International Journal of Advanced Technology in Engineering and Science
Vol. No.4, Issue No. 08, August 2016
www.ijates.com
ijates
ISSN 2348 - 7550

INVESTIGATION OF THE EFFECT OF PROCESS PARAMETERS ON CUTTING SPEED IN WIRE ELECTRIC DISCHARGE MACHINING OF EN31 TOOL STEEL

Rajeev Kumar[1], Vijay Kumar[2] and Anmol Bhatia[3]

[1,2]*IIMT College of Engineering, Greater Noida, (INDIA)*

[3]*The NorthCap University, Gurgaon, Haryana (INDIA)*

ABSTRACT

Modernization of today's industries has taken the lead to develop hard materials which are difficult to machine. Wire Electric discharge machine proves to be one of the player in machining of these hard materials that can be used to machine such materials. The present study deals with investigation of the effects of process parameters such as Wire tension, pulse on time, pulse off time and peak current with the help of brass electrode. The study also incorporates Taguchi's methodology and uses L9 orthogonal array with the help of a software Minitab 17. The study further leads to finding out the effect of each parameter using Analysis of Variance(ANOVA).The theoretical value obtained by experimentation is further validated with help of confirmation experiments.

Keywords: WEDM, Process Parameters, ANNOVA, Taguchi Design Methodology

I. I INTRODUCTION

The new player in the field of machining hard materials is WEDM in which the workpiece is eroded by the sparks being produced between the job and the wire electrode which is immersed in a dielectric. Due to this sparking, the melting or vaporization leads to the removal of minute particles from the job which are flushed away using the dielectric. The process can be explained using figure 1. This machine is capable of producing precision parts that are complex inn natureand are difficult to produce using conventional procedures. At this point of time WEDM is a widely used technique for machining the precision parts of materials which are good conductors [1-3]. Nowadays these machines are becoming hybrid in combination with the pulse generating circuit and low power for ignition and high power for machining. But the limitation of this process is that it is not suitable for finishing process because the energy generated by the circuit is very high so as to get the required surface finish irrespective of the short value of pulse off time [

As the demands to make more complex shapes are increasing, the conventional methods have their own limitations [5]. The machine is also considered as the modified EDM machine that uses electrode to initiate the process of producing sparks. But in Wire Cut EDM process there is a travelling electrode which can be made of copper, brass, tungsten within the diametric range of 0.05 to 0.30 mm, with the help of which corner radius can

be provided. Inorder to keep wires tight (in tension), there is a mechanical tension device with the help of which there is less tendency of producing inaccurate parts.

