International Journal of Engineering and Advanced Technology (IJEAT)
ISSN: 2249-8958 (Online), Volume-7 Issue-2, December 2017

Experimental Investigation for Optimum Process Parameters in Wire Cut EDM Process using Taguchi Method

Basawaraj S. Hasu, S. Mohan Kumar, Chiranjeevi V.

Abstract: ***The intention of the prevailing is to investigate the results of the numerous Wire lessen EDM machine parameters on the surface high-quality, most material elimination and achieve the most useful technique parameters , so the superiority and MRR of machined parts may be optimized. Experiments are accomplished on the Aluminum alloy 7075 portions by using various parameters. The system parameters several and their respective values are Pulse Time on - 102µsec, 105 µsec, 114 µsec & Pulse Time off – 50 µsec, 53 µsec, 55 µsec & Input Current - 0.5Amp, 1.1Amp, and 1.8Amp. Other parameters are saved constantly along with Wire Dia – 0.25mm, Wire feed – 8.4mm/mi, Servo Voltage – 20V, Coolant is Distilled water, Wire Tension – 7Kgf. The optimization is finished by way of the usage of Taguchi method considering L9 orthogonal array. Optimization is done in Minitab software program***

Keywords: EDM, MRR, 7075 Portions, 102µsec, 114 µsec, Wire Tension – 7Kgf.

I. INTRODUCTION

The wire-cut type of machine arose in the 1960s for the purpose of making tools (dies) from hardened steel. The tool electrode in wire EDM is simply a wire. To avoid the erosion of material from the wire causing it to break, the wire is wound between two spools so that the active part of the wire changing. The earliest numerical controlled (NC) machines were conversions of punched-tape vertical milling machines. The first commercially available NC machine built as a wire-cut EDM machine was manufactured in the USSR in 1967. Machines that could optically follow lines on a master drawing were developed by David H. Dulebohn's group in the 1960s at Andrew Engineering Company for milling and grinding machines. Master drawings were later produced by computer numerical controlled (CNC) plotters for greater accuracy. A wire-cut EDM machine using the CNC drawing plotter and optical line follower techniques was produced in 1974. Dulebohn later used the same plotter CNC program to directly control the EDM machine, and the first CNC EDM machine was produced in 1976.

Manuscript published on 30 December 2017.

* Correspondence Author (s)

Prof. Basavaraj S. Hasu, (Ph.D), Professor and Head, Department of Mechanical Engineering, AVN Institute of Engineering and Technology, Ranga Reddy (Telangana), India.

S. Mohan Kumar, (Ph.D), Assistant Professor, Department of Mechanical Engineering, AVN Institute of Engineering and Technology, Ranga Reddy (Telangana), India.

Chiranjeevi.V, PG Student, Department of Mechanical Engineering, AVN Institute of Engineering and Technology, Ranga Reddy (Telangana), India.

1.1. Influence of Process Parameters on the Wire EDM Process

Fig.1. Factors Influencing the Wire EDM Process.

1.2. Introduction to Surface Roughness

Surface roughness, usually shortened to roughness, may be a live of the feel of a surface. it's quantified by the vertical deviations of a true surface from its ideal kind. If these deviations area unit giant, the surface is rough; if they're tiny the surface is swish. Roughness is usually thought-about to be the high frequency, short wavelength element of a measured surface (see surface metrology). However, in observe it's usually necessary to grasp each the amplitude and frequency to confirm that a surface is acceptable purpose.

1.3. Taguchi Method

Dr. Taguchi of Nihon Telephones and Telegraph Company, Japan has developed a way supported "ORTHOGONAL ARRAY" experiments which supplies abundant reduced "variance" for the experiment with "optimum settings "of management parameters."Orthogonal Arrays" (OA) offer a group of well balanced (minimum) experiments and Dr. Taguchi's Signal to Noise ratios (S/N), that area unit log functions of desired output, function objective functions for optimization, facilitate in information analysis and prediction of optimum results. Taguchi technique treats optimization issues in 2 classes,

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)

II. LITERATURE SURVEY

In the paper by S V Subrahmanyam, 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 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. The models were checked for his or her adequacy. Results of confirmation experiments showed that the established mathematical models will predict the output responses with cheap accuracy. Within the paper by Atul Kumar, 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 zero.25mm diameter and Skd sixty one steel with 10mm thickness were used as tool and work materials within the experiments. The 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 area unit 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.

