March – April 2020
ISSN: 0193-4120 Page No. 9531 - 9535

Parametric Optimization on Wear Behaviour of Rice Husk-MoS_2 Reinforced Al MMC by Taguchi Approach

N.Sathish Kumar[1] , K.P.Harshavardhan[2], R. Arul Murugan[3]
[1]Asst Prof, Dept of Mech, Karpagam Academy of Higher Education, India
[2]Asst Prof, Dept of Mech, Karpagam Institute of Technology, India
[3]Asst Prof, Dept of Mech, Karpagam College of Engineering, India
sathiskumar.n@kahedu.edu.in

Article Info
Volume 83
Page Number: 9531 - 9535
Publication Issue:
March - April 2020

Article History
ArticleReceived*: 24 July 2019*
Revised*: 12 September 2019*
Accepted*: 15 February 2020*
Publication*: 11 April 2020*

Abstract:
In this research, compo casting method was utilized to developed Aluminium metal matrix composite. Varying percentage of rice husk (5, 10, 15 wt. %) and constant wt. % of molybdenum disulphide(MoS_2). Wear behaviour of developed composite was studies with various wear parameter viz. applied load (10, 20, 30N) and sliding velocity (2, 4, 6 m/s). Taguchi approach was adopted to understand the influence of wear parameter over wear rate.Resultrevel that wear rate decrease with increasing rice husk percentage and wear rate increase with increase applied load. Among the wear parameter,sliding velocity showcase lower influence over wear rate.

Keywords: *Aluminium MMC; compo casting; wear behaviour; Taguchi method.*

1. Introduction:

In recent days Aluminium based alloys are interchanged extensively by means of aluminium metal matrix composites in industrial sector that includes transport industry. Aluminium metal matrix composites compromiseconvincedbenefitssuch as high strength to weight ratio and excellent resistance to corrosion. Aluminium metal matrix composites are fabricated by reinforcing hard ceramic materials such SiC,TiCetc[1–3]. and solid lubricants such as graphite,BN, MOS_2etc. to improve the basic and functional behaviour of base materials[4]. some studies depicts that naturally available agricultural waste such as rice husk ash have better potential to utilized to reinforcement material to improve the mechanical strength and wear resistance of base matrix material. Usage of these rice husk ash have several advantages such as low cost, easily available. These rice husk consist of silicon and carbon as the major composition[5,6].

Theseeco-friendly reinforcement have higher hardness compare to the available ceramic particles, this fact made them suitable for fabricating of light weight and better strength aluminium metal matrix composites.Fabrication of aluminium metal matrix composites with agricultural based waste as reinforcement a materialhas gained major attractiveness in few years.[7,8]aluminium metal matrix composites developed from these forms of wastesdelivervarious advantages vizlow processing costs and low coefficient ofthermal expansion this make them as a appropriate for applications demanding thermal considerationsand stress bearing capacity based application. These naturally available low cost r materials are also

Published by: The Mattingly Publishing Co., Inc

March – April 2020
ISSN: 0193-4120 Page No. 9531 - 9535

reflected as reinforcement materials in developing countries owing to high cost and restricted availability of traditional reinforcement particles[9].

In this research an attempt have been made to reuse the agricultural waste rice husk ash as the reinforcement for Aluminium matrix composite. Varying percentage of rice husk and constant percentage ofMoS_2 was used as the reinforcement to improve the wear resistance of Al6061 alloy. Traditional Taguchi method was utilized to study the influence of wear behaviour of over wear rate

2. Materials and Methods

The method selected for fabricating the novel cost effective high performance hybrid composite is compo casting which is also called as multi step stir casting. The setup utilized for fabricating the composite materials is shown in figure 1. The measure quantity of rice husk ash and MoS_2 particles were preheated separately in a muffle furnace at 250°C in the view of eliminating the moisture content and increasing the wettability with base molten alloy. The amount (weight %) of RHA particles in aluminium matrix is varied as 0, 5, 10 and 15 in order to identify the effect of RHA on the performance of Al MMC wherein the secondary reinforcement (MoS_2 solid lubricant) percentage is fixed as 3. The amount of secondary reinforcement is kept as minimal as because of its soft nature which will deduce the properties of AMC when added more.