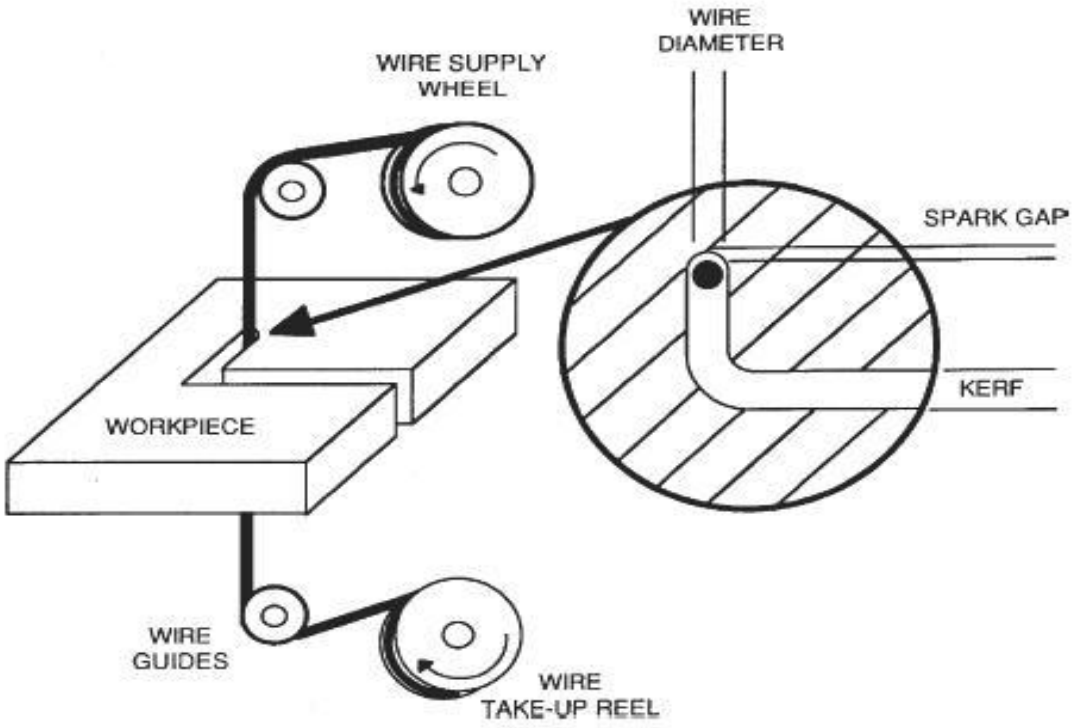
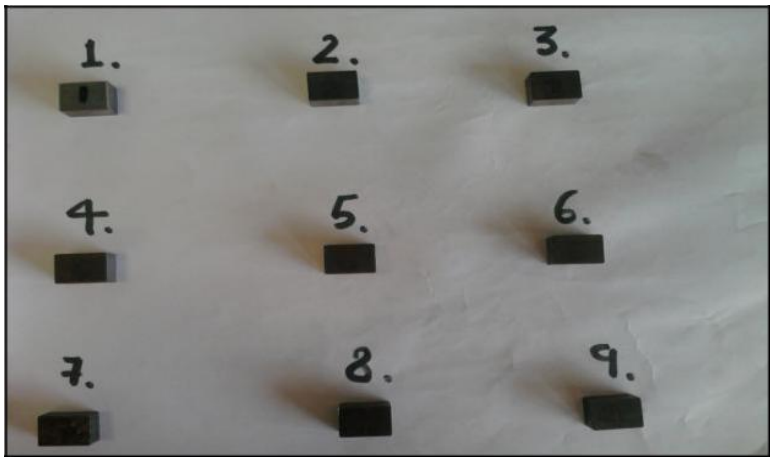


Fig.(1):Schematic representation of WEDM cutting process

II. EXPERIMENTATION

In this experimentation Taguchi parametric design methodology was used. The experiments were conducted by using Taguchi's L_9 OA array. In this phase, four process parameters viz. peak current, pulse on time, pulse off time, and wire tension were selected as given in table 5.1. Experiments were conducted according to the test conditions specified by the L_9 OA. Each experiment was repeated two times in each of the trial conditions.



Fig(2): Cut Specimens

ijates
ISSN 2348 - 7550

Table (3): Response table for cutting speed

Run	PC	T_{on}	T_{off}	WT	Trial 1	Trial 2	Mean of CS1 & CS2
	(A)	(B)	(C)	(D)	CS1	CS2	
1	1	1	1	1	1.12	1.1	1.11
2	1	2	2	2	1.16	1.14	1.15
3	1	3	3	3	2.21	2.19	2.2
4	2	1	2	3	1.83	1.78	1.805
5	2	2	3	1	3.36	3.36	3.36
6	2	3	1	2	2.83	2.8	2.815
7	3	1	3	2	2.2	2.19	2.195
8	3	2	1	3	2.61	2.58	2.595
9	3	3	2	1	3.64	3.61	3.625
							Avg. of Cutting Speed= 2.317

III . RESULTS & DISCUSSIONS

3.1 Normal probability plot for Cutting speed

It is a technique for analyzing the data is distributed normally or not. Figure 3 describes the normal probability plot that forms a nearly linear pattern that interprets as a good result. This plot shows the array of the response variables that are close to median of values and unable to get deviated from mid value.

