ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

Experimental Investigation to Determine Influence of Process Parameters on Surface Quality and MRR in Wire Cut EDM

Kondi Vivek
M.Tech (Advanced Manufacturing Systems)
Ellenki College of Engineering and Technology,
JNTU, Hyderabad, Telangana, India.

Sri.G.Gopi Nath
Assistant Professor,
Ellenki College of Engineering and Technology,
JNTU, Hyderabad, Telangana, India.

ABSTRACT

The objective of the present work is to investigate the effects of the various Wirecut EDM process parameters on the surface quality, maximum material removal rates and obtain the optimal sets of process parameters so that the quality and MRR of machined parts can be optimized. Experiments are conducted on the Aluminum alloy 6082 pieces by varying parameters. The process parameters varied and their respective values are Pulse Time on - 110µsec, 114µsec & Pulse Time off - 57µsec, 59µsec & Input Current - 0.7Amp, 1.3Amp, Wire dia - 0.25mm, 0.15mm & Wire feed – 8.69mm/min, 10.48mm/min.Other parameters are Servo Voltage – 20V, Coolant is Distilled water, Wire Tension – 7Kgf.The optimization is done by using Taguchi technique considering L12 orthogonal array. Optimization is done in Minitab software.

INTRODUCTION TO EDM

A machining technique generally used for hard metals, Electric discharge Machining (commonly called "EDM Machining") makes it possible to figure with metals that ancient machining techniques machining are ineffective. A crucial purpose to recollect with EDM Machining is that it'll solely work with materials that area unit electrically semiconducting.With sensible EDM Machining instrumentation it's possible to chop tiny odd-shaped angles, elaborated contours or cavities in hardened steel similarly as exotic metals like Ti, hastelloy, kovar, inconel, and inorganic compound.

The EDM method is often employed in the Tool and Die business for mold-making, but in recent years EDM has become an integral half for creating model and production elements. This is often seen within the region and natural philosophy industries wherever production quantities stay low.

LITERATURE SURVEY

In the paper by S V Subrahmanyam, etal [1], the improvement of Wire discharge Machining method parameters for the machining of H13 HOT DIE STEEL, with multiple responses Material Removal Rate (MRR), surface roughness (Ra) supported the Grey–Taguchi methodology. Taguchi'Sl27(21x38) Orthogonal Array was wont to conduct experiments, that correspond to indiscriminately chosen completely different mixtures of method parameter setting, with eight method parameters: TON, TOFF, IP, SV WF, WT, SF, WP every to be varied in 3 completely different levels. knowledge associated with the every response viz. material removal rate (MRR), surface roughness (Ra) are measured for every experimental run; With gray relative Analysis optimum levels of method parameters were known. The comparatively vital parameters were determined by Analysis of Variance.

The variations of output responses with method parameters were mathematically shapely by exploitation non-linear multivariate analysis. Within the paper by Atul Kumar, etal [2], variation of cutting performance with pulse on time, pulse off time, open voltage, feed rate override, wire feed, servo voltage, wire tension and flushing pressure were through an experiment investigated in wire spark machining (WEDM) method. Brass wire with 0.25mm diameter and Skd sixty one steel with 10mm thickness were used as tool and work materials within the experiments. The

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

cutting performance outputs thought-about during this study were material removal rate (MRR) and surface roughness. Experimentation has been completed by exploitation Taguchi L18 (21 completely different conditions of parameters. optimum mixtures of parameters were obtained by this system. The study shows that with the minimum variety of experiments the entire downside are often resolved when put next to full factorial style. The results obtained are analyzed for the choice of associate optimum combination of WEDM parameters for correct machining of Skd sixty one alloy to attain higher surface end. Additionally the importance of the cutting parameters on the cutting performance outputs is decided by exploitation analysis of variance (ANOVA) L37 orthogonal array.

Experimental setup and procedure

Experiments have been performed in order to investigate the effects of one or more factors of the process parameters on the surface finish of the wire cut machined surface of Aluminumalloy 6082.The main aim of the project is to determine the influence of time on, time off, wire feed, input current and wire dia. The investigation is based on surface roughness and material removal rate during machining of Aluminum alloy 6082.

