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OPTIMIZATION OF MATERIAL REMOVAL RATE ON EDM USING TAGAUCHI METHOD

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Abstract- Electro-discharge machining is non-conventional method and non-contact machining process which is preferred for high precision product. Hard and brittle material is commonly used for electro-discharge machining. The work-piece material for the current research work was 7070 Aluminum alloy. This alloy is basically used in the transport and aviation industry due to high specific strength. Response parameter like material removal rate (MRR) has been investigated on 7070 Aluminum alloy by EDM. 7070 Aluminum alloy material has been selected for the treatment by U-shaped copper tool.. Taguchi method was implemented for obtaining desired result. As a input parameter electrode diameter, spark on time, discharge current and polarity was taken and response parameter was material removal rate (MRR).Moreover, the signal-to-noise ratios associated with the observed values in the experiments were determined by which factor is most affected by the Responses of Material Removal Rate (MRR).

Keywords: MRR, Taguchi, Copper Tool

I. INTRODUCTION

EDM is an electro-thermal machining Process, where electrical energy is used for material removal. EDM is mainly used to machine hard materials and high strength temperature resistant alloys [1]. EDM can be used to machine difficult geometries in small batches. Work material to be machined by EDM has to be electrically conductive. EDM is a machining process in which high energy spark column is used. EDM process is used for high accuracy & precision [2]. This machining is used for electrical conductive which is extremely hard and brittle. Process of EDM used for metal removal from the work piece due to erosion by rapidly recurring spark discharge taking place between the tool and work piece [3].

II. LITERATURE REVIEW

Giancarlo maccrani et.al studied through experimental work choose of electrode material has high degree effect on the geometry characteristic of the work-piece in the machining process. By Brass electrode machining is faster [4]. Titanium is more easily machining than stainless steel. Water is more friendly dielectric compare to kerosene. The accuracy and precision of the work-piece is obtained by using brass electrode. Result is further analyzed by ANOVA, it is found that each parameter like electrode, dielectric and machining parameter has significant effect on geometrical characteristic of the drilled holes [5].

Karthikeyan et.al has generated mathematical equation in the function of the voltage, current and pulse on time where response parameter is MRR,TWR and SR. three level of factorial design of taguchi method is implemented for optimize the response parameter result [6]. Result is further analyzed by ANOVA analysis. Finally analyzed by the interaction plot between input factors, MRR decrease with increase in SIC volume.

J. Simao et.al was developed a innovative method to improve surface modification by using EDM. for this process powder metallurgy and powder suspended dielectric has been used for the surface alloying AISIH13 hot work steel during die sink operation [7]. L8 orthogonal array has been implemented to identify the significant factor which highly effected. Micro hardness and electrode wear are the response parameter [8]. Through ANOVA analysis percentage contribution electrode, peak current, pulse on time. Even so, the very low error PCR value (for micro hardness ~6%) implies that all the major effects were taken into account [9].

III. EXPERIMENT AND RESULT

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In the experimental work, Electric Discharge Machine, model ELECTRONICA- ELECTRAPULS PS 50ZNC (die-sinking type) with servo-head (constant gap) and positive polarity for electrode was used to conduct the experiments. Commercial grade EDM oil was used as dielectric fluid, its specific gravity is 0.76 and freezing point is 94 degree Celsius. For internal flushing U-shaped copper tool was introduced at the pressure of 0.2kgf/cm2. In the experimental work electrode is connected with positive polarity. In the experimental set up, the input parameter are discharge current, pulse on time, flushing pressure and polarity [10].
Input factor are discharge current, pulse on time, flushing pressure and polarity. Copper electrode has been used in the machining of the 7075 Aluminum alloy. Two level of four input parameter has been implemented in the electro-discharge machining [11]. For experimental work L8 orthogonal array has been used for different combination of input parameter to get desired result.

Table - 1 Machining Parameter and Their Values

Machining	Symbol	Unit	Level	Level
Electrode diameter	(D)	mm	8	16
Spark on time	(Ton)	µs	463	1010
Discharge current	(Ip)	A	5	10
Polarity			N	R

Table - 2 The Response Table for Metal Removal Rate (MRR)

Sl. No.	Discharge Current	Pulse on time	Flushing Pressure	Polarity	MRR
1	8	463	5	N	6.51
2	8	463	10	R	0.43
3	8	1010	5	R	0.24
4	8	1010	10	N	6.15
5	16	463	5	R	3.29
6	16	100	10	N	11.65
7	16	463	5	N	12.08
8	16	1010	10	R	3.53

Machining parameter for larger is better criteria:

$$SN= -10\text{Log}[(1/n)\sum_{i=1}^{n}(\frac{1}{y2})\ ] \quad (1)$$

Table - 3 SN ratio of the response parameter

Serial no.	MRR	SN ratio(MRR)
1	6.51	16.27
2	0.43	-7.33
3	0.24	-12.40
4	6.15	15.78
5	3.29	10.34
6	11.65	21.33
7	12.08	21.64
8	3.53	10.96

In the below table A, B, C, D represent by discharge current, pulse on time, flushing pressure and polarity respectively.

