International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-9 Issue-5, March 2020

Process Parameter Optimization in EDM using Heat Treated Al Tool and without Heat Treated Al Tool

Rashmi Ranjan Panda, Chiranjibi Mohanty, Kailash Kumar Sahu, Pravata Kumar Sahoo

Abstract: ***In this experimental work , we investigated optimization of process parameters in EDM using Taguchi method by taking Low carbon steel as work piece. Process parameters chosen were Pulse on-time (Ton), Flushing pressure(P) and Pulse Current(I_P) . Here we have chosen L_9 orthogonal array to study the effect of main factors and interaction between factors on the response variable i.e. Surface Roughness (SR), Material removal Rate (MRR) and Tool Wear Rate (TWR). The contribution of the main factors and interaction were determine here. The MR), TWR and surface integrity are some of the important performance attributes of EDM process. The objective of EDM is to get high MRR along with achieving reasonably good surface quality of machined component with reduced tool wear rate for Low carbon steel material.***

Keywords: SR, MRR, TWR, EDM, Taguchi etc.

I. INTRODUCTION

There are different ways of machining, Some are conventional machining where cutting tool is directly comes to contact with the work piece where as some are non-conventional machining for which there is no physical contact of tool and work piece. Here our focus is limited to EDM machining process, where electrically conductive materials is machined by using precisely controlled sparks that occur between an electrode and a work-piece in the presence of a dielectric fluid.

Different types of EDM-

1. Die sinking EDM
2. WEDM

In this experiment we have used Die sinking EDM.

II. SET UP OF EDM

Electrode, Servo System, Power Supply, Dielectric system.

III. EDM PROCESS PARAMETERS

Spark On-time (pulse time or T_{on}), Over cut , Voltage (V), Duty cycle (τ),Spark Off-time (T_{off})Arc gap (or gap),Discharge current (Ip)

Revised Manuscript Received on March 30, 2020.

***** Correspondence Author

Rashmi Ranjan Panda*, Assistant Professor, Dept. of Mechanical Engineering, Centurion University of Technology and Management, Bhubaneswar, Odisha, India. E-mail: rashmi.panda@cutm.ac.in

Chiranjibi Mohanty, Assistant Professor, Dept. of Mechanical Engineering, Centurion University of Technology and Management, Bhubaneswar, Odisha, India. E-mail:chiranjibimahanty@gmail.com

Kailash Kumar Sahu, Lecturer, Dept. of Mechanical Engineering, Centurion University of Technology and Management, Bhubaneswar, Odisha, India. E-mail: kailashkumar.sahu@cutm.ac.in

Pravata Kumar Sahoo, M.Tech Scholar, Dept. of Mechanical Engineering, Centurion University of Technology and Management, Bhubaneswar, Odisha, India. E-mail: pravata26@gmail.com

IV. DIELECTRIC FLUID

There are various types of dielectric fluids are used in EDM such as EDM oil, Kerosene, Transformer oil, Distilled water etc. Here we have used the Fresh EDM oil Grade-II.

V. EDM SPECIFICATIONS

Table-1 EDM machine Specifications

Model	ZNC25
Operating platform (mm)	28X450
Operating groove(mm)	820X500X280
X-axis range Y-axis range Z-axis Range	250mm 200mm 200mm
Electric pole carrying capacity	30Kg
Maximum capacity of the operating platform	205kg
Maximum dimensions (mm)	1390X1480X2010
Weight of the machine tool	1010Kg
Motor	3phase, ½ hp, 50hz

VI. ELECTRODE AND WORK PIECE.

Low carbon steel specimen has been chosen as work piece. The composition of Low carbon steel is-
Carbon- 0.10-0.25 %,Si- 0 to 0.30%,Mn- 0.30 to 0.70%,P- 0 to 0.04%,S- 0 to 0.05%

VII. HEAT TREATMENT

Here, we have used two Aluminum tools out of which one is heat treated and other is without heat treated. One tool is heat treated in an electric arc furnace for 1 hour and temperature range was 300-500 ^{0}C

VIII. VARIABLES

Design parameters-Material removal rate(MRR), Tool wear rate (TWR), Surface roughness(SR)

Machining parameter- Pulse current (I_P), pulse on time, pulse (T_{ON}), flushing Pressure (P).

