International Journal of Research
Available at https://edupediapublications.org/journals
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 05 Issue 12
April 2018

Experimental Investigation to Determine Influence of Process Parameters on Surface Finish and Mrr in Wire Cut Edm

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ABSTRACT

Wire Electric Discharge Machining (WEDM) is one of the greatest innovations in the tooling and machining industry. This process has brought dramatic improvements in accuracy, quality, productivity and earnings. Before wire EDM, costly processes were often used to produce finished parts. Now with the aid of computer and wire EDM machines, extremely complicated shapes can be cut automatically, precisely and economically even in materials as hard as carbide. The selection of optimum machining parameters in WEDM is an important step. Improperly selected parameters may result in serious problems like short-circuiting of wire, wire breakage and work surface damage which is imposing certain limits on the production schedule and also reducing productivity.

The objective of the present work is to investigate the effects of the various Wire cut 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 7475 pieces by varying parameters. The process parameters varied and their respective values are Pulse Time on - 100µsec, 110 µsec, 120 µsec & Pulse Time off – 52 µsec, 56 µsec, 60 µsec, Servo Voltage – 20V, 30V, 40V and Wire Feed – 2mm/min, 3mm/min, 4mm/min. Other parameters are kept constant such as Wire diameter - 0.25mm, Peak Current – 1.1Amp, Coolant is Distilled water, Wire Tension – 7Kgf. The optimization is done by using Taguchi technique considering L9 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 are 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.

When the space between the 2 electrodes is reduced, the intensity of the electrical field within the volume between the electrodes becomes larger than the strength of the insulator (at least in some point(s)), that breaks, permitting current to flow between the 2 electrodes. This development is that the same because the breakdown of an electrical device (condenser) (see conjointly breakdown voltage). As a result, material is far from each the electrodes. Once this flow stops (or it's stopped – counting on the kind of generator), new liquid insulator is sometimes sent into the inter-electrode volume enabling the solid particles (debris) to be anxious and therefore the insulating properties of the insulator to be fixed. Adding new liquid insulator within the inter-electrode volume is often spoken as flushing. Also, when a current flow, a distinction of potential between the 2 electrodes is fixed to what it absolutely was before the breakdown, in order that a replacement liquid insulator breakdown will occur.

EDM machine

LITERATURE SURVEY

Research Work in the field of EDM

EDM machining is one of the most common and high capability machining process which is used for machining of many hard materials and difficult to machine materials which cannot done by normal conventional machining process. Several researchers have made studies in the optimization of parameters of EDM process.

Experimental Models

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. 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, 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 zero.25mm diameter and 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. Within the paper by M. Durairaja, etal [3], summarizes the gray relative theory and Taguchi improvement technique, so as to optimize the cutting parameters in Wire EDM for SS304. The target of improvement is to realize the minimum kerf breadth and also the best surface quality at the same time and one by one. During this gift study stainless-steel 304 is employed as a piece, brass wire of zero.25 millimeter diameter used as a tool and H2O is employed as a stuff fluid. For experimentation Taguchi’s L16, orthogonal array has been used. The input parameters elect for improvement area unit gap voltage, wire feed, pulse on time, and pulse off time. Stuff fluid pressure, Wire speed, wire tension, resistance and cutting length area unit taken as fastened parameters. For every experiment surface roughness and kerf breadth resolve by exploitation contact kind surf applied scientist and video instrument severally. By exploitation multi – objective improvement technique gray relative theory, the optimum worth is obtained for surface roughness and kerf breadth and by exploitation Taguchi improvement technique, optimized worth is obtained one by one. In addition, the analysis of variance (ANOVA) is just too helpful to spot the foremost necessary issue. Within the paper by Ricky Agarwal [4], Wire discharge machining method could be an extremely advanced, time varied & framework. The method output is suffering from giant no of input variables. Thus an appropriate choice of input variables for the wire discharge machining (WEDM) method depends heavily on the operator’s technology & expertise owing to their varied & various vary. WEDM is extensively employed in machining of semi conductive materials once preciseness is of prime importance. Rough cutting operation in wire EDM is treated as difficult one as a result of improvement of quite one performance measures viz. Metal removal rate(MRR), surface end & cutting breadth (kerf) area unit sought-after to get preciseness work. During this paper associate approach to work out parameters setting is projected. Exploitation taguchi‟s parameter style, vital machining parameters poignant the performance measures area unit known as pulse peak current, pulse on time, and duty issue. The result of every management issue on the performance live is studied singly exploitation the plots of signal to noise magnitude relation. The study demonstrates that the WEDM method parameters are often adjusted thus on deliver the goods higher metal removal rate, surface end, conductor wear rate. within the paper by J.T. Huang, etal [5], several Wire-EDM machines have adopted the heartbeat generating circuit exploitation low power for ignition and high

