International Journal of Advance Research in Science and Engineering
Vol. No.5, Issue No. 06 , June 2016
www.ijarse.com
IJARSE
ISSN 2319 - 8354

EXPERIMENTAL STUDY OF MATERIAL REMOVAL RATE OF METAL MATRIX COMPOSITE IN ELECTRIC DISCHARGE MACHINING PROCESS USING TAGUCHI ANALYSIS

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ABSTRACT

The world is moving towards the excellence in terms of the machining of materials in the manufacturing sector. The improvement in rate of machining of the materials is the biggest challenge in hybrid machining process like electric discharge machining. In the present paper, a hybrid Al(SiC+Al_2O_3*) metal matrix compositeis machined using electric discharge machining process. The experimentation procedure was designed with the help of taguchi design. The* L_9 *orthogonal array was used to analyze the effect of input parameters i.e. voltage, current and pulse duration. The test results show that the best parametric combination for maximum material rate is A3B3C2.*

Keywords: Electric Discharge Machining, MMC, Material Removal Rate, Taguchi Analysis, Voltage

I INTRODUCTION

The hybrid machining processes are the future of the manufacturing industries in the coming time. These processes use the alternate energy sources like chemical electrical and sound for the processing. The materials having better strength as compared to the conventional materials are now a day possesses better opportunities in the manufacturing industries. The electric discharge machining is the process which is used to machine conductive materials. In the EDM process, the metal is eliminating from the work piece due to erosion case by quickly recurrent spark ejection taking place among the tool and work piece. Both tool and work piece are immersed in a dielectric fluid. Deionized water is very common kind of liquid dielectric while vaporous dielectrics are also used in certain cases. The tool is ended cathode and work piece is anode. Once the voltage across the gap becomes adequately high it releases over the breach in the form of the spark in pause of from 10 of micro seconds. And positive ions and electrons are augmented, generatingaejectioncanal that becomes conductive. It is fair at this point when the spark fences initiating collisions between ions and electrons and making a passage of plasma. During Electric Discharge Machining process numerous material coatings take place on the workpiece surface within the processing zone. G.Dusro et.al [1] worked on the production of micro holes using micro-EDM technology. The examinationemphases on the effect of different electrodes and workpiece materials on the process performance, expressed in terms of tool wear ratio.Due to an inefficient removal of debris when increasing hole depth, a new strategy based on the use of helical-shaped electrodes has been proposed [2]. In case of conflicting type performance measures, it is necessary to get possible optimum values of all performances simultaneously, like greater material removal rate (MRR)with lessermiddling surface roughness (ASR) in electric discharge machining (EDM) process [3]. A. Soveja et al [4] have defined the experimental study of the surface laser texturing of TA6Valloy. The inspiration of the functioningaspects on the laser texturing process has been studied usingtwo experimental approaches: Taguchi methodology and RSM. The MRR was found to diminution with an upsurge in the percent volume of SiCwhile the tool wear rate and the surface roughness upsurge with an upsurge in the size of SiCand shown in the graph between interactive effect of the percent volume of Sic and the current on MRR [5]. EDM drilling is outstanding for machining cavernous and slender holes irrespective of material hardness and location, whereas die-sinking EDM works well to machine micro-parts and perpendicular walls of die and molds [6]. Wang et.al [7]investigates in depth the influence of the alternating current movement on the tool-workpieceinterface, a pulse counting method based on the detection of the current highest has been projected to computation the number of operative pulses. In the present paper, the machining of the hybrid metal matrix composite is performed with the help of the electric discharge machining to analyze the material removal rate.

II EXPERIMENTAL STUDY

The experimental study involves the fabrication of the composite and the planning of the experimentation. The experiments were performed on the Elektra EMS 5535. The round shaped copper electrode of diameter 10 mm are used for the entire work combination.

2.1 Fabrication of the Composite

The Al(SiC+Al_2O_3) metal matrix composite was fabricated using casting process. Casting is a processin which molten metal is poured into into a stack of continuous fiber reinforcements or discontinuous reinforcements (short fibers and particulates) and is then allowed to solidify between the inter-reinforcement spaces. In this composite, aluminum 6063 was used as matrix and 10% wt. of SiC and 10% wt. of $Al_2O_3$was used as reinforcement. The aluminum 6063 was heated up to 700 degree Celsius to convert it in to molten state and with the help of manual stirring the SiC and Al_2O_3powder with their specific weight percentage was mixed with the molten metal and again the mixture was heated up to 750 degree Celsius.

2.2 Electric Discharge Machine

Electro Discharge Machining (EDM) is an electro-thermal non-traditional machining Process, where electrical energy is used to produce electrical spark and removal of material mostlyarises due to currentdynamism of the

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www.ijarse.com
IJARSE
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spark. EDM is primarily used to machine hard-to-machine ingredients and high strength temperature resistant alloys. In the present work, Elektra EMS 5535 is used for the experimentation.

