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 – 53 µsec, 55 µsec, 57 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 cord-reduce kind of gadget arose inside the Sixties to make dies from hardened steel. The device electrode in twine EDM is surely a wire. To keep away from the erosion of fabric from the cord, the twine is wound between spools in order that the lively part of the wire is continuously changing. The earliest numerical controlled (NC) machines had been conversions of punched-tape vertical milling machines. The first commercially to be had NC device built as a cord-reduce EDM gadget changed into artificial within the USSR in 1967. Machines that would optically comply with strains on a draw close drawing were advanced with the aid of David H. Dulebohn's organization in the Nineteen Sixties at Andrew Engineering Company for milling and grinding machines. Master drawings had been later produced via computer numerical managed (CNC) plotters for additional accuracy. A twine-lessen EDM device using the CNC drawing plotter and optical line follower strategies changed into produced in 1974. Dulebohn later used the identical plotter CNC software to directly manage the EDM gadget, and the number one CNC EDM device turned into produced in 1976.

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1.1. Influence of Process Parameters on the Wire EDM Process

WEDM is superior in nature and is controlled by using massive quantity of parameter as shown in Figure.1.

Fig.1. Factors Influencing the Wire EDM process.

1.2. Introduction to Surface Roughness

Surface roughness, normally shortened to roughness, can be alive of the texture of a ground. It's quantified by the vertical deviations of an actual floor from its perfect kind. If those deviations location unit massive, the surface is difficult; if they're tiny the ground is swish. Roughness is commonly idea-approximately to be the excessive frequency, brief wavelength element of a measured floor (see floor metrology). However, in have a have a look at it's far usually important to recognize every the amplitude and frequency to affirm that a floor is suitable motive.

1.3. Taguchi Method

Dr. Taguchi of Nihon Telephones and Telegraph Company, Japan has developed a manner supported ORTHOGONAL ARRAY experiments which materials plentiful decreased variance for the experiment with top-rated settings of manage parameters. Therefore the wedding of a style of Experiments with optimization of management parameters to get BEST effects is completed within the Taguchi approach. Orthogonal Arrays (OA) offer a group of nicely balanced (minimal) experiments and Dr. Taguchi's Signal to Noise ratios (S/N), that place unit log features of favored output, characteristic objective capabilities for optimization,

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Facilitate in statistics analysis and prediction of most appropriate effects. Taguchi method treats optimization problems in 2 schooling.

II. LITERATURE SURVEY

In the paper thru S V Subramanian, the development of Wire discharge machining method parameters for the machining of H13 HOT DIE STEEL, with a couple of responses Material Removal Rate (MRR), floor roughness (Ra) supported the Grey–Taguchi method. Taguchi'Sl27(21x38) Orthogonal Array come to be wont to conduct experiments, that correspond to indiscriminately chosen surely one-of-a-type mixtures of approach parameter putting, with eight technique parameters: TON, TOFF, IP, SV WF, WT, SF, WP each to be numerous in 3 definitely unique stages. Expertise associated with the every reaction viz. Material removal charge (MRR), the surface roughness (Ra) are measured for every experimental run; With grey relative Analysis predominant ranges of method parameters have been acknowledged. The pretty vital parameters have been determined through Analysis of Variance. Within the paper thru Atul Kumar, version of cutting average overall performance with pulse on time, pulse off time, open voltage, feed rate override, cord feed, servo voltage, twine tension and flushing stress had been through an take a look at investigated in wire spark machining (WEDM) approach. Brass wire with 0.25mm diameter and Skd 61 steel with 10mm thickness were used as tool and work substances in the experiments. The cutting overall performance outputs perception-about at some point of this look at have been cloth removal fee (MRR) and floor roughness. Experimentation has been completed with the aid of exploitation Taguchi L18 (21 absolutely one-of-a-type situations of parameters. Foremost combinations of parameters were acquired through this device. They have a look at suggests that with the minimum fashion of experiments the complete downside are often resolved whilst positioned subsequent to complete factorial fashion. The consequences received place unit analyzed for the selection of companion gold standard aggregate of WEDM parameters for correct machining of Skd sixty one alloy to attain higher floor give up. Additionally the importance of the reducing parameters at the decreasing typical performance outputs is determined with the aid of exploitation evaluation of variance (ANOVA) L37 orthogonal array.

III. EXPERIMENTAL SETUP AND PROCEDURE

Experiments were done in order to analyze the consequences of 1 or greater elements of the method parameters at the surface finish, and cloth removal prices of the twine reduce machined ground of Aluminum alloy 7075. The vital aim of the project is to decide they have an impact on of time on, time without work, input modern-day. The research is primarily based on floor roughness and material removal rate for the duration of 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 (T_{ON}) (µSEC)	Pulse Time Off (T_{OFF}) (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 (T_{on}) (µsec)	Pulse Time Off (T_{off}) (µsec)	Current (IP) (Amp)	Surface roughness (R_a) 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

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8	114	53	0.5	2.49
9	114	55	1.1	2.783

IV. MATERIAL REMOVAL RATES RESULTS

In WEDM the fabric erodes from the paintings piece through a chain of discrete sparks between the paintings and the tool electrode immersed inside the liquid dielectric medium. These electric powered discharges melt and vaporize minute portions of the paintings cloth, which might be then ejected and flushed away by way of manner of the dielectric fluid.

