EXPERIMENTAL INVESTIGATION TO DETERMINE INFLUENCE OF PROCESS PARAMETERS ON SURFACE QUALITY AND MRR IN WIRE CUT EDM

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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 will be conducted on the pieces by parameters. The material used for machining is Aluminum alloy and the process parameters varied are Pulse Time on 110µsec, 109µsec, 108 µsec, Pulse Time off 60µsec, 61µsec, 61µsec and Peak Current180Amps, 170Amps, 160Amps. Wire Feed, ServoVoltage and Wire Tension are kept constant. The optimization is done by using Taguchi technique by considering L9 orthogonal array. Optimization is done using Minitab software.

I. INTRODUCTION TO WIRE-CUT EDM

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 is constantly changing. Electrical discharge machining is a machining method primarily used for hard metals or those that would be very difficult to machine with traditional techniques. EDM typically works with materials that are electrically conductive, although methods for machining insulating ceramics with EDM have also been proposed. EDM can cut intricate contours or cavities in pre-hardened steel without the need for heat treatment to soften and re-harden them. This method can be used with any other metal or metal alloy such as titanium, hastelloy, kovar, and inconel. Also, applications of this process to shape polycrystalline diamond tools have been reported.

II. LITERATURE SURVEY

In the paper by S V Subrahmanyam, etal[1], the optimization of Wire Electrical Discharge Machining process parameters for the machining of H13 HOT DIE STEEL, with multiple responses Material Removal Rate (MRR), surface roughness (Ra) based on the Grey–Taguchi Method. Taguchi'Sl27(21x38) Orthogonal Array was used to conduct experiments, which correspond to randomly chosen different combinations of process parameter setting, with eight process parameters: TON, TOFF, IP, SV WF, WT, SF, WP each to be varied in three different levels. Data related to the each response viz. material removal rate (MRR), surface roughness (Ra) have been measured for each experimental run; With Grey Relational Analysis Optimal levels of process parameters were identified. In 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 experimentally investigated in wire electric discharge machining (WEDM) process. Brass wire with 0.25mm diameter and Skd 61 alloy steel with 10mm thickness were used as tool and work materials in the experiments. The cutting performance outputs considered in this study were material removal rate (MRR) and surface roughness. Experimentation has been completed by using Taguchi L18 (21 different conditions of parameters.

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 of the wire cut machined surface of Aluminum material. The main aim of the project is to determine the influence of time on, time off, wire feed and input power. The investigation is based on surface roughness during machining of Aluminum material.

EXPERIMENTAL PROCEDURE

The selected work piece materials for this research work are Aluminum alloy material. Experiments have been conducted on wire cut edm. The machine details are:

Fig 1: Wire cut CNC

An electrolytic brass (Zinc coated) wire with a diameter of 2mm has been used as a tool electrode (positive polarity) and work piece materials used are Aluminum alloy and Copper materials rectangular plates of dimensions 80×30 mm and of thickness 6 mm.

IV. PROCESS PARAMETERS AND DESIGN

Input process parameters such as Pulse Ontime (TON), Pulse Offtime (TOFF), Peak Current (Amp), 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 Tension is 4Kgf, Servo Feed is 20V, Servo Feed 2100 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.

The L9 orthogonal array for input parameters Pulse on time, pulse off time and peak current is shown in table below:

Table 1: L9 parameters

TRAIL	A	B	C
1	108	60	160
2	108	61	170
3	108	62	180
4	109	60	170
5	109	61	180
6	109	62	160
7	110	60	180
8	110	61	170
9	110	62	160

V. OBSERVATION

The following are the surface roughness observations made by testing using Surface Roughness Measurement Tester, Model No: SJ-210, Mitutoyo. Surface Roughness Values with no. of trials

Table 2: L9 parameters and Surface Roughness Results

Trail	Pulse Time On (µsec)	Pulse Time Off (µsec)	Peak Current (Amps)	Surface Finish Values R_a µm
1	108	60	160	2.214
2	108	61	170	3.359
3	108	62	180	3.987
4	109	60	170	3.881
5	109	61	180	2.632
6	109	62	160	3.218
7	110	60	180	3.98
8	110	61	170	3.89
9	110	62	160	3.775

a) Material Removal Rates Results

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

Table 2: L9 parameters and MRR Results

Trail	PulseTime On (µsec)	Pulse Time Off (µsec)	Peak Current (Amps)	MRR (mm^3/sec)
1	108	60	160	0.5515
2	108	61	170	1.8347
3	108	62	180	1.8614
4	109	60	170	2.1414
5	109	61	180	0.6818
6	109	62	160	3.3333
7	110	60	180	3.7515
8	110	61	170	4.5586
9	110	62	160	0.6303