EDM Specification	
Work Tank	650 * 400* 280 mm
Work Table Size	400*250 mm
Table Transverse	220*150 mm
Max. Working Current	20+2 Amp
Min. Electrode Wear	≤ 0.1 %
Power Supply	3 phase, 415 V* AC, 50 Hz

Table 2.1 EDM Specification

Figure 2.1 Electric Discharge Machine

2.3 Design of Experiments

In present work, four process parameters namely current, pulse-on time, pulse-off time and voltage were selected as input variables for machining of Al(SiC+Al_2O_3) metal matrix composite with EDM.

Symbol	Parameter	Level 1	Level 2	Level 3
A	Current	8	10	12
B	Voltage	40	50	60
C	Pulse duration	6	8	10

Table 2.2 Process Parameters and their levels

Based on the combination of process parameters and their levels, L_9 orthogonal array was suggested for the experimentation.

Exp. no.	A	B	C
1	1	1	1
2	1	2	2
3	1	3	3
4	2	1	2
5	2	2	3
6	2	3	1
7	3	1	3
8	3	2	1
9	3	3	2

Table 2.3 Orthogonal Array for L_9

III RESULTS AND DISCUSSION

The table 3.1 shows the effect of various process parameters on material removal rate and shows S/N ratio of the composite. The table 3.2 shows the model summary of the experimental study. The figure 3.1 shows the main effect plots for the S/N ratio and the best parametric combination obtained for maximum material removal rate is A3B3C2

A	B	C	MRR	S/N Ratio
1	1	1	0.015385	-36.2580
1	2	2	0.030625	-30.2785
1	3	3	0.042800	-27.3711
2	1	2	0.112500	-18.9769
2	2	3	0.023100	-32.7278
2	3	1	0.047340	-26.4954
3	1	3	0.264700	-11.5449
3	2	1	0.315600	-10.0173

Table 3.1 MRR and S/N ratio

S	R-sq	R-sq(adj)	R-sq(pred
0.0381522	98.01%	92.03%	59.64%

Table 3.2Model Summary

Regression Equation

MRR = 0.1325 - 0.1029 A_1 - 0.0715 A_2 + 0.1744 A_3 - 0.0017 B_1 - 0.0094 B_2 + 0.0111 B_3- 0.0064 C_1 + 0.0287 C_2 - 0.0223 C_3

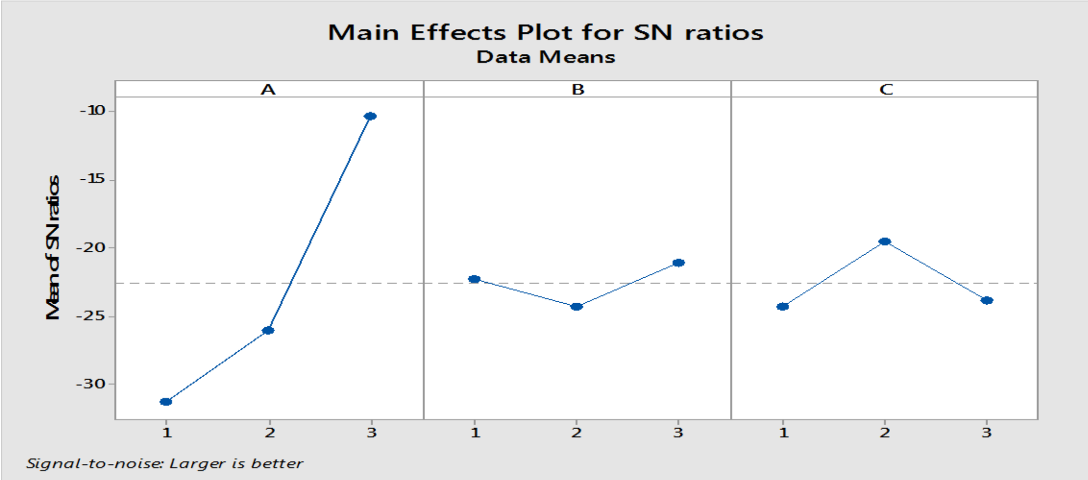

Figure 3.1 Main effect plots for S/N ratio

Figure 3.2 Main effect plots for data means

IV CONCLUSIONS

In this study the experiment was conducted by considering three variable parameters namely voltage, current, pulse duration. The objective was to find the maximum material removal rate.L_9 OA based on Taguchi design was used for analysis the result and these responses were partially validated experimentally.The following conclusions were deducted from the study:

- The hybrid Al ($SiC+Al_2O_3$) metal matrix composite is successfully fabricated using casting process.
- The experiments were successfully conducted on electric discharge machining setup.
- Current is the most significant factor for the machining in EDM process.

- The best parametric combination for the maximum material removal rate is A3B3C2.

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