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The influence of process parameters on cutting speed of WEDM using Taguchi's technique

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ABSTRACT: The aim of this paper is to investigate the effect of machining parameters of wire electric discharge machining on H-21 die tool steel for cutting speed (CS) of WEDM using Taguchi'technique.L_{18} array is used for carrying out the experiment. Input response are selected in this research which affects the response characteristics. These are Discharge current P-ON time P-OFF time Wire feed. It has been observed that effect of each input response characteristic for optimization of each performance measure is different. MINITAB15 software is also used to find the effect of each parameter on response characteristic and to predict the setting of control parameters.. In this study process parameters are optimized simultaneously for different response characteristics in die cutting to reduce the total manufacturing cost. The average cutting speed is affected by pulse-on, pulse-off, peak current and wire feed and Average value of Cutting speed, calculated from experimented data is 2.58mm/min. It is cleared that S/N ration plots shown the maximum S/N ratio observed at A6B3C3D1is 3.71 mm/min.

Keyword: WEDM, Taguchi,s Technique, cutting speed,minitab15

I. INTRODUCTION

WEDM is a metal working process with help material is separated from electrically conductive work piece, by means electrical erosion. The wire never come in contact with conductive work piece. The wire electrode leave the path on the work piece which is slightly larger the than wire.

The investigation on WEDM to improve the surface roughness on titanium using RSM and optimized using multi response optimization technique. ANOVA is used to identify the significance of parameters and modeling the influence parameters. (Anish Kumar *et al,* 2012.) to study the response parameter surface finish at cutting speed on EN31 using Taguch's Technique. Design of experiment of L_{27} array results improved MRR and reduced surface roughness (Jaganathan P *et al*,). To optimize the response characteristic of WC-Co composite made through powder metallurgy on electric discharge machining and studied the influential parameter and their interaction needed. The output studied in this work were material removal rate surface roughness which important in any machining process. ANOVA table constructed to analyzed the result (Muthuraman *et al* 2012).

To optimize the response characteristic using WEDM on tool die material O1 at different conditions. Output analyzed were the MRR, wire wear ratio surface roughness and dimensional deviation and result of machining parameter justify the real requirement in practices. (Muthuraman *et al,* 2012).

To improve the environmental impact in machining surrounding used the de ionized water in place of oxygen as di electric medium in WEDM. For the output parameter MRR and surface roughness Taguchi method used for optimization of machining parameter and ANOVA used for predict the influence the process parameter (Boopathi *et al,* 2012). To optimized the response characteristics using WEDM on tool die material O1 at different condition. The outputs analyzed were, the material removal rate (MRR), wire-wear ratio, surface roughness and dimensional deviation and Results of the machining parameters justify the real requirement in practice (Muthuraman *et al,* 2012). Wire-cut electric discharge machine of Aluminum-24345 with low rigidity to obtained high MRR and better surface finish Experimentation was done using Taguchi's L18 orthogonal array different parametric condition and response of output parameters for improving the machining efficiency (Pujari Srinivasa Rao, Koona Ramji, 2011) to optimize the WEDM process parameter of Incoloy800 super alloy with multiple output parameter like material removal rate surface roughness and Kerf. Identify the optimum level of process parameters using Grey-Taguchi method and significant of parameters by ANOVA.

Nonlinear regression analysis method used mathematically modeled output response with process parameters. Results of confirmation experiments the established mathematical models to predict out responses with reasonable accuracy (Muthuraman *et al*, 2010) Machinability of Aluminium matrix composite(AMC) using WDEM is used to achieved better stability and high productivity of manufacturing process. Fractional design of experiment with two level was used to determine the optimal parameters. Regression analysis method to determine the mathematical model between machining parameter and response parameters (Ahmad *et al,* 2010). The methodology DFA used for optimization of machining parameters on turning AL-15%SiCp metal matrix composite and analysis is called desirability function analysis.Taguchi'sL$_{27}$ orthogonal array is used for experimental design. The machining parameter such as cutting speed, feed rate and depth of cut are optimized with multiple response consideration surface roughness and power consumption. The optimal machining parameter was identified by composite desirability value obtained from DFA as performance index and influence of parameters are identified. Experimental results of machining performance has improved effectively DFA and analyzed by desirability function. (Ramanujam *et al,* 2010). The effect of machining parameters like pulse duration discharge current sustained pulse time pulse interval time ,polarity effect, material and di electric on surface roughness in finished cut of WEDM .Results surface roughness is decrease by decreasing both pulse duration and discharge current and when pulse energy per discharge is constant short pulse and long pulse have obtained the same surface roughness but different surface morphology and different MRR. The short pulse duration combined with a high peak current has generated better surface which can't be obtained with long pulse. Present investigation obtained the better machine surface in reversed polarity with appropriate pulse energy in straight polarity. (Fuzhu Han *et al*, 2007).