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 (T_{ON}) (µsec)	Pulse Time Off (T_{OFF}) (µsec)	Current (IP) (Amp)	MRR (mm^3/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

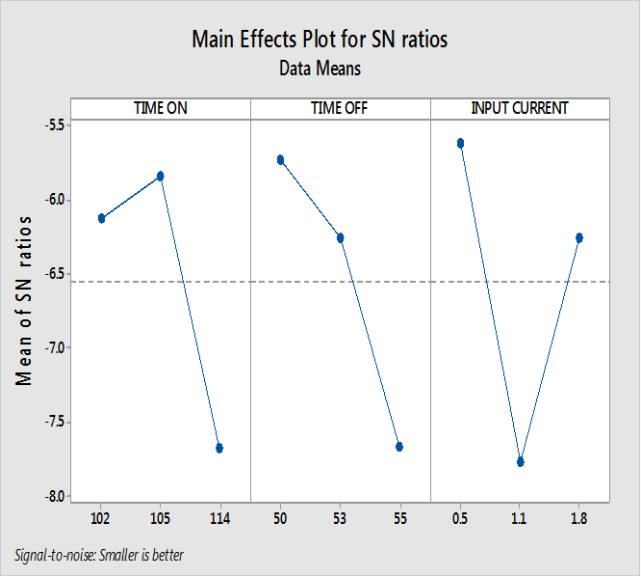

Fig.3. Effect of Machining Parameters on Surface Roughness for S/N ratio for Smaller is Better

Regardless of the class of the overall performance traits, a greater S/N price corresponds to a better performance. Therefore, the best diploma of the machining parameters is the level with the finest fee.

Pulse Time On: - The effect of the parameter Pulse time on ground roughness values is proven above parent for S/N ratio. The pinnacle-rated pulse time on is 105µsec.

Pulse Time Off: - The effect of parameter Pulse break day on ground roughness values is proven above determine for S/N ratio. The finest pulse break day is 50µsec.

Input Current: - The effect of parameter Input Current on floor roughness values is shown above parent for S/N ratio. The premier Peak Current is 0.5Amps.

5.3. Higher MRR

Options – Larger is better

5.4. Results Table

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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

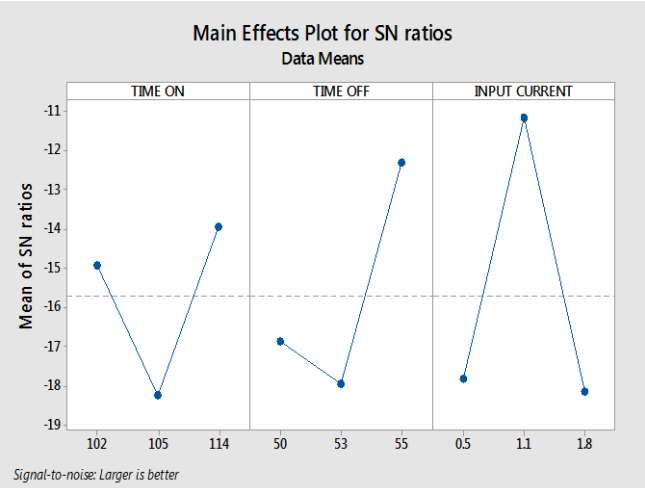

Fig.4. Effect of Machining Parameters on MRR for S/N ratio for Larger is Better

5.5. Analysis and Discussion

Regardless of the class of the overall performance trends, a more S/N fee corresponds to a better overall performance. Therefore, the most high-quality level of the machining parameters is the extent with the greatest price.

Pulse Time On: - The impact of parameter Pulse time on ground roughness values is proven above figure for S/N ratio. The gold preferred pulse time on is 114µsec.

Pulse Time Off: - The impact of parameter Pulse day off on floor roughness values is shown above determine for S/N ratio. The maximum perfect pulse day without work is 55µsec.

Input Current: - The impact of parameter Input Current on floor roughness values is proven above determine for S/N ratio. The most beneficial Peak Current is 1.1Amps.

VI. CONCLUSION

By Staring at the Experimental Consequences and Thru Manner of Optimizing the Parameters, the Subsequent Conclusions may be Made:

The important parameter affecting surface roughness and MRR are entering cutting-edge. Material elimination rate will growth with growth in pulse on time in which as surface stop will decrease. Material elimination fee decreases with increase in pulse on time in which as floor end wills growth. Material removal price at once will growth with stepped forward enter present day where as ground prevent will decrease. From Taguchi approach, the optimized parameters for floor roughness are TON = one zero 5 µsec, TOFF = 50 µsec, Peak current = zero.5Amp. The optimized parameters for MRR are TON = 114 µsec, TOFF = 55 µsec, Peak contemporary-day = 1.1Amp.

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