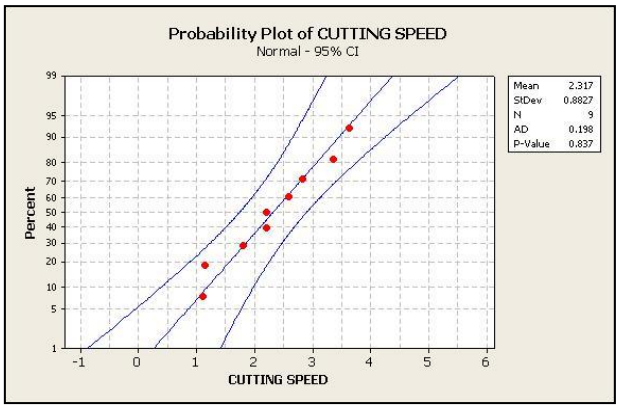
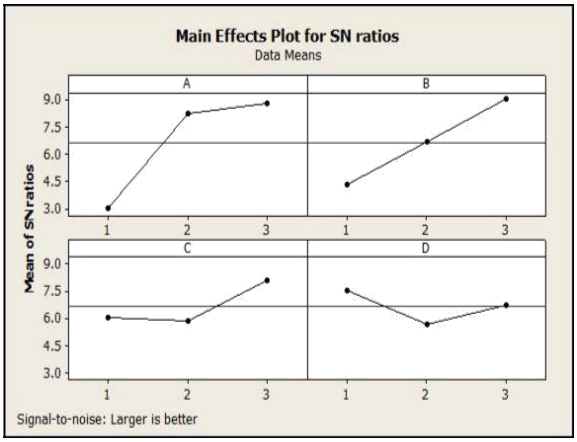


Fig (3) Normal Probability plot for Cutting Speed

3.2 Effect of input factors on Cutting Speed

Level	A	B	C	D
1	2.990	4.288	6.060	**7.540**
2	8.215	6.674	5.843	5.677
3	**8.766**	**9.008**	**8.068**	6.754
Delta	4.720	5.776	1.862	2.225
Rank	2	1	4	3

Table (4) Table on effect of input factors on cutting speed

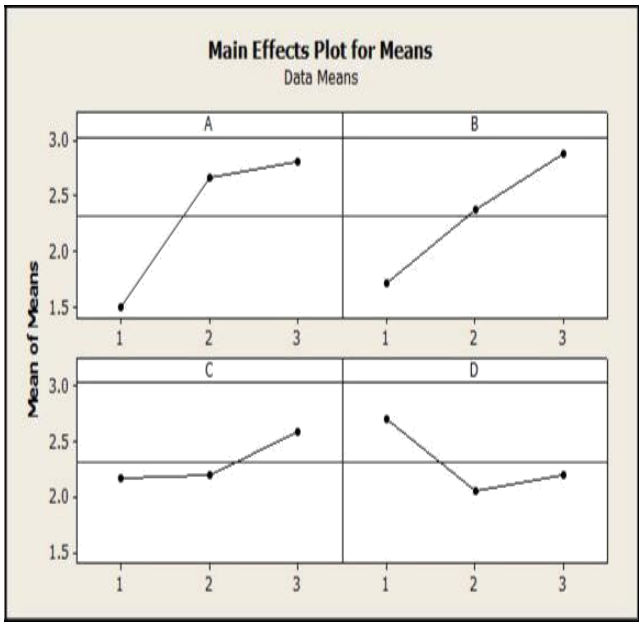


Fig(4): Main Effect Plot for S/N Ratio for cutting speed

Signal to noise ratio plot shows that maximum S/N ratio occurs correspond to $A_3 B_3 C_3 D_1$

Level	A	B	C	D
1	1.487	1.703	2.173	2.698
2	2.660	2.368	2.193	2.053
3	2.805	2.880	2.585	2.200
Delta	1.177	1.318	0.412	0.645
Rank	2	1	4	3

Table (5) : Mean table for Cutting speed



Fig(5): Main Effect Plot for Means

optimum values will be described according to these factors but the only significant factors needs be selected. The significant factors are chosen from ANNOVA table. In order to study the significance of process parameters toward the cutting speed, analysis of variance (ANNOVA) is performed.

SOURCE	DOF	SS	MS	Contribution
A	2	5.1207	2.5603	25.482

B	2	5.33	2.665	26.524
C	2	4.804	2.402	23.906
D	2	4.84	2.42	24.085
Total	8	20.094		100

Table (6) ANNOVA Table

Predicted mean or optimal value of cutting speed= $T + (A_3 - T) + (B_3 - T) + (C_3 - T) + (D_1 - T)$

On putting the required values in the above equation, optimal Value of Cutting Speed is calculated as **2.883677 mm/min.**

IV. CONFIRMATION EXPERIMENTS

The data from the confirmation runs and their comparisons with the predicted values. From the analysis, we can observe that the calculated error is small.