To study several literature it's observed that enough research work had done on WEDM in different field. Several research paper have been published on process parameter design for different response characteristic in WEDM are surface finished, cutting speed, MRR. In this study process parameters are optimized simultaneously for different response characteristics in die cutting to reduce the total manufacturing time and predict the optimal value of response characteristic corresponding to the optimal parameter's setting using Taguchi's technique and analysis of variance used to obtained influence of process parameter.

II. EXPERIMENTAL DESIGN

Work material: the work piece material used in this investigation is H21 die tool steel work material because it's characterized by high dimensional stability after hardening and tempering, high compressive strength. It is commonly used used for hot working die and tooling such as die casting extrusion and hot forming of parts.

Table: 1: Composition of H21 die tool steel.

Element	**C**	**Mn**	**Si**	**Cr**	**Ni**	**W**	**V**	**Cu**	**P**	**S**
%content	0.3	0.3	0.2	3.6	0.3	8.5	0.4	0.25	0.03	0.03

Table 2: Physical Properties.

Properties	**Density**	**Poisson's ratio (25°C)**	**Thermal conductivity**	**Specific heat (cal/g^{o}C)**
	8.19g/cm^3	8.19g/cm^3	27.0 W/mK	0.110

Table 3: Selection factor with levels.

Factor/level	Discharge current ,A	Pulse on B	Pulse off C	Wire speed D	Wire tension E
1	180	120	48	3	6
2	190	124	52	4	7
3	200	128	56	5	8
4	210				
5	220				
6	230				

Selection factor and orthogonal array

To investigate the effect of six parameter on cutting speed simultaneous of WEDM experimental design was completed using fractional factorial experiment and L_{18} orthogonal array is selected according to DOF. Level of discharge current are 6 DOF less than one are 5.similarly each for pulse on, Pulse off ,Wire speed, Wire tension is 2. Total degree of freedom are 13 is labeled.

Table 4: fixed parameter.

Fixed parameter	Wire type	Angle of cut	Work piecethickness	Di electric flow
Specification	Zinc coated brass,025mm	Vertical	20 mm	12LPM

Based on experimental data collected according to test trial inL_{18}S/N Ratio and mean repeated trails are shown in table 2.5.

Table 5: Response table for mean and SN Ratio.

Sr. No	R1	R2	R3	S/N RATIO	MEAN
1	2.54	2.68	2.7	8.32974	2.61
2	2.51	2.57	2.56	8.091620	2.54
3	2.51	2.55	2.6	8.061593	2.53
4	2.16	2.64	2.8	7.497700	2.405
5	2.51	2.53	2.56	7.991610	2.51
6	2.50	2.54	2.66	8.095867	2.54
7	2.02	2.06	2.05	6.126513	2.025
8	1.99	2.07	2.02	5.992227	1.995
9	3.67	3.71	3.9	11.39855	3.715
10	1.50	1.5	1.53	3.4331	1.485
11	3.00	3.10	3.10	9.670867	3.045
12	2.83	2.87	2.96	9.126683	2.86
13	1.93	1.94	2.02	5.731444	1.935
14	2.08	2.12	2.14	6.360061	2.08
15	3.75	3.89	3.91	11.65082	3.825
16	1.64	1.71	1.76	4.504339	1.68
17	3.14	3.25	3.3	10.08786	3.195
18	3.11	3.15	3.26	9.95158	3.145
Average Cutting speed (Tavg) is = 2.57 mm/min.					

