International Journal of Engineering Research-Online
A Peer Reviewed International Journal
Email:editorijoer@gmail.com http://www.ijoer.in

Vol.4., Issue.1., 2016
(Jan-Feb)

RESEARCH ARTICLE

ISSN: 2321-7758

OPTIMIZATION OF WIRE EDM PROCESS PARAMETERS

MOHD ATIF[1], Dr. GAURAV AGARWAL[2], ADNAN KHAN[3], MOHD ASHAR[4]
[1,3,4]M.Tech scholar Invertis university Bareilly
[2]Asst. Professor , Dept. of Mechanical Engineering. Invertis university Bareilly

ABSTRACT

Wire electrical discharge machining is a nontraditional technology used to machine hard metals, alloys, composites and ceramics but only conductive materials. This paper reports a study that investigates the effect of WEDM process parameters on the EN31 tool steel nine experimental run technique of taguchi method is used to determine an optimal WEDM parameter setting surface roughness is selected as quality target. ANOVA is used to determine the level of importance of the machining parameters on surface roughness. An optimal combination of the WEDM process is obtain

Key words: Wire electrical discharge machining (WEDM), ANOVA, EN 31, Design of experiments, Surface roughness, Taguchi method,

INTRODUCTION

Wire Electrical Discharge Machining (WEDM), sometimes colloquially also referred to as spark machining, spark eroding, burning, wire erosion, wire burning EDM or travelling wire EDM, this process uses spark erosion to machine or remove material with a travelling wire electrode from any electrically conductive material submerged in a tank of dielectric fluid such as deionized water. This process can also cut plates as thick as 300mm and is used for making punches, tools and dies from hard material that are difficult to machine with other methods. There is no direct contact between wire and work piece which results in the omission of adverse effect such as mechanical stresses, chatter and vibration present in traditional machining. The WEDM produces very fine, precise and smooth cuts and the positioning errors are significantly diminished due to highly accurate CNC system [1]

Literature review:

WEDM is an essential operation in several manufacturing processes in some industries, which gives importance to variety, precision and accuracy. Several researchers have attempted to improve the performance characteristics namely the surface roughness, cutting speed, dimensional accuracy and material removal rate. But the full potential utilization of this process is not completely solved because of its complex and stochastic nature and more number of variables involved in this operation [2].Scott et. al. developed mathematical models to predict material removal rate and surface finish while machining D-2 tool steel at different machining conditions. It was found that there is no single combination of levels of the different factors that can be optimal under all circumstances [3]. Tarng et. al. formulated a neural network model and simulated annealing algorithm in order to predict and optimize the surface roughness and cutting velocity of the WEDM process in machining of SUS-304 stainless steel materials[4]. Spedding and Wang (1997) attempted to model the cutting speed and surface roughness of EDM process through the response-surface methodology and artificial neural networks (ANNs). The authors attempted further to optimize the surface roughness, surface waviness and used the artificial neural networks to predict the process performance [5]. Liao et. al. (1997) performed an experimental study using SKD11 alloy steel as the workpiece material and established mathematical models relating the machine performance like MRR, SR and gap width with various machining parameters and then determined the optimal parametric settings for WEDM process applying feasible-direction

method of non-linear programming [6]. Huang et. al.(1999) investigated experimentally the effect of various machining parameters on the gap width, SR and the depth of white layer on the machined workpiece (SKD11alloy steel) surface[7]. Puri and Bhattacharyya (2003) employed Taguchi methodology involving 14 thirteen control factors with three levels for an orthogonal array L27 to find out the main parameters that affect the different machining criteria, such as average cutting speed, surface roughness values and the geometrical inaccuracy caused due to wire lag[8]. Liao et. al. (2003) used the modified traditional circuit using low power for ignition for WEDM. With the assistance of Taguchi quality design, ANOVA and F-test, machining voltage, current-limiting resistance, type of pulse-generating circuit and capacitance were identified as the significant parameters affecting the surface roughness in finishing process[9]. Spedding and Wang (1997) attempted to optimize the process parametric combinations by modeling the process using artificial neural networks (ANN) and characterizing the WEDM machined surface through time series techniques. A feed-forward back-propagation neural network based on a central composite rotatable experimental design is developed to model the machining process. Optimal parametric combinations are selected for the process. [10]

Experimental work:

In this study, Taguchi method is used for single characteristics optimization has been used to establish correlation between the independent variables therefore; the experiments were performed according to a Taguchi design of experiments.