Experimental procedure

The selected work piece materials for this research work are Aluminum alloy 6082 material. Experiments have been conducted on**wire cut edm**. **Electrolytic copper**wire with diameters of 0.15mm and 0.25mm have been used as a tool electrode (positive polarity) and work piece material used is Aluminum alloy 6082 rectangular plates of dimensions 295×100*mm* and of thickness 6 *mm.* Distilled wateris used as dielectric fluid. Lateral flushing with a pressure of 7MPa is used. The influence of time on, time off, wire feed, input powerand wire dia have been treated as controllable process factors. A collection tank is located at the bottom to collect the used wire erosions and then is discarded. The wires once used cannot be reused again, due to the variation in dimensional accuracy.

Process parameters and design

Input process parameters such as PulseOntime (TON), PulseOfftime (TOFF), Peak Current (Amp), Wire Feed, Wire diameter, used in this thesis are shown in Table. Each factor is investigated at two levels to determine the optimum settings for the WEDM process. All other parameters such as Wire Tension, Servo voltage are kept constant.

The selection of parameters for experimentation is done as per Taguchi design. An orthogonal array for five controllable parameters is used to construct the matrix of two levels of controllable factors. The L12 orthogonal array contains 12 experimental runs at various combinations of five input variables.

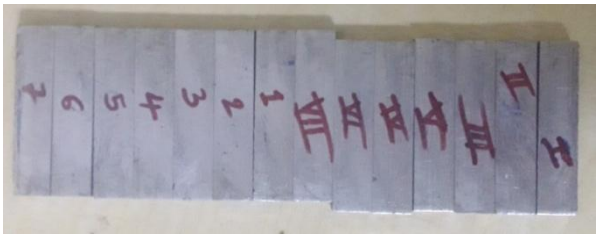
S.NO.	PROCESS PARAMETERS	LEVEL 1	LEVEL 2
1	PULSE TIME ON (T_{ON}) (µsec)	110	114
2	PULSE TIME OFF (T_{OFF}) (µsec)	57	59
3	CURRENT (IP) (Amp)	0.7	1.3
4	WIRE DIA (W_D) (mm)	0.15	0.25
5	WIRE FEED (W_F) (mm/min)	8.69	10.48

Taguchi L12 Orthogonal Array

The L12 orthogonal array for input parameters Pulse on time, pulse off time, current, wire feed and wire diais shown in table below:

JOB NO.	PULSE TIME ON (T_{on}) (µsec)	PULSE TIME OFF (T_{OFF}) (µsec)	CURRENT (IP) (Amp)	WIRE DIA (W_D) (mm	WIRE FEED (W_F) (mm/min)
1	110	57	0.7	0.15	8.69
2	110	57	0.7	0.15	8.69
3	110	57	1.3	0.25	10.48
4	110	59	0.7	0.25	10.48
5	110	59	1.3	0.15	10.48
6	110	59	1.3	0.25	8.69
7	114	57	1.3	0.25	8.69
8	114	57	1.3	0.15	10.48
9	114	57	0.7	0.25	10.48
10	114	59	1.3	0.15	8.69
11	114	59	0.7	0.25	8.69
12	114	59	0.7	0.15	10.48

Table – Process Parameters taken for machining



Final machined pieces

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

Surface Roughness Values with no. of trials

JOB NO.	PULSE TIME ON (T_{ON}) (µsec)	PULSE TIME OFF (T_{OFF}) (µsec)	CURRENT (IP) (Amp)	WIRE DIA (W_D) (mm	WIRE FEED (W_F) (mm/min)	Surface roughness (R_a)
1	110	57	0.7	0.15	8.69	2.14
2	110	57	0.7	0.15	8.69	2.135
3	110	57	1.3	0.25	10.48	2.97
4	110	59	0.7	0.25	10.48	2.56
5	110	59	1.3	0.15	10.48	2.75
6	110	59	1.3	0.25	8.69	2.69
7	114	57	1.3	0.25	8.69	3.09
8	114	57	1.3	0.15	10.48	3.15
9	114	57	0.7	0.25	10.48	2.44
10	114	59	1.3	0.15	8.69	2.61
11	114	59	0.7	0.25	8.69	2.27
12	114	59	0.7	0.15	10.48	2.64

Table 9 : L12 parameters and Surface Roughness Results

Material removal rates results

In WEDM the material erodes from the workpiece by aseries of discrete sparks between the work and the toolelectrode immersed in the liquid dielectric medium. Theseelectrical discharges melt and vaporize minute amounts of thework material, which are then ejected and flushed away by thedielectric fluid.