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power for machining. But it's not appropriate for finishing method since the energy generated by the high voltage sub-circuit is just too high to get a desired fine surface, in spite of however short the heartbeat on time is assigned. For the machine employed in this analysis, the simplest surface roughness Ra when finishing method is regarding zero.7µm. so as to get smart surface roughness, the standard circuit exploitation low power for ignition is changed for machining further. With the help of Taguchi quality style, multivariate analysis and F-test, machining voltage, current-limiting resistance, variety of pulse generating circuit and capacitance area unit known because the vital parameters poignant the surface roughness in finishing method. Additionally, it's found that a coffee physical phenomenon of stuff ought to be incorporated for the discharge spark to require place. When analyzing the result of every relevant issue on surface roughness, applicable values of all parameter area unit chosen and a fine surface of roughness Ra equals to zero.22µm is achieved. The advance is restricted as a result of finishing method becomes tougher thanks to the incidence of short attributed to wire deflection and vibration once the energy is step by step down.

Objective of the study

The objective of the present work is to investigate the effects of the various Wire cut 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 7475 pieces by varying parameters. The process parameters varied and their respective values are Pulse Time on - 100µsec, 110 µsec, 120 µsec & Pulse Time off – 52 µsec, 56 µsec, 60 µsec, Servo Voltage – 20V, 30V, 40V and Wire Feed – 2mm/min, 3mm/min, 4mm/min. Other parameters are kept constant such as Wire diameter - 0.25mm, Peak Current – 1.1Amp, Coolant is Distilled water, Wire Tension – 7Kgf. The optimization is done by using Taguchi technique considering L9 orthogonal array. Optimization is done in Minitab software.

EXPERIMENTATION PHOTOS

Wire Cut EDM Machine

Parameters display panel

Brass wire

Initial Aluminum Piece setup in the machine

Piece before Machining

Machining of Piece

Final machined pieces

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

The Experimental results show the effect of four process parameters on surface roughness.

EXPERIMENTAL RESULTS

Surface Roughness Values with no. of trials

JOB NO.	PULSE TIME ON (T_{ON}) (µsec)	PULSE TIME OFF (T_{OFF}) (µsec)	SERVO VOLTAGE (VOLTS)	WIRE FEED (mm/min)	Surface roughness (R_a) µm
1	100	52	20	2	3.253
2	100	56	30	3	1.773
3	100	60	40	4	2.333
4	110	56	40	2	2.773
5	110	52	30	4	2.954
6	110	60	20	3	3.016
7	120	52	40	3	3.569
8	120	56	20	4	3.292
9	120	60	30	2	2.732

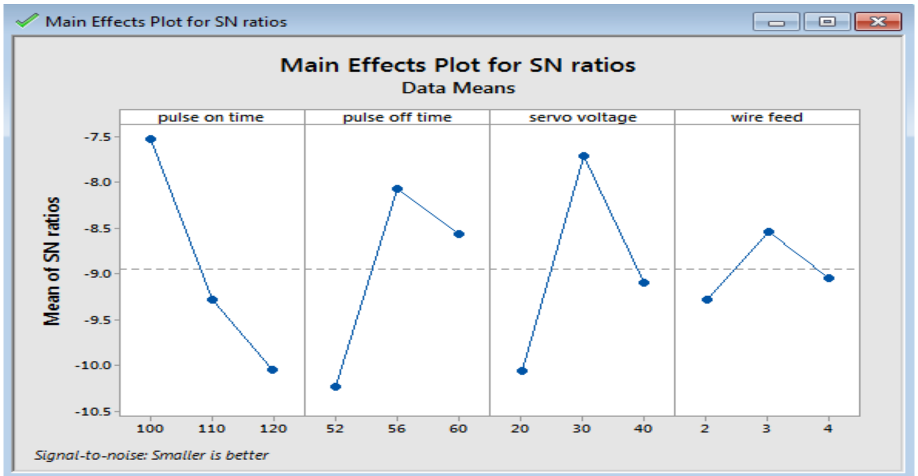
L9 parameters and Surface Roughness Results