Work material & cutting tool (electrode)

The work material selected in this study was EN31 steel. The chemical composition of the EN31 includes

S.No	Element	% of composition
1	Carbon (C)	0.90-1.10
2	Silicon (Si)	0.10-0.35
3	Manganese(Mn)	1.10 max
4	Phosphorus(P)	0.05 max
5	Sulfur (S)	0.05 max
6	Chromium (Cr)	1.00-1.501

Design : Fixed column, moving table

Table size : 440 x 650 mm

Workpiece height : 10 mm

Max. Workpiece weight : 300 gm Main table traverse (X, Y) : 300, 400 mm Auxiliary table traverse (u, v) : 80, 80 mm Wire electrode diameter : 0.25 mm Generator : ELPULS-40 A DLX Controlled axes : X Y, U, V simultaneous / independent

Connected load : 10 KVA

Design of experiments

L9 orthogonal array technique of taguchi method is used for design. In present research three process parameters chosen such as Pulse On(TON), Pulse Off(TOFF) and Peak current(Ip). All the factors were set at three different levels as in Table 1

Table 1: Level values of input parameters

Sr No	Parameters	unit	Level 1	Level 2	Level 3
1	Pulse on time	µs	115	120	125
2	Pulse off time	µs	30	40	50
3	Peak current	Amp	100	150	200

Table 2: L9 orthogonal Array Design Matrix

Exp.no	Parameter 1	Parameter 2	Parameter 3
1	115	30	100
2	115	40	150
3	115	50	200
4	120	30	150
5	120	40	200
6	120	50	100
7	125	30	200
8	125	40	100
9	125	50	150

Machine Tool

Experiment were conducted using an ELECTRONICA SPRINTCUT CNC WEDM with a wire of 0.25 dia having copper 64% and brass 34% as per L9 OA combination total 9 experiment were conducted. Figure shows the experiment setup for present study

Effect of process parameters on surface roughness

Table3: Response table for surface roughness

Experiment no	Value of surface Roughness	S/n ratio
1	3.95	-11.9319
2	3.43	-10.7059
3	3.76	-115038
4	3.91	-11.8435
5	3.89	-11.7990
6	3.49	-10.8565
7	3.82	-11.6413
8	3.97	-11.9758
9	4.11	-12.2768

Table 4: Response for S/N Ratios

Level	T_{ON}	T_{OFF}	I_P
1	-11.38	-11.81	-11.59
2	-11.50	-11.49	-11.61
3	-11.96	-11.51	-11.65
Delta	0.58	0.31	0.66
Rank	1	2	3

Table 5: Response Table for Means

Level	T_{ON}	T_{OFF}	I_P
1	3.713	3.893	3.803
2	3.763	3.763	3.817
3	3.967	3.787	3.823
Delta	0.253	0.130	0.020
Rank	1	2	3

Selection of optimal levels for MRR

Table 6: Anova for surface roughness value

Parameter	DOF	Seq.sum of square	Adj. sum of square	Adj. mean square	F	P
A	2	0.108022	0.108022	0.054011	0.41	0.709
B	2	0.028822	0.028822	0.014411	0.11	0.901
C	2	0.000622	0.000622	0.000311	0.00	0.998
Residual Error	2	0.263356	0.263356	0.131678		
Total	8	0.400822				