MATERIAL WEIGHT (gms)	
BEFORE MACHINING (W_1)	AFTER MACHINING (W_2)
46.42857	45.378
92.42852	90.910
138.8877	137.100
185.287	183.400
231.71134	230.523
278.1399	276.128
324.5683	322.163
370.997	368.777
410.425	409.100
463.85404	462.3125
510.28861	508.900

Material removal rate calculations

$$\text{MRR} = \frac{W1 - W2}{\rho * t}$$

W_1 = Weight before machining(gms)
W_2 = Weight after machining(gms)
ρ = Density (gm/mm^3)
t = Time in min

MRR Results table

JOB NO.	PULSE TIME ON (T_{ON}) (µsec)	PULSE TIME OFF (T_{OFF}) (µsec)	CURRENT (IP) (Amp)	WIRE DIA (W_D) (mm	WIRE FEED (W_F) (mm/min)	MRR (mm^3/sec)
1	110	57	0.7	0.15	8.69	0.297
2	110	57	0.7	0.15	8.69	0.297
3	110	57	1.3	0.25	10.48	0.321
4	110	59	0.7	0.25	10.48	0.37894
5	110	59	1.3	0.15	10.48	0.388
6	110	59	1.3	0.25	8.69	0.424
7	114	57	1.3	0.25	8.69	0.5806
8	114	57	1.3	0.15	10.48	0.719325
9	114	57	0.7	0.25	10.48	0.707930
10	114	59	1.3	0.15	8.69	0.63162
11	114	59	0.7	0.25	8.69	0.5818
12	114	59	0.7	0.15	10.48	0.67272

Table 9 : L12 parameters and MRR Results

Selection of optimal parameter combination for better surface quality in wire cut EDM using Taguchi technique

The Experimental results show the effect of five process parameters on surface roughness.
Options – Smaller is better

Results Table

Worksheet 1 ***

	C1	C2	C3	C4	C5	C6	C7
	Time On	Time Off	Current	Wire dia	Wire Feed	Surface Roughness	SNRA1
1	110	57	0.7	0.15	8.69	2.140	-6.59813
2	110	57	0.7	0.15	8.69	2.135	*
3	110	57	1.3	0.25	10.48	2.970	-9.45513
4	110	59	0.7	0.25	10.48	2.560	-8.16480
5	110	59	1.3	0.15	10.48	2.750	-8.78665
6	110	59	1.3	0.25	8.69	2.690	-8.59505
7	114	57	1.3	0.25	8.69	3.090	-9.79917
8	114	57	1.3	0.15	10.48	3.150	-9.96621
9	114	57	0.7	0.25	10.48	2.440	-7.74780
10	114	59	1.3	0.15	8.69	2.610	-8.33281
11	114	59	0.7	0.25	8.69	2.270	-7.12052
12	114	59	0.7	0.15	10.48	2.640	-8.43208

Table – Calculated Signal to Noise Ratios for Smaller is better

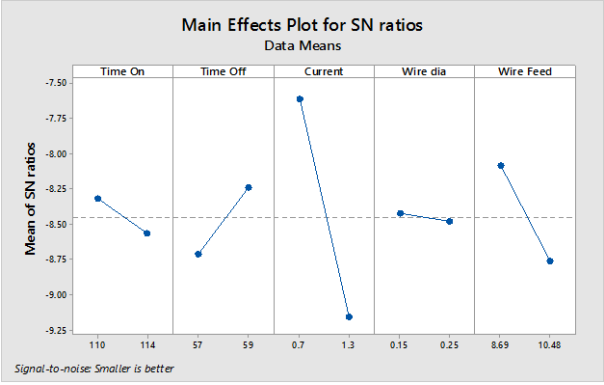


Fig - Effect of machining parameters on Surface Roughness for S/N ratio for Smaller is better

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

Analysis and Discussion

Regardless of the category of the performance characteristics, a greater S/N value corresponds to a better performance. Therefore, the optimal level of the machining parameters is the level with the greatest value.