III. 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 and material removal rates of the wire cut machined surface of Aluminum alloy 7075. The main aim of the project is to determine the influence of time on, time off, input current. The investigation is based on surface roughness and material removal rate during machining of Aluminum alloy 7075

3.1. Process Parameters and Design

Input process parameters such as Pulse On time (TON), Pulse Off time (TOFF), Peak Current (IP), used in this thesis are shown in Table. Each factor is investigated at three levels to determine the optimum settings for the WEDM process. All other parameters such as Wire dia., Wire Feed, Wire Tension, Servo voltage are kept constant. The selection of parameters for experimentation is done as per Taguchi design. An orthogonal array for three controllable parameters is used to construct the matrix of three levels of controllable factors. The L9 orthogonal array contains 9 experimental runs at various combinations of three input variables.

3.2. Taguchi L9 Orthogonal Array The L9 orthogonal array for input parameters Pulse on time, pulse off time, current is shown in table below:

Table1. Process Parameters Taken for Machining.

Job No.	Pulse Time on (TON) (μsec)	Pulse Time Off (TOFF) (μsec)	Current (IP) (Amp)
1	102	50	0.5
2	102	53	1.1
3	102	55	1.8
4	105	50	1.1
5	105	53	1.8
6	105	55	0.5
7	114	50	1.8
8	114	53	0.5
9	114	55	1.1

Fig 2. Final Machined Pieces Surface roughness values with no. of trials

Table 2. L9 Parameters and Surface Roughness Results

Job No.	Pulse Time on (TON) (μsec)	Pulse Time Off (TOFF) (μsec)	Current (IP) (Amp)	Surface Roughness (Ra) μm
1	102	50	0.5	1.455
2	102	53	1.1	2.467
3	102	55	1.8	2.636
4	105	50	1.1	2.43
5	105	53	1.8	1.61
6	105	55	0.5	1.925
7	114	50	1.8	2.05
8	114	53	0.5	2.49
9	114	55	1.1	2.783

IV. MATERIAL REMOVAL RATES RESULTS

In WEDM the material erodes from the work piece by a series of discrete sparks between the work and the tool electrode immersed in the liquid dielectric medium. These electrical discharges melt and vaporize minute amounts of the work material, which are then ejected and flushed away by the dielectric fluid.

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)

Table 3. Weight of the Work Pieces before and After Machining

Material Weight (gms)	
Before Machining (W_1)	**After Machining (W_2)**
494.44	494.05
494.05	493.65
493.65	493.267
493.267	492.875
492.875	492.482
492.482	492.09
492.09	491.69
491.69	491.305
491.305	490.913

Material removal rate calculations

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

4.1. MRR Results Table

Table 4. L9 Parameters and MRR Results

JOB No.	Pulse Time on (TON) (µsec)	Pulse Time Off (TOFF) (µsec)	Current (IP) (Amp)	MRR (mm3/sec)
1	102	50	0.5	0.210
2	102	53	1.1	0.182
3	102	55	1.8	0.151
4	105	50	1.1	0.136
5	105	53	1.8	0.122
6	105	55	0.5	0.11
7	114	50	1.8	0.103
8	114	53	0.5	0.0913
9	114	55	1.1	0.086

V. SELECTION OF OPTIMAL PARAMETER COMBINATION FOR BETTER SURFACE QUALITY IN WIRE CUT EDM USING TAGUCHI TECHNIQUE RESULTS

5.1. Surface Roughness

Options – Smaller is better

Surface Roughness to be calculated as Smaller is better

5.2. Results Table

Table 5. Calculated Signal to Noise Ratios for Smaller is Better

	TIME ON	TIME OFF	INPUT CURRENT	SURFACE ROUGHNESS	SNRA1
1	102	50	0.5	1.455	-3.25726
2	102	53	1.1	2.167	-6.71718
3	102	55	1.8	2.636	-8.41891
4	105	50	1.1	2.430	-7.71213
5	105	53	1.8	1.610	-4.13652
6	105	55	0.5	1.925	-5.68861
7	114	50	1.8	2.050	-6.23508
8	114	53	0.5	2.490	-7.92399
9	114	55	1.1	2.783	-8.89026

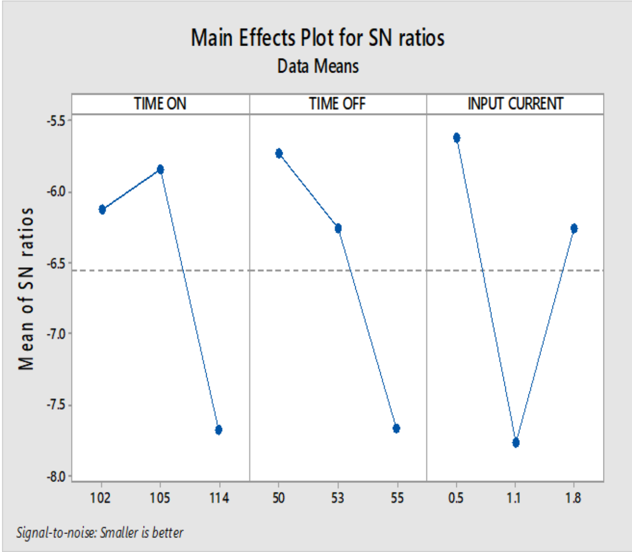

Fig.3. Effect of Machining Parameters on Surface Roughness for S/N ratio for Smaller is Better

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 105µsec.