Cutting speed	Quality Characteristic
$A_3B_3C_3D_1$	**Optimal setting Of process parameters**
2.8836 mm/min	**Predicted optimal value of quality characteristic**
3.0 mm/min	**Conformation Values**
4.03%	**Percentage Error**

V. CONCLUSION

In the present study, L9 Orthogonal array and ANOVA was applied to predict the effect of various machining characteristics inorder to obtain maximum cutting speed. The parameters chosen for the study was were there to establish the trend of variation of a few important machining criteria with these control factors.

The paper described the effect of various parameters on the response parameter. The significant parameters were discussed and higher the better approach was applied to get the optimum value of parameters so as to get

maximum cutting speed . After applying the Taguchi methodology optimum level of the parameters for the maximum cutting speed is **$A_3B_3C_3D_1$.** The experimentation is summarized as under.

- The average cutting speed (CS) is mostly affected by Pulse on time and Pulse off time.
- The combination of **$A_3B_3C_3D_1$** (i.e. A=230A, B=130µs, C=56µs, D=5g) gives the maximum Cutting Speed of 2.8836 mm/min
- The normal probability plot for CS which is normally distributed because set of values of all the responses are mostly close to mid value.
- The error between experimental and predicted values for CS is 4.03%.

REFERENCES

[1] Liao Y.S.,. Huang J.T, Chen Y.H., (2004) "A study to achieve a fine surface finish in Wire-EDM", *Journal of Materials Processing Technology* .149 165-171.

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

[3] Puertas I., Luis C.J., (2003) *"*A study on the machining parameters optimization of electrical discharge machining", *Journal of Materials Processing Technology*, 143-144 521-526.

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

[5] Gatto A., Luliano L., (1997) "Cutting mechanisms and surface features of WEDM metal matrix composite", *Journal of Material Processing Technology* 65 209-214.

[6] Eduardo Weingartner, Konrad Wegener, Friedrich Kuster (2012) "Wire electrical discharge machining applied to high-speed rotating work pieces" *Journal of Materials Processing Technology* vol. 212, pp. 1298–1304.

[7] Kamal Jangra, Sandeep Grover, Felix T. S. Chan & Aman Aggarwal (2011)*,"* Digraph and matrix method to evaluate the machinability of tungsten carbide composite with wire EDM*" International Journal of Advanced Manufacturing Technology* vol.56, pp.959–974.

[8] D.V. Ghewade and S.R Niparkar (2011) "Experimental Study of Electro Discharge Machining For Inconel Material", *Journal of Engineering Research and Studies* Vol.2, pp.107-112.

[9] F. Klocke, D. Welling & J. Dieckmann (2011),"Comparison of grinding and Wire EDM concerning fatigue strength and surface integrity of machined Ti6Al4V components" *Procedia Engineering* vol.19,pp. 184 – 186.

[10] S. Sarkar, M. Sekh, S. Mitra & B. Bhattacharyya (2011)*,"* A novel method of determination of wire lag for enhanced profile accuracy in WEDM" *Precision Engineering* vol.35,pp.339–347.

[11] N. G. Patil and P. K. Brahmankar (2010), "Some Studies into Wire Electro- Discharge Machining of Alumina Particulate-Reinforced Aluminum Matrix Composites", *International Journal of Advanced Manufacturing Technology*, vol. 48, 537–555.

[12] M. N. Islam, N. H. Rafai and S. S. Subramanian [2010], *"An Investigation into Dimensional Accuracy Achievable in Wire-cut Electrical Discharge Machining"*, Proceedings of the World Congress on Engineering, Vol. 3

[13] Kapoor, S. Singh and J. S. Khamba [2010], "*Recent Developments in Wire Electrodes for High Performance WEDM"*, Proceedings of the World Congress on Engineering, Vol.2.

[14] Hsien-Ching Chen, Jen-Chang Lin & Yung-Kuang Yang, [2010]," *optimization of wire electrical discharge machining for pure tungsten using a neural network integrated simulated annealing approach",* Expert Systems with Applications,vol.37,pp.7147–7153.

[15] Mu-Tian Yan & Yi-Ting Liu [2009]," *Design, analysis and experimental study of a high-frequency power supply for finish cut of wire-EDM",* International Journal of Machine Tools & Manufacture, vol. 49, pp.793– 796.