A measured quantity of base aluminium material is kept in the furnace and the temperature is raised to 610°C which makes the material semi solid. The preheated RHA and MoS_2 particles were added into the molten metal in multiple steps and temperatures. Then the molten mixture is stirred with the aid of a motorized stainless steel stirrer to get uniform distribution of reinforcements in the matrix. Then the mixture is poured into the preheated die and allowed to cool. Similarly other compositions with different RHA percentage are fabricated and the samples were prepared for further testing.

3. Design of experiment(DOE):

DOE is an organized methodology to regulate and understand the association among the factorsinfluencing the process and output response of adopted process. This method is also considered as effective approach to found the cause and effect based relationship among selected parameters. The results attained from the DOE are utilized to optimize input parameter in order to obtain required output .In this research taguchi method was adapted to design the experimental plans.

Table1. Parameter details for wear analysis

Factors	**Level 1**	**Level 2**	**Level 3**
Wt.%	*5*	*10*	*15*
Load	*10*	*20*	*30*
Sliding velocity	*2*	*4*	*6*

Taguchi approach is an traditional method used for effective statistical technique to understand the influence of input parameter over the output response. Taguchi method progresses the quality of product by accentuating a recital characteristic value exactly closer to set target instead of a using the specification limits[10].

Table 2 SNR and wear rate of developed MMC.

wt. %	**Load**	**Sliding velocity**	**Wear rate**	**SNR**
5	10	2	*0.732*	*2.7098*
5	20	4	*0.561*	*5.0207*

Published by: The Mattingly Publishing Co., Inc

March – April 2020
ISSN: 0193-4120 Page No. 9531 - 9535

5	30	6	*1.112*	*-0.9221*
10	10	4	*0.202*	*13.8930*
10	20	6	*0.514*	*5.7807*
10	30	2	*0.911*	*0.8077*
15	10	6	*0.118*	*18.5183*
15	20	2	*0.390*	*8.1787*
15	30	4	*0.211*	*13.4979*

In general the results attained from the DOE are converted in the form of signal-to-noise ratio (SNR).There are three SNR values used in Taguchi approach, viz. nominal is better, larger is better, smaller is better. Based on literature survey, applied load and sliding velocity are the influencing factor for governing wear rate. Hence in this research three factors and three levels are adopted and same are illustrated in table 1. Henceforth L9 orthogonal array was utilized for directing the experiments as depicted in table 2. ASTM G99 standard was utilized to conduct the wear analysis.

