Research Paper

OPTIMIZATION OF ELECTRICAL DISCHARGE MACHINING PROCESSPARAMETERS USING TAGUCHI METHOD

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ABSTRACT

The objective of this research study is to investigate the optimal process parameters of Electric Discharge Machining on EN8 material with copper as a tool electrode. The effect of various process parameters on machining performance is investigated in this study. The input parameters considered are current, voltage and pulse on time are used for experimental work and their effect on Material Removal Rate. The Taguchi method is used to formulate the experimental layout on the machining characteristics and find the optimal process parameters of Electric Discharge Machining. The results of the present work reveal that proper selection of input parameters will play a significant role in Electric Discharge Machining.

KEYWORDS: Electrical Discharge Machining, orthogonal array, metal removal rate.

1. INTRODUCTION

Electric Discharge machining (EDM) is a thermo-electric, non-traditional machining process used to machine precise and intricate shapes on difficult to cut materials and super tough metals such as ceramics, maraging steels, cast-alloys, titanium which are widely used in defence and aerospace industries. Electrical energy is used to generate electrical sparks and material removal mainly occurs due to localized melting and vaporization of material which is carried away by the dielectric fluid flow between the electrodes. The performance of this process is mainly influenced by many electrical parameters like, current, voltage, polarity, and pulse on time, pulse of time, electrode gap and also on non-electrical parameters like work and tool material, dielectric fluid pressure. All these electrical and non electrical parameters have a significant effect on the EDM output parameters like, Metal Removal Rate (MRR), Tool. The EDM is very complex and stochastic process and is very difficult to determine the optimal machining parameters. In the present study the output responses MRR are conflicting in nature. MRR reflects the productivity of the product. So in this work it was proposed to study the effects of different input parameter current, voltage, and pulse off time on Material removal rate with EDM oil as a dielectric. The experimental design has been done by using Taguchi technique.

2. EXPERIMENTAL DETAILS

The experiments were conducted on V3525 precision die sink electric discharge machine as shown in Fig.1 which consist a work table, a servo control system and a dielectric supply system. EDM oil Grade 30 is used as the dielectric fluid and the experiments were performed for a particular set of input parameters. The number of experiments and, input levels are decided based on the design of experiments and the input parameters and their levels are presented in Table 1.

Table 1 : Input Parameters Levels

Input Parameters	Current (amp)	Voltage (volt)	Pulse on time (μs)
Symbol	I	V	Ton
Leval1	2	40	50
Leval2	10	70	100
Leval3	20	100	150

3. OVER VIEW OF TAGUCHI METHOD

Taguchi method involves reducing the variation in a process through robust design of experiments. The overall objective of the method is to produce high quality product at low cost to the manufacturer. Taguchi developed a method for designing experiments to investigate how different parameters affect the mean and variance of a process performance characteristic that defines how well the process is functioning. The experimental design proposed by Taguchi involves using orthogonal arrays to organize the parameters affecting the process and the levels at which they should be varied; it allows for the collection of the necessary data to determine which factors most affect product quality with a minimum amount of experimentation, thus saving time and resources. Taguchi design method is to identify the parameter settings which render the quality of the product or process robust to unavoidable variations in external noise. The relative "quality" of a particular parameter design is evaluated using a generic signalto-noise (S/N) ratio. Depending on the particular design problem, different S/N ratios are applicable, including "lower is better" (LB), "nominal is best" (NB), or "higher is better" (HB).

As the objective is to obtain the high material removal rate, is concerned with obtaining larger value for 13. Menkar Rohit Ramesh.Hence, the required quality characteristic for high MRR is larger the better, which states that the output must be as large as possible.

4. DESIGN OF EXPERIMENTS AND DATA ANALYSIS

Based on L9 orthogonal array experiments are conducted on EN8 with copper tool and EDM grade 30 oil as dielectric medium for different experiment levels which are show in Table.2. To achieve validity and accuracy each test is repeated three times. Particular attention was paid to ensure that the operating conditions permitted the effective flushing of machining debris from the working region. The experiments were performed with the bottom surface of the electrode flat and parallel to the work surface.