MRR Results Table

b) Selection of Optimal Parameter Combination

For Better Surface Quality In Wire Cut EDM Using Taguchi Technique

RESULTS

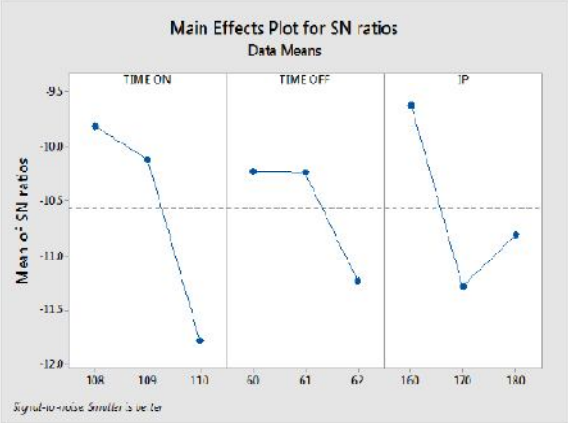

Fig.2. Effect of parameters surface roughness for S/N ratio

Taguchi method stresses the importance of studying the response variation using the signal–to–noise (S/N) ratio, resulting in minimization of quality characteristic variation due to uncontrollable parameter. The surface roughness is considered as the quality characteristic with the concept of "the smaller-the-better". The S/N ratio for the smaller-the-better is:

$$S/N = -10 * \log(\Sigma(Y^2)/n))$$

Where n is the number of measurements in a trial/row, in this case, n=1 and y is the measured

value in a run/row. The S/N ratio values are calculated by taking into consideration above Eqn. with the help of software Minitab 17.

The surface roughness measured from the experiments and their corresponding S/N ratio values are listed in Table

Table.3. S/N Ratio Results

Worksheet 1 ***

	C1	C2	C3	C4	C5
	TIME ON	TIME OFF	IP	SURFACE ROUGHNESS	SNRA1
1	108	60	160	2.214	-6.9036
2	108	61	170	3.359	-10.5242
3	108	62	180	3.987	-12.0129
4	109	60	170	3.881	-11.7789
5	109	61	180	2.632	-8.4057
6	109	62	160	3.218	-10.1517
7	110	60	180	3.980	-11.9977
8	110	61	160	3.890	-11.7990
9	110	62	170	3.775	-11.5383

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 108µsec.

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 60µsec.

Peak Current:-The effect of parameter "Peak Current" on surface roughness values is shown above figure for S/N ratio. The optimum Peak Currentis 160Amps.

c) Selection Of Optimal Parameter Combination For Better MRR In Wire Cut EDM Using Taguchi Technique

RESULTS

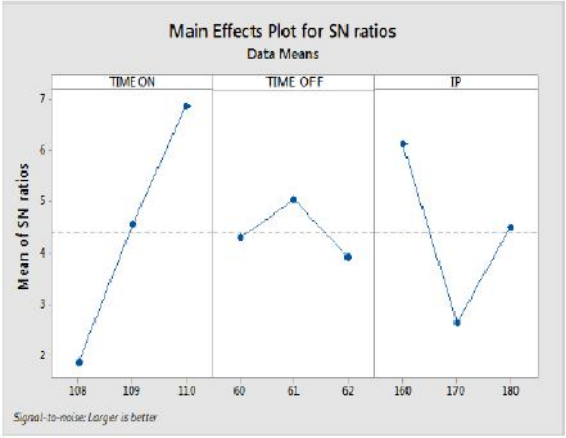

Fig.3. Effect of parameters on MRR for S/N ratio

The MRR measured from the experiments and their corresponding S/N ratio values are listed in Table

Table4. S/N Ratio Results

Worksheet 1 ***

	C1	C2	C3	C4	C5
	TIME ON	TIME OFF	IP	MRR	SNRA2
1	108	60	160	0.5515	-5.1691
2	108	61	170	1.8347	5.2713
3	108	62	180	1.8614	5.3968
4	109	60	170	2.1414	6.6140
5	109	61	180	0.6818	-3.3269
6	109	62	160	3.3333	10.4575
7	110	60	180	3.7515	11.4841
8	110	61	160	4.5586	13.1766
9	110	62	170	0.6303	-4.0091

Pulse Time On - The effect of parameter "pulse time on" on MRR 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 MRR is shown above figure for S/N ratio. The optimum pulse time off is 61µsec.

Peak Current - The effect of parameter "Peak Current" on MRR is shown above figure for S/N ratio. The optimum Peak Current is 160Amps.

CONCLUSION

By observing the experimental results and by optimizing the parameters using Taguchi Method, the following conclusions can be made:

- To get better surface finish the optimized parameters are pulse time on - 108µsec, pulse time off is 60µsec and Peak current is 160Amps.
- To get high MRR the optimized parameters are pulse time on - 110µsec, pulse time off is 61µsec and Peak current is 160Amps.

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.