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Study of the Effects of Process Parameters on Tool Wear Rate in Electrical Discharge Machining by Taguchi Method

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ABSTRACT

EDM machines are used to cut conductive metals of any hardness or that are difficult or impossible to cut with traditional methods. The problem of arriving at the optimum levels of the operating parameters has attracted the attention of the researchers and practicing engineers for a very long time. This paper introduces the research results of tool wear rate of SKD11 steel after EDM. The influence of the process paramaters to the surface roughness (Ra) is surveyed and the optimal value Ra (Ratoiuu) also be established. The process parameters: current (I), pusle on time (ton), pulse off time (tof) and voltage is used in research on SR in EDM. Taguchi method is used in this study.

KEYWORDS: *TWR; EDM; PMEDM; Taguchi method*

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1. INTRODUCTION

EDM is a non traditional machining process that has become a well established machining option in manufacturing industries throughout the world and has replaced drilling, milling, grinding and other traditional machining operations. The machines also specialize in cutting complex contours or fragile geometries that would be difficult to be produced using conventional cutting methods. Machine tool industry has made exponential growth in its manufacturing capabilities in last decade but still machine tools are not utilized at their full potential. This limitation is a result of the failure to run the machine tools at their optimum operating conditions. With the continuous process improvement in EDM, the demand for high machining precision with low surface roughness at relatively high machining rates arise in die, mold and tool manufacturing industries.

Optimization of process parameters of EDM has been treated as single-objective optimization process. Taguchi's method has been employed by many researchers as single-objective optimization technique to find the optimal combination of process parameters by considering each performance measure as a separate objective [1]. [2] employed Taguchi's method to find the best combination of parameters for surface finish characteristics. [3] optimized the process parameters of EDM by Taguchi's method. [4] used Taguchi dynamic approach coupled with proposed ideal function model to optimize a high-speed EDM process. [5] obtained optimum parameter settings during EDM by Taguchi's approach. [6] optimized the machining parameters in EDM for SKH 57 steel. There are many authors to cite who have employed Taguchi's method as optimization technique in EDM [7].

The intent of the present study is to study the effect of different input parameters, namely, workpiece material, tool material, polarity, pulse-on time, current, pulse-off time, and powder concentration and some their interactions on the TWR in PMEDM using Ti powder. The effect of various input parameters on output response have been analyzed using Analysis of Variance (ANOVA). Main effect plot and interaction plot for significant factors have been used to determine the optimal design for TWR.

2. Experimental procedure

Through conducting the EDM, experiments involve I, U, ton, tof. SKD11 steel having dimensions of 15x15x20 mm. Copper (Cu) electrode was used in the EDM process. The dielectric fluid of the experiment is D323 oil. The CNC- CM323C die-Sinking machining (CHMER, Taiwan) has been used to experiment. Their measurements are performed on each test sample, and the result is the average value of each measurement. The surface roughness is also measured using surf-test (Model: SV–2100, Mitutoyo Japan).

The Taguchi method is used to design experiments based on the orthogonal matrix, and is used to assess the process parameters. This method included a simple experimental design and standardization. The experimental design of Taguchi method was implemented by the orthogonal matrix (table 1) for placement of the process parameters, which were examined by their levels with the smallest number of experiments during the time as well as the least expensive. The selection of tables was based on the number of parameters and their change rates. ANOVA was based on data obtained from Taguchi's experimental design and was used to select new parameter values to optimize the quality characteristics. Data from the table was analyzed by using charts, pictures, ANOVA and the Fisher ratio test (F). Based on the 20 degrees of freedom, the L_{25} orthogonal array suited the present requirements as it had 20 degrees of freedom, as shown in Table 2.

Table1. The L25 array with experimental conditions and measured responses.

Exp. No	I	U	Ton	Tof	TWR (mg/min)
1	1	30	18	9	0.2500
2	1	40	25	12	0.1500
3	1	50	37	18	0.1220
4	1	60	50	25	0.1110
5	1	70	75	37	0.0330
6	2	30	25	18	0.1960
7	2	40	37	25	0.2000
8	2	50	50	37	0.0830
9	2	60	75	9	0.0740
10	2	70	18	12	0.2160
11	3	30	37	37	0.1750
12	3	40	50	9	0.1500
13	3	50	75	12	0.1500
14	3	60	18	18	0.3750
15	3	70	25	25	0.3000
16	4	30	50	12	0.1000
17	4	40	75	18	0.1000
18	4	50	18	25	1.2600
19	4	60	25	37	0.9160
20	4	70	37	9	0.2500
21	5	30	75	25	0.1000
22	5	40	18	37	1.7000
23	5	50	25	9	0.6000
24	5	60	37	12	0.2000
25	5	70	50	18	0.1000

3. Results and discussion

The results for SR were analyzed using ANOVA for identifying the significant factors affecting the performance measures. ANOVA for the mean SR at 99 % confidence interval is given in Table 2. The variance data for each factor and their interactions were F-tested to find the significance of each. ANOVA table shows that I (F value 103.35), ton (F value 16.79,41), tof (F value 9.54) significantaffect the SR. U is insignificant to affect SR. It is observed that the I is the most significant factor which contributes SR. Main effects plot for TWR are shown in the Figure 1 that shows SR increases with increase in current from 1 Amp to 5 Amp and also increases with increase in tof from 12 µs to 37 µs. Table 3 shows ranks to various factors; I has highest rank, most significant that affecting SR. The U is least significant in SR.