IX. EXPERIMENTAL WORK

Table 2 process parameters

Machining parameter	Symbol	Unit	Level		
			Level 1	Level 2	Level 3
Pulse on Time	T_{ON}	µs	30	150	300
Pulse Current	I_P	A	2	6	9
Flushing Pressure	P	Kg/ cm^2	0.3	1	1.1

Target is 2mm for machining the work piece. Time is not constant. TWR and MRR have been calculated by measuring the electrode and work piece respectively with the help of semi micro balance.

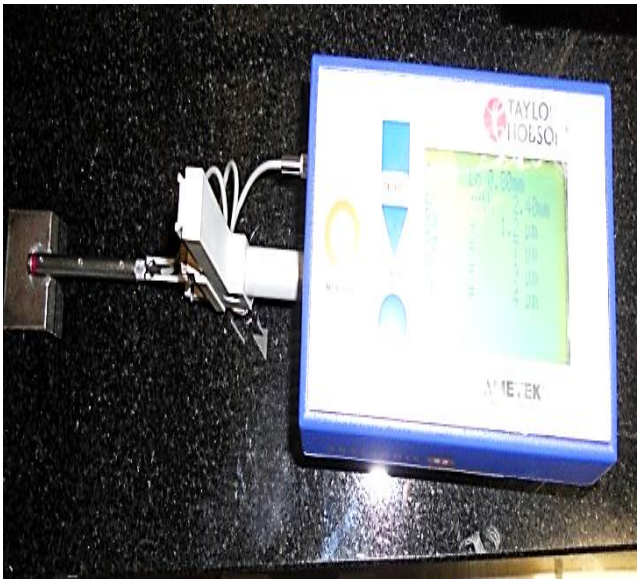


Fig. 1.2 and 3

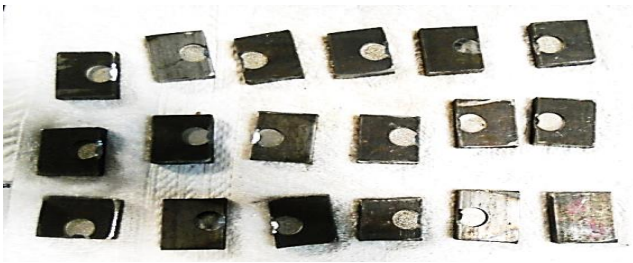


Fig. 4

Table-3

Sl No.	TON (µm)	IP (A)	P Kg/ cm^2	MRR (gm/min)	TWR (gm/min)	SR (µm)	S/N Ratio (for MRR)	S/N Ratio (for TWR)	S/N Ratio (for SR)
1	30	2	0.5	0.02632	0.00532	1.6	-31.594	34.481	-4.082
2	30	6	1.0	0.09262	0.00649	2.2	-20.665	34.212	-6.848
3	30	9	1.2	0.19196	0.01039	2.8	-14.335	39.667	-8.943
4	150	2	1.0	0.01298	0.00012	1.2	-37.734	78.416	-1.583
5	150	6	1.2	0.11258	0.00055	4.8	-18.970	65.192	-6.812
6	150	9	0.5	0.28946	0.00045	5	-10.768	66.935	-13.979
7	300	2	1.2	0.012	0.00007	1	-38.416	83.098	0

8	300	6	0.5	0.13536	0.00008	2.6	-17.370	81.938	-8.299
9	300	9	1.0	0.33731	0.00122	5.2	9.43	58.27	-14.320

Sl No.	TON (µm)	IP (A)	P Kg/cm^2	MRR (gm/min)	TWR (gm/min)	SR (µm)	S/N Ratio (for MRR)	S/N Ratio (for TWR)	S/N Ratio (for SR)
1	30	2	0.5	0.02160	0.00715	1.8	-33.310	42.913	-5.105
2	30	6	1.0	0.10206	0.00532	2.4	-19.823	45.481	-7.604
3	30	9	1.2	0.18533	0.01255	3.4	-14.641	38.027	-10.629
4	150	2	1.0	0.01240	0.00008	1.8	-38.131	81.938	-5.105
5	150	6	1.2	0.08207	0.00040	3.2	-21.716	67.958	-10.102
6	150	9	0.5	0.22957	0.00188	4.0	-12.781	54.516	-12.041
7	300	2	1.2	0.01406	0.00001	1.2	-46.582	100.00	-1.583
8	300	6	0.5	0.11976	0.00083	3.0	-18.433	61.618	-9.542
9	300	9	1.0	0.28788	0.00077	3.2	-10.815	62.270	-10.102