Table 2 : L_9Orthogonal Array

Trial	V	I	Ton
1.	1	1	3
2.	1	2	2
3.	1	3	1
4.	2	1	2
5.	2	2	1
6.	2	3	3
7.	3	1	1
8.	3	2	2
9.	3	3	3

Table 3 : Experimental results of different trials

Trial No.	Input Current Ip	Input Voltage V	Pulse on time T_{on}	Initial Weight kg	Final Weight kg	Depth in 'Z' direction mm	MRR
1.	2	40	150	1.970	1.966	1.5	17.0940
2.	10	40	100	1.958	1.956	1.520	8.5470
3.	20	40	50	1.966	1.958	2.70	34.188
4.	2	70	100	1.956	1.955	0.215	4.2735
5.	10	70	50	1.955	1.948	0.970	29.9145
6.	20	70	150	1.948	1.942	1.910	25.6410
7.	2	100	50	1.940	1.939	0.180	4.2735
8.	10	100	150	1.942	1.940	0.485	8.5470
9.	20	100	100	1.939	1.935	1.035	17.0940

Table 4 : S/N ratios of different experiments for MRR

Expt. No.	S/N ratio of MRR
1	-5.9926
2	-10.3519
3	-11.8919
4	6.6319
5	5.5996
6	4.0000
7	10.5976
8	9.4539
9	7.7677

Fig. 1 : The Experimental equipment. (EDM)

The MRR are calculated using the following expression

$$MRR = \frac{(w_i - w_f)}{\rho \times t}$$

w_i = initial weight material (gm)

w_f = Final weight of material (gm)

ρ = Desnsity of material (gm/mm^3)

t = Machining time (min)

Table 4 : Response table for Means of MRR

Level	Current	Voltage	Pulse on Time
1	2.973	12.819	9.143
2	10.634	9.867	9.124
3	15.995	6.916	11.336
Delta	13.022	5.904	2.212
Rank	1	2	3

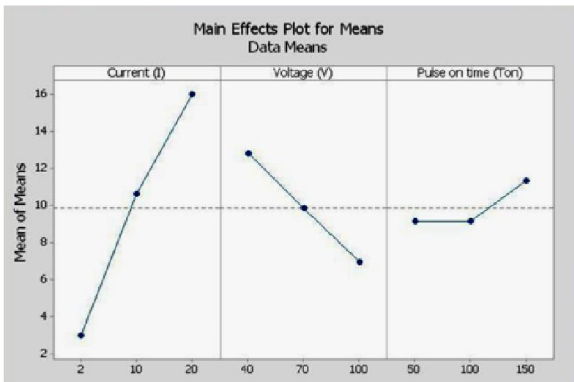

Fig 2 : Main effect plot of mean value for MRR

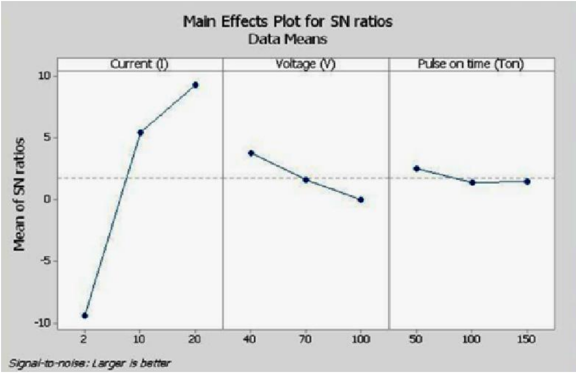

Fig 3 : Main effect plot S/N ratio for MRR

5. EXPERIMENTAL RESULTS AND ANALYSIS

After collection of experimental data the calculated S/N ratios value for MRR is shown in the table no. 4. Current, Voltage, Pulse on time is assigned as rank 1, 2 and 3 respectively according to their larger value of delta. Rank 1 means highest contribution factoer for MRR and 3 means lowest contribution factor for 13. Menkar Rohit Ramesh. Pulse on time is least contribution factor for MRR. From fig.2 it is observe that MRR goes on increasing with higher values of current. MRR has highest value ot current 20A.

6. CONCLUSION

The result shows that current, pulse on time and pulse off time have significant effect on MRR, TWR and SR. The results of the present work reveal that proper selection of input parameters will play a significant role in Electric Discharge Machining.

- The MRR is increasing with increase in current.
- MRR is decreasing initially with increase in the pulse on time and increasing later with an increase in pulse on time.
- MRR is increasing with increase in the pulse off time but the increase is less as compared to pulse on time.
- For optimum MRR**, I3V1C3** levels must be selected.

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