III. RESULT AND DISCUSSION

Effect of Parameters on Cutting Speed (CS)

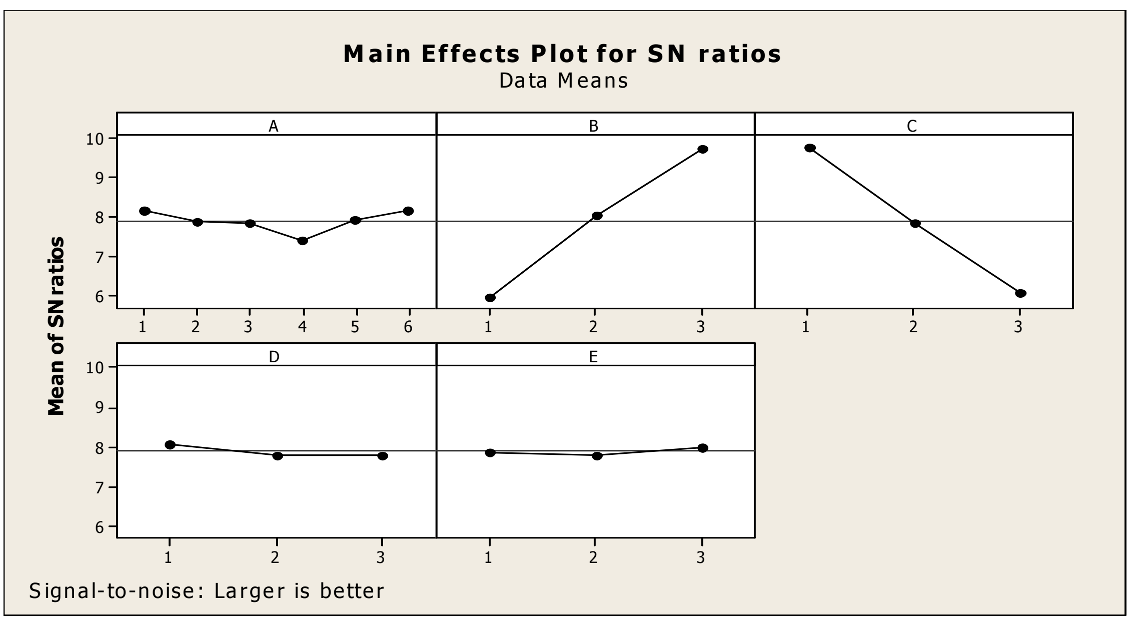
The mean cutting speed and the S/N ratio were measured after each trail conditions using minitab15 in table 2.5 and analyzed using analysis of variance to identify the significant factor and relative influence on response parameter. The response tables for mean and S/N ratio are given in table 3.1 and 3.2these values are shown in figure 3.1

Table 6. 1Response table for S/N ratio (larger is batter).

Level No.	Peak current A(Amp)	Pulse on B(µm)	Pulse off C(µm)	Wired speed D(mm/min)	Wire tension E(kg)
1	8.161	5.937	9.773	8.089	7.894
2	7.862	8.032	7.837	7.811	7.789
3	7.839	9.714	6.075	7.784	8.001
4	7.410				
5	7.914				
6	8.181				
Delta	0.771	3.777	3.698	0.305	0.212
Rank	3	1	2	4	5

Table 7: Response table for mean.