Table 4 Response table for S/N ratio of MRR for Without Heat treated tool

Level	Pulse on time	Pulse current	Flushing pressure
1	-22.59	-36.16	-21.51
2	-24.21	-19.99	-22.92
3	-22.10	-12.75	-24.47
Delta	2.11	23.41	2.96
Rank	3	1	2

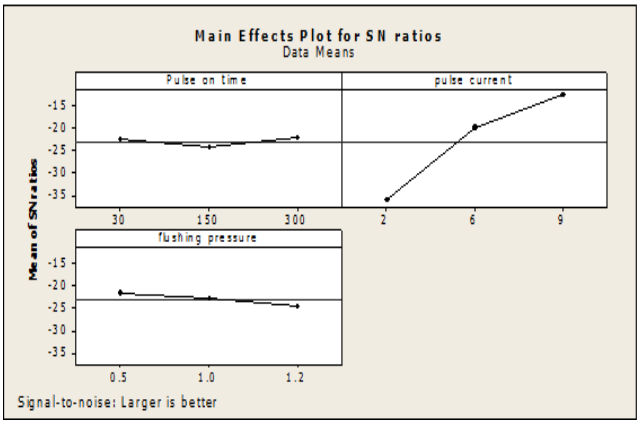


Table 5 Response table for S/N ratio of TWR for Without Heat treated tool

Level	Pulse on time	Pulse current	Flushing pressure
1	42.14	74.95	53.02
2	68.14	58.35	63.23
3	74.63	51.60	68.66
Delta	32.49	23.35	15.65
Rank	1	2	3

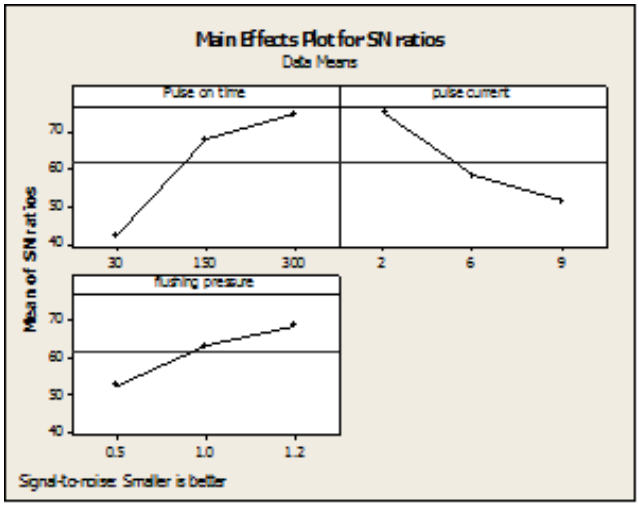


Table 6 Response table for S/N ratio of SR for Without Heat treated tool

Level	Pulse on time	Pulse current	Flushing pressure
1	-7.780	-3.404	-8.896
2	-9.083	-9.083	-7.604
3	-6.548	-10.925	-6.911
Delta	2.535	7.521	1.985
Rank	2	1	3

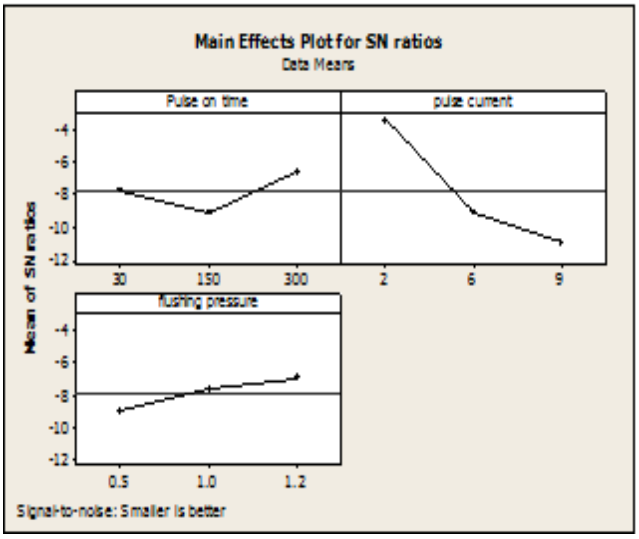


Table 7 Response table for S/N ratio of TWR for Heat treated tool

Level	Pulse on time	Pulse current	Flushing pressure
1	-22.20	-35.92	-19.91
2	-22.49	-19.00	-22.61
3	-21.74	-11.51	-23.91
Delta	0.75	24.40	4.00
Rank	3	1	2