4. Results and discussion:

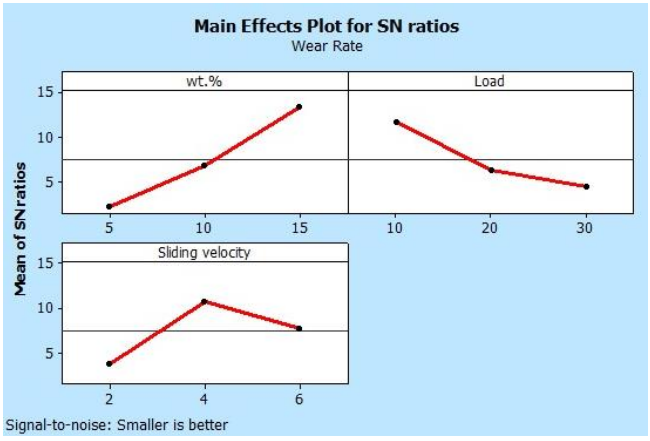

Figure 1 Main effect plot for wear analysis

Effect of input parameter over wear rate of the developed MMC was showcased in figure 1. I can be notified that addition of reinforcement weight percentage increases the wear resistance of the fabricated MMC. These hard reinforcement particles uniformly dispersed over the matrix phase that initiates the incremental wear resistance. These rice husk consists of silicon and silicon oxide as the major contribution elements which has higher hardness while compared to the aluminium based ferrous material. Addition of hard reinforcement over the soft matrix phase helps in increasing its hardness. According to archardslaw, increment in hardness decrease the wear loss of the material.Further it can be notified from figure 1. It also visualize that increase in applied decrease the wear resistance.during wear test increase inn load increase the contact surface between the pin and counter disk plate. This fact results in increased wears loss.It can be noticed from figure1 that wear rate shows incremental and decremental trend this might be due to the thermal effects that happens between composite surface.From table 3 it can notified that reinforcement weight percentage plays a key role in governing the wear rate however sliding velocity have the least influence over the wear rate[9].

Table 3 Response table for wear analysis

Level	**wt.%**	**Load**	**Sliding velocity**
1	2.269	11.707	3.899
2	6.827	6.327	10.804
3	13.398	4.461	7.792
Delta	11.129	7.246	6.905
Rank	***1***	***2***	***3***

Published by: The Mattingly Publishing Co., Inc

March – April 2020
ISSN: 0193-4120 Page No. 9531 - 9535

Table 4 ANOVA for wear analysis

Source	DF	Seq SS	Adj SS	Adj MS	F	P
wt.%	2	0.47413	0.47413	0.23707	46.68	***0.021***
Load	2	0.23994	0.23994	0.11997	23.62	***0.041***
Sliding velocity	2	0.19973	0.19973	0.09986	19.66	***0.048***
Error	2	0.01016	0.01016	0.00508		
Total	8	0.92396				

ANOVA results helps in understand the role and contribution of wear parameter over wear rate. In general P value less than 0.05 are consider as the significant factor. From table 4 it can be seen that P value all the parameters are less that 0.05 hence all the parameter have significant over the wear rate. The contribution of wear parameter over wear rate was depicted in figure 2. Among them reinforcement wt.% have major contribution of 51.3% and sliding velocity have the minimal contribution of 21.6%

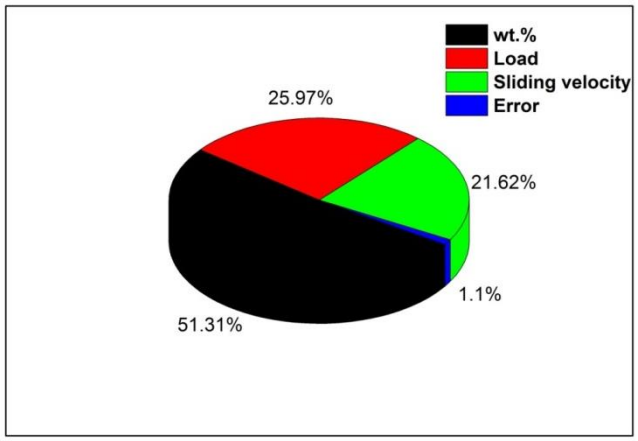

Figure 2 Contribution percentage of wear parameter

Conclusion:

Rice husk reinforced hybrid aluminium metal matrix composite was developed by compo casting route. Taguchi method was adopted to understand the wear behaviour of fabricated composite and the observed results are as follows.

1) Incremental percentage of rice husk show decremental trend in wear rate
2) ANOVA results depicts that all the wear parameter have significance over wear rate
3) Reinforcement weight percentage have major contribution (51%) over wear rate
4) These agricultural waste reinforced composite can be used for fabricating brake drums.

Reference:

[1] Kumar KR, Pridhar T, Balaji VSS. Mechanical properties and characterization of zirconium oxide (ZrO2) and coconut shell ash (CSA) reinforced aluminium (Al 6082) matrix hybrid composite. J Alloys Compd 2018;765:171–9.