Pulse Time On :-The effect of parameter "pulse time on" on surface roughness values is shown above figure for S/N ratio. The optimum pulse time on is 110µsec.

Pulse Time Off:-The effect of parameter "pulse time off" on surface roughness values is shown above figure for S/N ratio. The optimum pulse time off is 59µsec.

Peak Current :-The effect of parameter "Peak Current" on surface roughness values is shown above figure for S/N ratio. The optimum Peak Current is 0.7Amps.

Wire Dia. :- The effect of parameter "Wire Dia." on surface roughness values is shown above figure for S/N ratio. The optimum Wire Dia. is 0.15mm.

Wire Feed :-The effect of parameter "Wire Feed" on surface roughness values is shown above figure for S/N ratio. The optimum Wire Feed is 8.69mm/min.

HIGHER MRR

Taguchi method is used to optimize the process parameters Speed, Feed rate, Depth of cut, Cutting tool and Cutting fluid for higher Material Removal Rate values.

Options – Larger is better

Results Table

Worksheet 1 ***

	C1	C2	C3	C4-T	C5-T	C6	C7
	Speed (rpm)	Feed Rate (mm/rev)	DOC (mm)	Cutting Tool	Coolant	MRR	SNRA2
1	600	0.1	2	HSS	Synthetic	200.96	46.0622
2	600	0.1	2	HSS	Synthetic	200.96	*
3	600	0.1	6	Tungstencarbide	Vegetable	602.88	55.6046
4	600	0.2	2	Tungstencarbide	Vegetable	401.92	52.0828
5	600	0.2	6	HSS	Vegetable	1205.76	61.6252
6	600	0.2	6	Tungstencarbide	Synthetic	1214.12	61.6852
7	1200	0.1	6	Tungstencarbide	Synthetic	1217.55	61.7097
8	1200	0.1	6	HSS	Vegetable	1205.76	61.6252
9	1200	0.1	2	Tungstencarbide	Vegetable	401.92	52.0828
10	1200	0.2	6	HSS	Synthetic	2411.52	67.6458
11	1200	0.2	2	Tungstencarbide	Synthetic	803.84	58.1034
12	1200	0.2	2	HSS	Vegetable	801.16	58.0744

Table – Calculated Signal to Noise Ratios for Larger is better

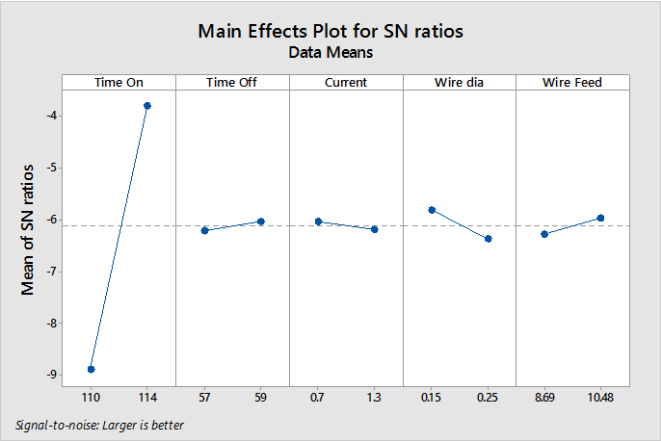


Fig - Effect of machining parameters on MRR for S/N ratio for Larger is better

Analysis and Discussion

Regardless of the category of the performance characteristics, a greater S/N value corresponds to a better performance. Therefore, the optimal level of the machining parameters is the level with the greatest value.

Pulse Time On :-The effect of parameter "pulse time on" on surface roughness values is shown above figure for S/N ratio. The optimum pulse time on is 114µsec.