TAGUCHI PARAMETER DESIGN OPTIMIZATION OF PARAMETERS USING MINITAB SOFTWARE

Results Table:-

↓	C1	C2	C3	C4	C5	C6
	pulse on time	pulse off time	servo voltage	wire feed	surface roughness	SNRA1
1	100	52	20	2	3.253	-10.2457
2	100	56	30	3	1.773	-4.9742
3	100	60	40	4	2.333	-7.3583
4	110	52	30	4	2.954	-9.4082
5	110	56	40	2	2.773	-8.8590
6	110	60	20	3	3.016	-9.5886
7	120	52	40	3	3.569	-11.0509
8	120	56	20	4	3.292	-10.3492
9	120	60	30	2	2.732	-8.7296

Calculated Signal to Noise Ratios for Smaller is better



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

TAGUCHI ANALYSIS: SURFACE ROUGHNESS VERSUS PULSE ON TIME, SERVO VOLTAGE, WIRE FEED

Response table for signal to noise ratios

Smaller is better

Level	Pulse on time	Pulse off time	Servo voltage	Wire feed
1	-7.526	-10.235	-10.061	-9.278
2	-9.285	-8.061	-7.704	-8.538
3	-10.043	-8.559	-9.089	-9.039
Delta	2.517	2.174	2.357	0.740
Rank	1	3	2	4

Response table for signal to noise ratios

RESULTS AND DISCUSSIONS

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".

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 100µsec.

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 56µsec.

e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 05 Issue 12
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Servo Voltage: - The effect of parameter "Servo Voltage" on surface roughness values is shown above figure for S/N ratio. The optimum Servo Voltage is 30V.

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 3mm/min.

HIGHER MRR

Taguchi method is used to optimize the process parameters Pulse Time On, Pulse Time Off & Servo Voltage, Wire Feed for higher Material Removal Rate values.

JOB NO.	PULSE TIME ON (T_{ON}) (µsec)	PULSE TIME OFF (T_{OFF}) (µsec)	SERVO VOLTAGE (VOLTS)	WIRE FEED (mm/min)	MRR (mm^3/sec)
1	100	52	20	2	0.1494
2	100	56	30	3	0.147500
3	100	60	40	4	0.145540
4	110	52	30	4	0.144545
5	110	56	40	2	0.157900
6	110	60	20	3	0.179000
7	120	52	40	3	0.188600
8	120	56	20	4	0.143800
9	120	60	30	2	0.143800

L9 parameters and MRR Results

Enter MRR Values in the table:-

Worksheet 1 ***

↓	C1	C2	C3	C4	C5
	Pulse Time On	Pulse Time Off	Servo Voltage	Wire Feed	MRR
1	100	52	20	2	0.149400
2	100	56	30	3	0.147500
3	100	60	40	4	0.145540
4	110	52	30	4	0.144545
5	110	56	40	2	0.157900
6	110	60	20	3	0.179000
7	120	52	40	3	0.188600
8	120	56	20	4	0.143800
9	120	60	30	2	0.127800