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 50µsec.

Input Current: - The effect of parameter "Input Current" on surface roughness values is shown above figure for S/N ratio. The optimum Peak Current is 0.5Amps

5.3. Higher MRR

Options – Larger is better

5.4. Results Table

Table 6. Calculated Signal to Noise Ratios for Larger is better

Worksheet 1 ***

↓	C1	C2	C3	C4	C5
	TIME ON	TIME OFF	INPUT CURRENT	MRR	SNRA2
1	102	50	0.5	0.2100	-13.5556
2	102	53	1.1	0.1820	-14.7986
3	102	55	1.8	0.1510	-16.4205
4	105	50	1.1	0.1360	-17.3292
5	105	53	1.8	0.1220	-18.2728
6	105	55	0.5	0.1100	-19.1721
7	114	50	1.8	0.1030	-19.7433
8	114	53	0.5	0.0913	-20.7906
9	114	55	1.1	0.8600	-1.3100

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

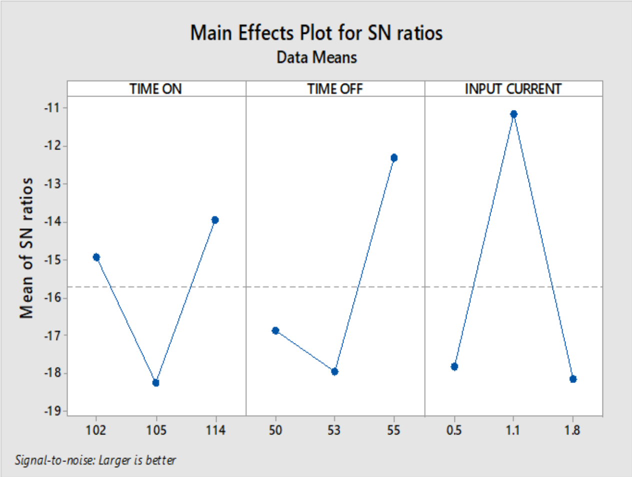

Fig.4. Effect of Machining Parameters on MRR for S/N Ratio for Larger is Better

5.5. 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 55µsec.

Input Current: - The effect of parameter “Input Current” on surface roughness values is shown above figure for S/N ratio. The optimum Peak Current is 1.1Amps.

VI. CONCLUSION

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

The important parameter affecting surface roughness and MRR are input current. Material removal rate increases with increase in pulse on time where as surface finish will decrease. Material removal rate decreases with increase in pulse on time where as surface finish will increase. Material removal rate directly increases with increased input current where as surface finish will decrease. From Taguchi method, the optimized parameters for surface roughness are TON = 105 µsec, TOFF = 50 µsec, Peak current = 0.5Amp. The optimized parameters for MRR are TON = 114 µsec, TOFF = 55 µsec, Peak current = 1.1Amp.

REFERENCES

1. Evaluation of Optimal Parameters for machining with Wire reduce EDM Using Grey-Taguchi Method by means of S V Subrahmanyam, M. M. M. Sarcar
2. Performance Analysis of Wire Electric Discharge Machining (W-EDM) by means of manner of 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 via M. Durairaja, D. Sudharsunb, N. Swamynathan
4. Optimization of technique parameters of micro cord EDM via Ricky Agarwal.
5. A Study to Achieve a Fine Surface Finish in Wire-EDM with the aid of the use of 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. Eleven, 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. Eight. J.Prohaszka, A.G. Mamalis and N.M.Vaxevanidis, The effect of electrode material on machinability in cord electro-discharge machining, Journal of Materials Processing technology, sixty nine, 1997, PP 233-237.
9. Nine. (A) Y.S. Liao, Y.Y. Chu and M.T. Yan, Study of twine breaking method and monitoring of WEDM, International Journal of Machine Tools & Manufacture, 37 (1997) pp. 555-567. (B) Y.S Liao , J.T.Huang, A look at on the machining parameter optimization of WEDM, Journal Fof Material Processing Technology, seventy one(1997) pp. 487-493.
10. Jose Marafona, Catherine Wykes., A new method of optimizing MRR using EDM with Copper–tungsten electrodes. International magi of Machine gear and production. Vol. Forty, 22 June 1999, PP 153-164.

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)