[2] Prakash Kumarasamy S, Vijayananth K, Thankachan T, Pudhupalayam Muthukutti G. Investigations on mechanical and machinability behavior of aluminum/flyash cenosphere/Gr hybrid composites processed through compocasting. J Appl Res Technol 2017;15:430–41.

[3] Prakash KS, Moorthy RS, Gopal PM, Kavimani V. Effect of reinforcement, compact pressure and hard ceramic coating on aluminium rock dust composite performance. Int J Refract Met Hard Mater 2016;54:223–9.

[4] Kavimani V, Prakash KS, Starvin MS, Kalidas B, Viswamithran V, Arun SR. Tribo-Surface Characteristics and Wear Behaviour of SiC@r-GO/Mg Composite Worn under Varying Control Factor. Silicon 2019. https://doi.org/10.1007/s12633-019-0095-2.

Published by: The Mattingly Publishing Co., Inc

[5] Prakash KS, Gopal PM, Kavimani V. Effect of rock dust, cenosphere and E-waste glass addition on mechanical, wear and machinability behaviour of Al 6061 hybrid composites 2017.
[6] Kamal T, Siddiqui MA. Evaluation of mustard husk ash as reinforcement for aluminium matrix composite. Mater Res Express 2018;5:86509.
[7] Saravanan SD, Kumar MS. Effect of mechanical properties on rice husk ash reinforced aluminum alloy (AlSi10Mg) matrix composites. Procedia Eng 2013;64:1505–13.
[8] Alaneme KK, Olubambi PA. Corrosion and wear behaviour of rice husk ash—Alumina reinforced Al–Mg–Si alloy matrix hybrid composites. J Mater Res Technol 2013;2:188–94.
[9] Alaneme KK, Sanusi KO. Microstructural characteristics, mechanical and wear behaviour of aluminium matrix hybrid composites reinforced with alumina, rice husk ash and graphite. Eng Sci Technol an Int J 2015;18:416–22.
[10] Dhuria GK, Singh R, Batish A. Application of a hybrid Taguchi-entropy weight-based GRA method to optimize and neural network approach to predict the machining responses in ultrasonic machining of Ti–6Al–4V. J Brazilian Soc Mech Sci Eng 2016. https://doi.org/10.1007/s40430-016-0627-2.
[11] Jeevanantham, S., Sivaram, N. M., Smart, D. R., & Nallusamy, S. (2017). Optimization of Internal Grinding Process Parameters on C40E Steel Using Taguchi Technique. International Journal of Applied Engineering Research, 12(19), 8660-8664.
[12] Prakash, K. S., Gopal, P. M., & Karthik, S. (2020). Multi-objective optimization using Taguchi based grey relational analysis in turning of Rock dust reinforced Aluminum MMC. Measurement, 107664.
[13] Kavimani, V., & Prakash, K. S. (2017). Tribological behaviour predictions of r-GO reinforced Mg composite using ANN coupled Taguchi approach. Journal of Physics and Chemistry of Solids, 110, 409-419.
[14] Sivanantham, A., Manivannan, S., & Babu, S. P. (2019). Parametric Optimization of Dissimilar TIG Welding of AISI 304L and 430 Steel Using Taguchi Analysis. In Materials Science Forum (Vol. 969, pp. 625-630). Trans Tech Publications Ltd.
[15] Kavimani, V., Prakash, K. S., Thankachan, T., Nagaraja, S., Jeevanantham, A. K., & Jhon, J. P. (2019). WEDM Parameter Optimization for Silicon@ r-GO/Magneisum Composite Using Taguchi Based GRA Coupled PCA. Silicon, 1-15.
[16] Shanmughasundaram, P., Subramanian, R., & Prabhu, G. (2011). Some studies on aluminium–fly ash composites fabricated by two step stir casting method. European journal of scientific research, 63(2), 204-218.