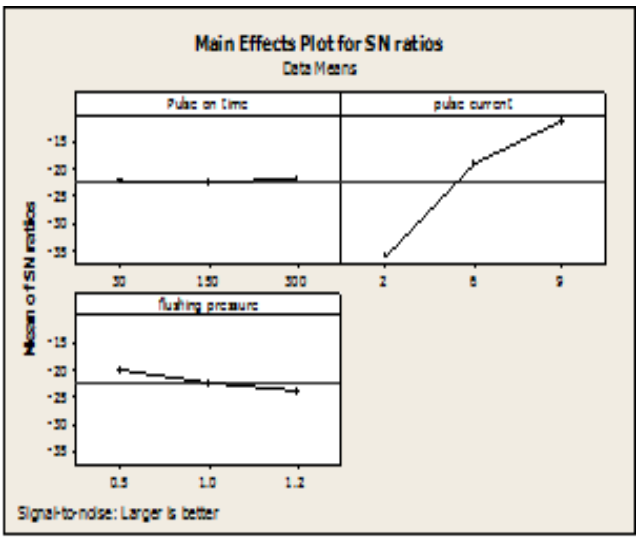


Table 8 Response table for S/N ratio of TWR for Heat treated tool

Level	Pulse on time	Pulse current	Flushing pressure
1	42.97	69.00	64.79
2	70.18	63.63	60.15
3	74.44	54.96	62.65
Delta	31.47	14.04	4.64
Rank	1	2	3

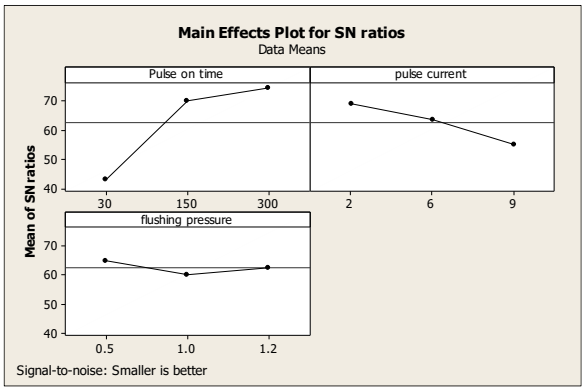
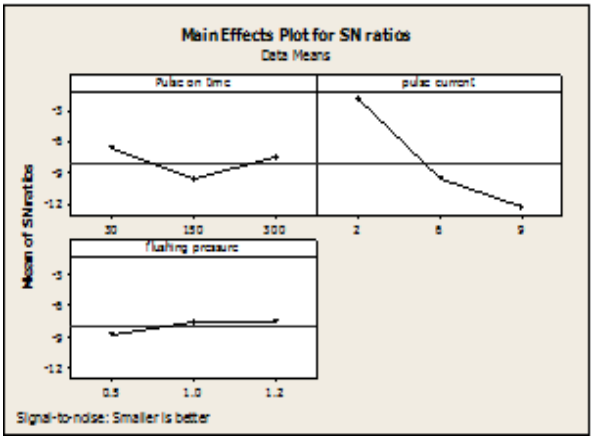


Table 9 Response table for S/N ratio of SR for Heat treated tool

Level	Pulse on time	Pulse current	Flushing pressure
1	-6.625	- 1.889	-8.787
2	-9.729	- 9.591	-7.584
3	-7.540	-12.414	-7.523
Delta	3.105	10.526	1.264
Rank	2	1	3



X. RESULTS

Referring to the different response tables, we found that pulse current is the main parameter for increasing the MRR, whereas the effect of Pulse on time and flushing pressure are equal. The MRR gives highest value in case of run no 8 and lowest value in case of run no 6.

Referring to the table 5, it was observed that pulse on time is the main parameter for reducing the TWR and pulse current and flushing pressure are also playing as main effective parameters for TWR. The TWR gives highest value in case of runs no 2 and lowest value in case of run no6.