Pulse Time Off:-The effect of parameter "pulse time off" on surface roughness values is shown above figure for S/N ratio. The optimum pulse time off is 59µsec.

Peak Current :-The effect of parameter "Peak Current" on surface roughness values is shown above figure for S/N ratio. The optimum Peak Current is 0.7Amps.

Wire Dia. :- The effect of parameter "Wire Dia." on surface roughness values is shown above figure for S/N ratio. The optimum Wire Dia. is 0.15mm.

Wire Feed :-The effect of parameter "Wire Feed" on surface roughness values is shown above figure for S/N ratio. The optimum Wire Feed is 10.48mm/min.

CONCLUSION

From the experimental results, the following conclusions can be made:

The important parameters affecting surface roughness are pulse time on, time off & peak current and for MRR are pulse time on, wire dia. and wire feed.Material

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

removal rate increases with increase in pulse ontime where as surface finish will decrease. Material removal rate decreases with increase in pulse ontime where as surface finish will increase. Material removal rate directly increases with increasedpeak currentwhere as surface finish will decrease. Material removal rate increases with increase in wire dia.where as surface finish will decrease. Material removal rate increases with increase in wire feedwhere as surface finish will decrease.From Taguchi method, the optimized parameters for surface roughness are T_{ON} = 110µsec, T_{OFF} = 59µsec, Peak current = 0.7Amp, Wire dia. = 0.15mm and Wire feed – 8.69mm/min. The optimized parameters for MRR are T_{ON} = 114µsec, T_{OFF} = 59µsec, Peak current = 0.7Amp, Wire dia. = 0.15mm and Wire feed – 10.48mm/min.

REFERENCES

1. Evaluation of Optimal Parameters for machining with Wire cut EDM Using Grey-Taguchi Method by S V Subrahmanyam, M. M. M. Sarcar

2. Performance Analysis of Wire Electric Discharge Machining (W-EDM) by Atul Kumar, DR.D.K.Singh

3. Analysis of Process Parameters in Wire EDM with Stainless Steel Using Single Objective Taguchi Method and Multi Objective Grey Relational Grade by M. Durairaja, D. Sudharsunb, N. Swamynathan

4. Optimization of process parameters of micro wire EDM by Ricky Agarwal

5. A Study to Achieve a Fine Surface Finish in Wire-EDM by J.T. Huang, Y.S. Liao and Y.H. Chen

6. Rajurkar K.P., Scott D, Boyina S., "Analysis and Optimization of Parameter Combination in Wire Electrical Discharge Machining", International Journal of Production Research, Vol. 29, No. 11, 1991, PP 2189- 2207.

7. Y. S. Tarng., Ma S.C., Chung L.K., "Determination of Optimal Cutting Parameters in Wire Electrical Discharge Machining", International Journal of Machine Tools and Manufacture, Vol. 35, No. 12, 1995, PP. 1693-1701.

8. J.Prohaszka, A.G. Mamalis and N.M.Vaxevanidis, "The effect of electrode material on machinability in wire electro-discharge machining", Journal of Materials Processing technology, 69, 1997, PP 233-237.

9. (A) Y.S. Liao, Y.Y. Chu and M.T. Yan, Study of wire breaking process and monitoring of WEDM, International Journal of Machine Tools & Manufacture, 37 (1997) pp. 555-567. (B) Y.S Liao , J.T.Huang, A study on the machining parameter optimization of WEDM, Journal of Material Processing Technology,71(1997) pp. 487-493

10. Jose Marafona, Catherine Wykes., "A new method of optimizing MRR using EDM with Copper–tungsten electrodes". International journal of Machine tools and manufacturing. Vol. 40, 22 June 1999, PP 153-164.

Author Details

Kondi Vivek, M.Tech in ADVANCED MANUFACTURING SYSTEMS from Ellenki college of Engineering and Technology, JNTU, Hyderabad, Telangana, India

Sri.G.Gopi Nath, Assistant professor, Ellenki college of Engineering and Technology, JNTU, Hyderabad, Telangana, India