Table2. ANOVA of SR

Source	DF	SS	V	F	P
I (A)	4	278.362	69.5904	**103.34**	0.000
U (B)	4	3.314	0.8285	1.23	0.371
ton (C)	4	45.217	11.3043	**16.79**	0.001
tof (D)	4	25.689	6.4221	**9.54**	0.004
Error	8	5.387	0.6734		
Total	24	357.969			

Table3. Response table for a mean of SR.

Level	I	U	Ton	Toff
1	3.8877	-1.6153	-4.2515	-1.2768
2	-1.6028	-1.8066	-2.8072	-0.6688
3	-2.5343	-2.3956	-2.1086	-2.2887
4	-4.5948	-2.6028	-0.6385	-2.9541
5	-5.7278	-2.1517	-0.7661	-3.3836
Delta	9.6155	0.9875	3.6130	2.7148
Rank	1	4	2	3

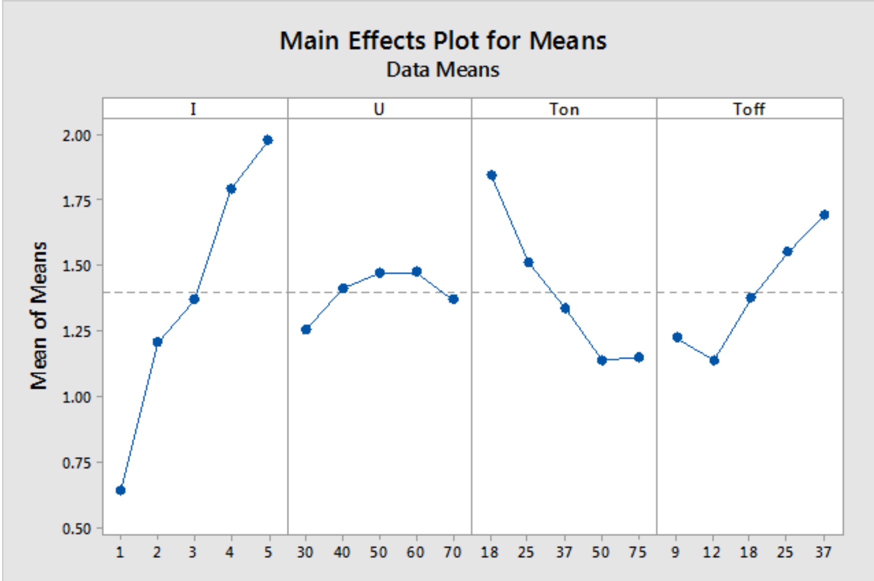

Figure2. Main effects plot for SR.

4. Conclusion

The effect of parameters i.e. pulse on time, pulse off time, current and voltage were evaluated using ANOVA and factorial design analysis. The purpose of the ANOVA was to identify the important parameters in prediction SR. Some results consolidated from ANOVA and plots are given below: pulse on time, current, pulse on time were the significant factors which affects the SR. Voltage was found to be insignificant for SR. Only SKD11 had been used. Other materials such as SKD61, OHNS die steel and tungsten hot work die steel can be machined.

Reference

[1] Bharti, Pushpendra S., Maheshwari, S., & Sharma, C. (2010). A comparative study of Artificial Neural Network training algorithms for modeling of Electric Discharge Machining process. Journal of Mechanical Engineering (Slovak), Vol. 61, No. 5-6, pp. 323-340.

[2] Dev, A., Patel, K.M., Pandey, S. and Aravindan, S. (2009). Machining charactersistics and optimization of process parameters in micro-EDM of SiCp-Al composites. International Journal of Manufacturing Research, 4(4) pp 458-480.

[3] Ghani, J. A., Choudhary, I. A., & Hassan, H. H. (2004). Application of Taguchi method in the optimization of end milling parameters. Journal of Material Processing Technology, 145, pp. 84-92.

[4] Ho, K.H., & Newman, S.T. (2003). State of the art electrical discharge machining (EDM). International Journal of Tools Manufacturing, 43, pp. 1287-1300.

[5] Jain, N. K., Jain, V. K., Deb, K. (2007). Optmization of process parameters of mechanical type advanced machining processes using genetic algorithms. International Journal of Machine Tools and Manufacture, pp. 900-919.

[6] Jung, J. H., & Kwon, W.T. (2010). Optimization of EDM process for multiple performance characteristics using Taguchi method and Grey relational analysis, Journal of Mechanical Science and Technology, 24 (5), pp. 1083-1090.

[7] Marafona, J. (2007). Black layer characterisation and electrode wear ratio in electrical discharge machining (EDM). Journal of Material Processing Technology, 184, pp. 27-31.

[8] R. Roy, A Primer on the Taguchi Method, *New York: Van Nostrand Reinhold*, 1990.