Level no.	Peak current A(Amp)	Pulse on B(µm)	Pulse off C (µm)	Wire speed, D (mm/min)	Wire tension, E (kg)
1	2.560	2.023	3.133	2.574	2.523
2	2.485	2.561	2.502	2.551	2.562
3	2.578	3.103	2.052	2.562	2.603
4	2.463				
5	2.613				
6	2.673				
Delta	0.210	1.079	1.081	0.023	0.080
Rank	3	2	1	5	4



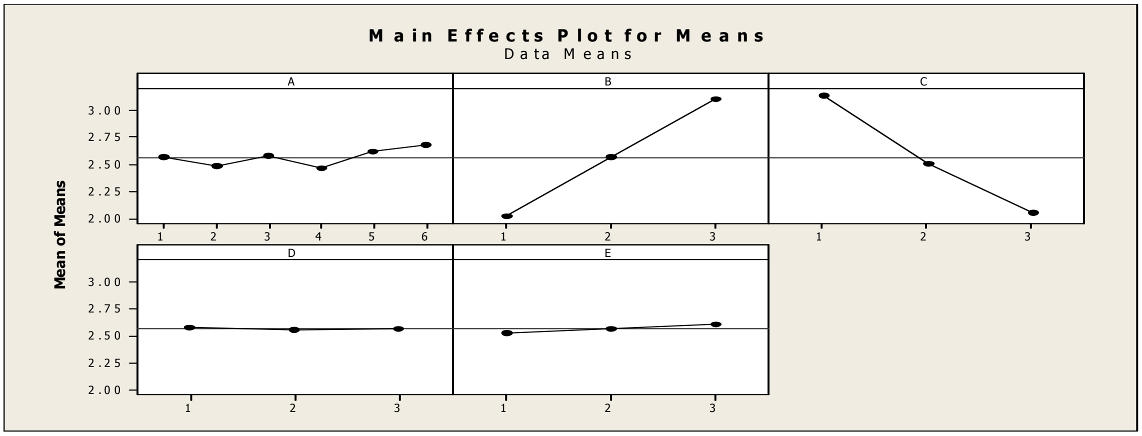


Fig. Main Effect Plot for S/N ratio and Mean.

Average cutting speed 2.58mm/min, calculated from raw data. It is cleared from the S/N plots the maximum S/N ratio occur correspondingA6B3C3D1. There for optimal value will correspond to these factor but only significant factor would be selected. This factor will be selected from the ANOVA table.

Selection of Optimum Level. To study of influencing process parameter for cutting speed ANOVA is performed. The ANOVA of the row data and S/N ratio data are given in table 3.3 and 3.4. MINITAB 15.

Table 3.3 ANOVA for S/N data.

Source	**DOF**	**Seq.SS**	**AdjMS**	**F**	**P**
A	5	1.1768	0.2354	15.14	0.010
B	2	42.9688	21.4844	1382.28	0.000
C	2	41.0570	20.5285	1320.78	0.000
D	2	0.3427	0.1713	11.02	0.024
E	2	0.1350	0.0675	4.34	0.099
Error	4	0.0622	0.0155		
Total	17	85.7425			
SS= Sum of Square, DOF =Degree of freedom Adj MS= adjusted mean square or variance.					

Table 3.4 ANOVA for Mean.

Source	**DOF**	**Seq.SS**	**AdjMS**	**F**	**P**
A	5	0.09289	0.01858	1.55	0.0345
B	2	3.49382	1.74691	146.17	0.000
C	2	3.53670	1.76835	147.96	0.000
D	2	0.00164	0.00082	0.07	0.0435
E	2	0.01920	0.00960	0.80	0.5003
Error	4	0.04781	0.01195		
Total	17	7.19206			
Seq.SS =Sum of Square, DOF – degree of freedom Adj MS= adjusted mean square or variance.					

For 95% confidence level $f_{critical}$ value is 0.05 but calculated value of fisher's ratio is less than 0.5 has influence the mean and variation of cutting speed. Therefore from ANOVA Table calculated value of fisher's ratio less than 0.05 only four parameter as peak current pulse on time pulse off time wire speed. Cutting speed is the "higher is better" characteristic. Higher value of cutting speed is considered to optimal. Optimal value cutting speed of cutting speed = (A6+B3+C1+D1) = 3 (Tavg) = 3.71mm/min

IV. CONCLUSION

The average cutting speed is affected by pulse on time pulse off time peak current and wire feed during rough cut and average value of cutting speed calculated from row data is 2.58mm/min .its cleared that from the S/N plots the maximum S/N ratio occur corresponding A6B3C3D1 is3.71mm/min.

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