Table - 4 Ranking of input parameter (MRR)

Level	**A**	**B**	**C**	**D**
I	3.08	10.23	8.97	18.75
II	16.07	8.92	10.18	0.39
Diff	12.99	1.32	1.22	18.36
Delta Rank	**II**	**III**	**IV**	**I**

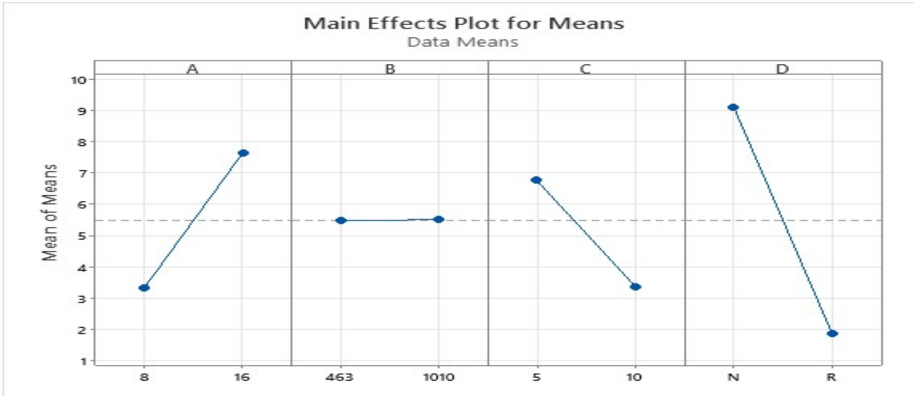

Figure 1. Main effect plot for means(MRR) (generated through MINITAB)

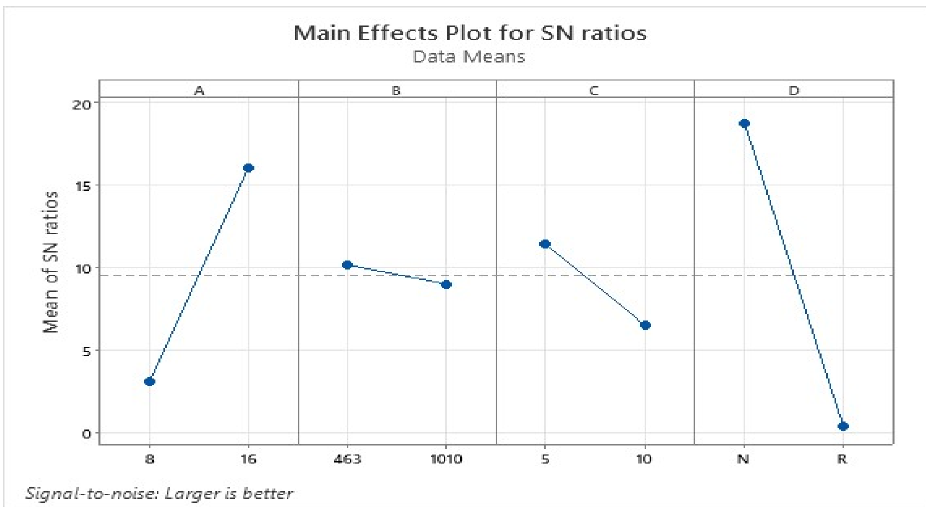

Figure 2. Means of SN Ratio for (MRR) (generated through MINITAB)

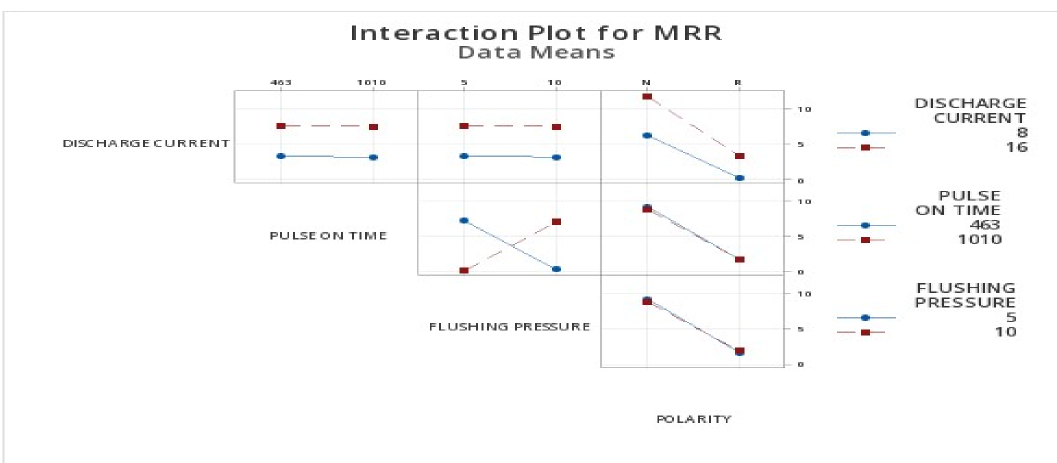

Figure 3. Interaction plot of input parameter (MRR)(generated through MINITAB)

Table - 5 ANOVA analysis for determining contribution of each input factor in the metal removal rate

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Discharge current	1	37.066	37.066	35.17	0.01
Pulse on time	1	0.052	0.052	0.05	0.838
Flushing pressure	1	0	0	0	0.997
Polarity	1	104.401	104.401	99.07	0.002
Error	3	3.161	1.054		
Total	7	144.697			

ANOVA signify that the Polarity is the most significant factor for increasing the MRR, whereas flushing pressure is the least significant factor. From both the tables the same rank order of the input factors has been occurred [12]. It was also observed that in case of MRR only polarity and discharge current were found to be significant. Polarity was found to be more significant than discharge current [13].

IV. CONCLUSION

Based on the calculation of S/N ratio for larger the better characteristics, the optimal parameters combination for MRR was obtained at Discharge current at14 A, pulse ON time at 450µs, Flushing Pressure at 10kgf/cm2 and Normal Polarity. The MRR is increases with increase in Current and Flushing pressure with Normal Polarity The optional conditions for MRR (maximum metal removal rate) was obtained as Discharge current at14A, pulse ON time at 450µs, Flushing Pressure at 10kgf/cm2 and Normal Polarity.

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