Referring to the table 6, we found that pulse current is the main parameter for reducing the SR and whereas the effect of Pulse on time and flushing pressure are equal. The SR gives highest value in case of run no. 5 and lowest value in case of run no 6, For **Heat treated tool**, the response table for S/N ratios for MRR, TWR and SR are shown in tables 7, 8 and 9 respectively with graphical representation of the three control factors i.e. T_{ON}, I_P, and P on MRR, TWR and SR.

Referring to the table7, it was observed that pulse current is the main parameter for increasing the MRR, Pulse on time also gives average effect whereas flushing pressure gives least effect. The MRR gives highest value in case of run no 8 and lowest value in case of run no 6.

Referring to the table 8, it was observed that pulse on time is the main parameter for reducing the TWR and pulse current and flushing pressure are also playing as main effective parameters for TWR. The TWR gives highest value for run number 3 and lowest value for run number 7.

XI. CONCLUSIONS

1. For MRR, the most significant factors were found to be pulse current and flushing pressure followed by pulse on time.
2. For TWR, the most significant factor was Pulse on time, pulse current.
3. For SR , the most significant factor was pulse current .
4. Increase in pulse current and pulse on time, the MRR, SR and TWR were increased.
5. TWR can be reduced by heat treatment process and it gives better surface finish as compare to without heat treated tool.

6. The best condition for minimize the SR for both Heat Treated and without heat treated tool is 2A pulse current, 300µs of pulse on time and 1.2kg/cm^2.
7. The best condition for minimize the TWR for both Heat Treated and without heat treated tool is 2A pulse current, 300µs of pulse on time and 1.2kg/cm^2.
8. The best condition for MRR for both Heat Treated and without heat treated tool is 9A pulse current, 300µs of pulse on time and 1.0kg/cm^2.

From confirmation test it has been observed that the experimental values give better result as compare to predicted values. So the Taguchi Method is most effective technique for better solution of single objective optimization process.

REFERENCES

1. www.meetminitab.com
2. www.sciencedirect.com.
3. J. laxman.,Kotakonda G. R, *Optimization of EDM process parameters using Taguchi Technique*, International Journal of advance Mechanical Engineering.[2014], volume-4.
4. Garg.R.K., Singh.K.K., Sachdeva.A., Sharma.V., Ojha.K., Singh.S. *Review of research work in sinking EDM and WEDM on metal matrix composite materials*, International journal of advanced manufacturing technology (2010); 50:611-624.
5. Tomadi S.H., Hassan M.A., Hamedon Z., *Analysis of the influence of EDM parameters on surface quality, material removal rate and electrode wear of tungsten carbide*, Proceedings of the International MultiConference of Engineers andComputer Scientists, Vol II [2009].
6. Dewangan S.K., *Experimental Investigation of Machining parameters for EDM using U-shaped Electrode of AISI P20 tool steel*, M-Tech Thesis 2010
7. Text book of Manufacturing science by Amitabha Ghose &Asok mallik in 2005 West press private Ltd.

AUTHORS PROFILE

Prof. Rashmi Ranjan Panda, is an Assistant Professor, Dept. of Mechanical Engineering, Centurion University of Technology and Management, Bhubaneswar, Odisha, India. He had completed his M.Tech degree in 2014 from Centurion University with gold medal , Bhubaneswar, Odisha, India. He had more than four years of research experience in different fields of engineering and had 10 publications in different UGC indexed journals. His areas of interests are Manufacturing, Additive manufacturing, Renewable energy and Internal combustion Engines.

Prof. Chiranjibi Mohanty is an Assistant Professor, Dept. of Mechanical Engineering, Centurion University of Technology and Management, Bhubaneswar, Odisha, India. He had completed his M.Tech degree in 2014 from Centurion University , Bhubaneswar, Odisha, India. He had more than four years of research experience in different fields of engineering and had 2 publications in different UGC indexed journals. His areas of interests are Manufacturing, and advanced manufacturing,and Internal combustion Engines.

Mr. Kailash Kumar Sahu,Lecturer, Dept. of Mechanical Engineering, Centurion University of Technology and Management, Bhubaneswar, Odisha, India. He had completed his M.Tech in Mechanical Engineering from Centurion University , Bhubaneswar, Odisha, India..

Mr. Pravata Kumar Sahoo, Research Scholar, Dept. of Mechanical Engineering, Centurion University of Technology and Management, Bhubaneswar, Odisha, India. He had completed his B.Tech. in Mechanical Engineering from Sophitorium Engineering College, Bhubaneswar,Odisha.