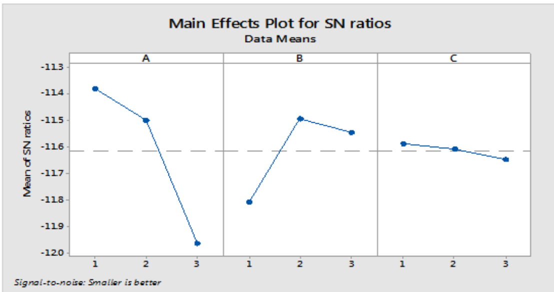

Figure 1 Effects of Process parameters on raw data and Ra (S/N Data)

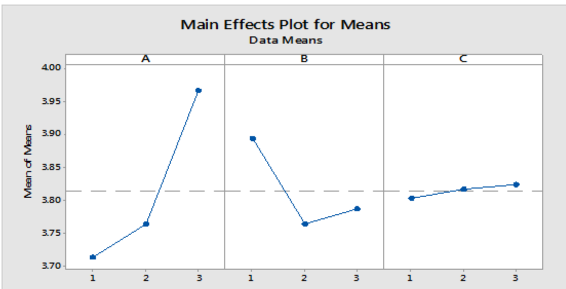

Figure 2 Effects of Process parameters on raw data and Ra (S/N Data)

Conclusion

This paper has presented an investigation on the optimization and the effect of machining parameters on the surface roughness in WEDM operations. The level of importance of the machining parameters on the surface roughness is determined by using ANOVA. Based on ANOVA method, the highly effective parameters on the surface roughness As Surface roughness is the "Smaller is better" type quality characteristic, it can be seen from Fig.1that the first level of pulse on time (A1) second level of pulse off time (B2) and first level of peak current(C2) provide minimum value of surface roughness. The S/N data analysis also suggests the same levels of the variables (A1, B2 and C1) as the best level for minimize Surface roughness in WEDM Process. The L9 OA of Taguchi method is summarized as follows:

1. The recommended levels of WEDM parameter for surface roughness are Pulse ON (TON) 115µs, Pulse OFF (TOFF) 40µs and Peak Current (Ip) is 150A
2. The Pulse on time shows the major correlation as compared to pulse off and Peak current

References

[1]. S. Kalpakjian and S. Schmid, "Manufac-turing process for engineering materials", Pearson education, South Asia, 2009.

[2]. Spedding, T. A. Wang, Z.Q.(1997), "Param-etric optimization and surface characterize-ation of wire electrical discharge machining process", Precision Engineering, 20, 5-15.

[3]. Scott, D., Boyina, S., Rajurkar, K.P. (1991), "Analysis and optimization of Parameter Combination in Wire Electrical Discharge Machining", International Journal of Produ-ction Research, 29, 2189-2207.

[4]. Tarng, Y. S., Ma, S. C., Chung, L. K. (1995), "Determination Of optimal cutting parameter in wire electrical discharge machining", International Journal of Machine Tools and Manufacture, 35, 169-170.

[5]. Spedding, T. A., Wang, Z.Q. (1997), "Study on modeling of wire EDM process", Journal of Materials Processing Technology,

[6]. Liao, Y.S. and Woo, J.C. (1997) "The effects of machining setting on the behavior of pulse trains in the WEDM process" Journal of Materials Processing Technology, 71, 434-440

[7]. Huang, J.T., Liao, Y.S., Hsue, W.J. (1999), "Determination of finish-cutting operation number and machining parameter setting in wire electrical discharge machining", Journal of Materials Processing Technology, 87, 69–81

[8]. Puri, A.B. and Bhattacharyya, B. (2003), "Modeling and analysis of the wire-tool vibration in wire-cut EDM", Journal of Materials Processing Technology, 141, 295–301.

[9]. Liao, Y.S. and Yu, Y.P. (2003), "The energy aspect of material property in WEDM and its application", Journal of Materials Processing Technology, 149, 77–82.

[10]. Spedding, T. A., Wang, Z.Q. (1997), "Study on modeling of wire EDM process", Journal of Materials Processing Technology, 69, 8-28