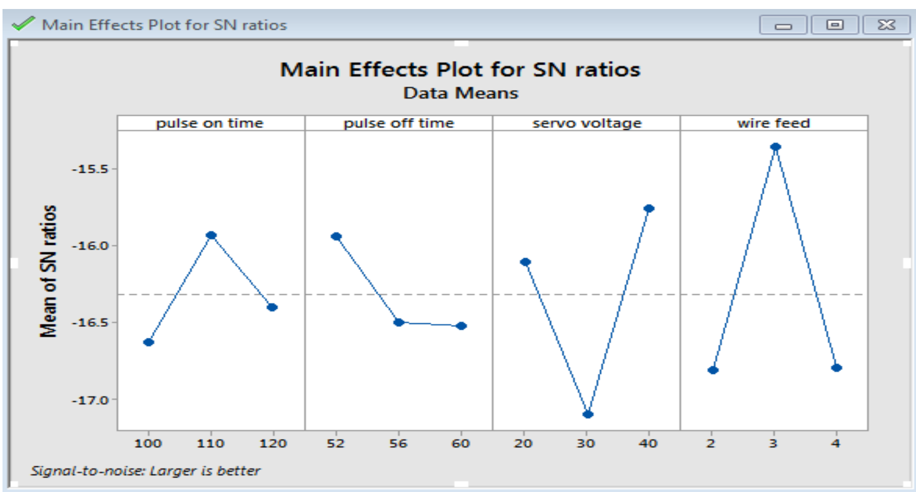
Observed MRR values from experimentation

Results Table:-

Worksheet 1 ***

↓	C1	C2	C3	C4	C5	C6
	Pulse Time On	Pulse Time Off	Servo Voltage	Wire Feed	MRR	SNRA2
1	100	52	20	2	0.149400	-16.1093
2	100	56	30	3	0.147500	-16.6242
3	100	60	40	4	0.145540	-16.7404
4	110	52	30	4	0.144545	-16.7999
5	110	56	40	2	0.157900	-16.0324
6	110	60	20	3	0.179000	-14.9429
7	120	52	40	3	0.188600	-14.4892
8	120	56	20	4	0.143800	-16.8448
9	120	60	30	2	0.127800	-17.8694

Calculated Signal to Noise Ratios for Larger is better



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

Taguchi analysis: MRR versus pulse on time, pulse off time, servo voltage, wire feed

Response Table for signal to noise ratios

Larger is better

Level	Pulse on time	Pulse off time	Servo voltage	Wire feed
1	-16.63	-15.93	-16.10	-16.80
2	-15.93	-16.50	-17.10	-15.35
3	-16.40	-16.52	-15.75	-16.80
Delta	0.70	0.58	1.34	1.45
Rank	3	4	2	1

e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 05 Issue 12
April 2018

Response table for signal to noise ratios

RESULTS

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 MRR is considered as the quality characteristic with the concept of "the larger-the-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 MRR 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 MRR values is shown above figure for S/N ratio. The optimum pulse time off is 52µsec.

Servo Voltage: - The effect of parameter "Servo Voltage" on MRR values is shown above figure for S/N ratio. The optimum Servo Voltage is 40V.

Wire Feed :- The effect of parameter "Wire Feed" on MRR values is shown above figure for S/N ratio. The optimum Wire Feed is 3mm/min.

CONCLUSION

Experiments are conducted on the Aluminum alloy (AA) 7475 pieces by varying parameters. The process parameters varied and their respective values are Pulse Time on - 100µsec, 110 µsec, 120 µsec & Pulse Time off – 52 µsec, 56 µsec, 60 µsec, Servo Voltage – 20V, 30V, 40V and Wire Feed – 2mm/min, 3mm/min, 4mm/min. Other parameters are kept constant such as Wire diameter - 0.25mm, Peak Current – 1.1Amp, Coolant is Distilled water, Wire Tension – 7Kgf. The optimization is done by using Taguchi technique considering L9 orthogonal array. Optimization is done in Minitab software.

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

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

The important parameter affecting surface roughness is pulse time off and MRR is pulse time on.

From Taguchi method, the optimized parameters for surface roughness are Pulse T_{ON} = 100 µsec, Pulse T_{OFF} = 56 µsec, Servo Voltage = 30V, Wire Feed = 3mm/min. The optimized parameters for MRR are T_{ON} = 110 µsec, T_{OFF} = 52 µsec, Servo Voltage = 40V, Wire Feed = 3mm/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.