evaluation of Mechanical Properties of al6061, Fly Ash and e-glass Fibre Reinforced Hybrid Metal Matrix Composites", ARPN, 2011, Vol.6, Issue.5.

[11]. Mahanthesh G, Umashankar, "Preparation and Property Evaluation of Aluminium Alloy (6061) Reinforced with Bottom Ash Particulate composite (ALBAP Composite)", IJSR, Vol.1, Issue.4.

[12]. M. Uthayakumar, S. ThirumalaiKumaran, and S. Aravindan, "Dry Sliding Friction and Wear Studies of Fly Ash Reinforced AA-6351 Metal Matrix Composites", Advances In Tribology, 2012.

[13]. Ajit Kumar Senapati, Purna Chandra Mishra, Bharat Chandra Routara, "Use of Waste Fly ash in Fabrication of Aluminium Alloy Matrix Composite", IJET, 2014, Vol. 6, Issue 2.

[14]. M. Sreenivasa Reddy, Dr. Soma V. Chetty, Dr.Sudheer Premkumar, "Evaluation of Hardness and Tensile Properties of Al 7075 Based Composite", IJAER, 2012, Vol.3, Issue.1.

[15]. Anilkumar H. C, H. Suresh Hebbar, " Effect of Particle Size of Fly Ash on Mechanical and Tribological Properties of Aluminium alloy (Al6061) Composites and Their Correlations", IJMSE, 2013, Vol. 3, Issue.1.

[16]. M. Raja Kumar, M. ShunmugaPriyana, A.Mani, " Investigation of Mechanical and Wear properties of Aluminium-Fly Ash composite material produced by Stir Casting Method", IJSER, 2014, Vol.5, Issue.5.

[17]. B.Babu, M.Prabhu, P.Dharmaraj, "Fabrication and Analysis of Aluminium Fly Ash Composite using Electro Chemical Machining", IJLTET, 2014, Vol .3, Issue.4.

[18]. G. N. Lokesh, M. Ramachandra, K. V. Mahendra, T. Sreenith, " Characterization of Al-Cu alloy reinforced fly ash metal matrix composites by squeeze casting method", IJEST, 2013,Vol.5,Issue.4.
[19]. Mr. Prashant Kumar Suragimath, Dr. G. K. Purohit, "A Study on Mechanical Properties of Aluminium Alloy (LM6) Reinforced with SiC and Fly Ash", International Organization of Scientific Research, 2014, vol.8 issue-6.
[20]. Dr. Selvi.S, Dr. Rajasekar.E, Sathish kumar. M, Ramkumar. B, "Theoretical and Experimental Investigations of Mechanical Properties of Aluminum based Metal Matrix Composite", Engineering Science and Technology: AnInternational Journal, 2013, vol.3.no.2.
[21]. P. Shanmughasundaram, R. Subramanian, G. Prabhu, "Some Studies on Aluminium-Fly Ash Composites Fabricated by Two Step Stir Casting Method", European Journal of Scientific Research, 2011, vol.63, pp.204-218.
[22]. Prabhakar Kammer, H.K.shivanand & Santhosh Kumar.S, "Experimental Studies on Mechanical Properties of E-glass short Fibres & fly ash reinforced al 7075 hybrid metal matrix composites", IJMIE, 2012, vol.1 Issue-4.
[23]. Mahendra Boopathi, M., K.P. Arulshri and N. Iyandurai,"Evaluation of Mechanical Properties Of Aluminium Alloy 2024Reinforced With Silicon Carbide And Fly Ash Hybrid Metal Matrix Composites", American Journal of Applied Sciences,2013.
[24]. Shivaprakash.Y.M, Yadavalli Basavaraj, K.V.Sreenivasa Prasad **, "**Comparative study of tribological characteristics of AA2024+10% flyash composite in non-heat treated and heat treated conditions", International Journal of Research in Engineering and Technology, 2013.
[25]. Prakash Gadade, Arun L.R, "Characterisation Of Aluminium Fly Ash-Alumina Composite for Piston Analysis By CAE Tools",International Journalof InnovativeResearchInScience,EngineeringandTechnology,2013.