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Effect of Wire Cutting Process on the Variables of Surface Roughness

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ABSTRACT

This paper was focused on intervening variables in wire cut process such as pulse on time, pulse off time, voltage, type of wire which is used in experiments, They Show that 98.9% of the observed variability in MRR could be explained by the independent variables. This means that the correlation coefficient between the observed value of the dependent variable and the predicted value based on the regression model is high as this means that the statistical model could predict the Ra with about 98.5 % and 95.9 % accuracy of the testing data set for coated wire respectively.

Key words: Wire EDM, Surface Roughness

INTRODUCTION

Wire EDM is not the new kid on the block. It was introduced in the late 1960s', and has revolutionized the tool and die, mold, and metal working industries. It is probably the most exciting and diversified machine tool developed for this industry in the last fifty years, and has numerous advantages to offer. It can machine anything that is electrically conductive regardless of the hardness, from relatively common materials such as tool steel, aluminium, copper, and graphite, to exotic space-age physical pressure imparted on the work piece compared to grinding wheels and milling cutters [1]. Wire cut process is one of non-traditional machining which has important applications and most widely in different industries, electrical discharge machining which is based on the principle of removing material by means of repeated electrical discharges between the tool termed as electrode and the workpiece in the presence of a dielectric fluid [2]. Most workpieces come off the machine as a finished part, without the need for secondary operations. It's a one-step process [3] .today has important applications in manufacturing solar cells which led to high dimensional accuracy and smooth work surfaces by using wire cut machine present work involve intervening effective variables in process such as (pulse on time, pulse off time, servo feed rate, Arc on time, wire tension) to predict metal removal and surface roughness [4]. Wire EDM also gives designers more latitude in designing dies, and management more control of manufacturing, since the machining is completed automatically [5]. The amount of clamping pressure required to hold small, thin and fragile parts is minimal, preventing damage or distortion to the workpiece. The accuracy, surface finish and time required to complete a job is extremely predictable, making it much easier to quote; EDM leaves a totally random pattern on the surface as compared to tooling marks left by milling cutters and grinding wheels. The EDM process leaves no residual burrs on the workpiece, which reduces or eliminates the need for subsequent finishing operations [6]. Parts that have complex geometry and tolerances don't require you to rely on different skill levels or multiple equipments. Substantial increases in productivity was achieved since the machining is untended, allowing operators to do work in other areas. Most machines run overnight in a "lights-out" environment [7]. Long jobs are cut overnight, or over the weekend, while shorter jobs are scheduled during the day.

EXPERIMENTAL PROCEDURE

Materials

The Work material was used steel (33) as shown Fig.1 and machined under different cutting conditions which has the following chemical composition as shown in Table.1 with dimensions (3 x 120 x 200 mm). Coated wire was used with 0.25 mm diameter.

Surface Roughness Measurement

Stand: Work table dimensions(600 mm×600 mm), maximum height of stylus from work table(400 mm), weight of stand: (60 kg) approx, maximum traversing length(0.5 mm), dimensions :(405×220×300 mm), and weight(15 kg) approx. Fig.2 shown Roughness measuring apparatus.

Cutting Conditions

There are four parameters used in experiments as shown in Table-2

Dielectric Used

Pure (distilled) water was used; flush WEDM (10 L), control of water conductivity: (2.5 - 5.0) ×104 L.cm.

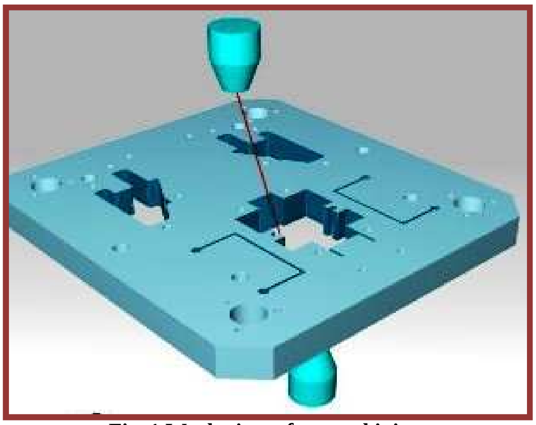

Fig. 1 Work piece after machining

Fig. 2 Roughness measuring apparatus

Table -1 Chemical Composition of Workpiece

Elements	***Fe***	***Cu***	***Ni***	***Mo***	***Cr***	***S***	***P***	***Mn***	***Si***	***C***
%Content	Rem.	0.002	0.039	0.4	0.007	0.03	0.03	0.35	0.13	0.2

Table -2 Cutting Conditions of Machine Number Two

NO.	***Parameters***	***symbol***	***Level 1***	***Level 2***	***Level 3***	***Level 4***	***Units***
1	Pulse on time	Ton	110	118	121	123	usec
2	Pulse off time	Toff	26	27	29	30	u.sec
3	Servo feed rate	SF	35	46	57	62	mm/min
4	Wire tension	WT	5	6	7	8	Kgf

RESULTS AND DISCUSSION

The effect of machining parameters on material removal rate and surface roughness in machining steel DIN 17100 are studied. From the results it is found that increasing pulse on time lead to increase surface roughness as shown in Table.3 and Table.4 from 3.25 to 3.90 (urn) at 100 usec and metal removal rate 0.585g while pulse of time 115 sec was 5.4016 (urn) and metal removal rate 1.58.

A statistical model was created by using regression function in SPSS from the test data set. From Table.5 the (R square) pieces are 0.971 coated wire, it show that 97% of the observed variability in, Ra could be explained by the independent variables. The multiple R is 0.986 for coated wire. This means that the correlation coefficient between the observed value of the dependent variable and the predicted value based on the regression. A mathematical technique known as the sum of squares is used to quantitatively evaluate the deviation of the control factor effect response averages from the overall experimental mean response. The value F- ratio is used to test the significance of factor affect. F results were (60.94) for coated wire, as shown in the ANOVA Table.6. In following Table (7) the coefficients for the independent variables are listed in column P for coated wire and coated wire respectively.

The R square pieces were (0.998). They show that 99.7% of the observed variability in MRR could be explained by the independent variables. The multiple R was 0.999 for coated wire. This means that the correlation coefficient between the observed value of the dependent variable and the predicted value based on the regression model is high as shown in Table.8. The value F- ratio used to test the significance of factor effect .F was 274.204 for coated wire respectively, as shown in the ANOVA Table .9. In Table.10, the coefficients of the independent variables are listed in column P for coated wire. This means that the statistical model could predict the MRR with 99.8% accuracy of the testing data set for coated wire, the relationship between measured and predicted values of Ra and MRR for coated wire is shown in Fig.3 and Fig.4. Also the relationship between measured and predicted values of Ra and MRR for coated wire is shown in these Figures.

Table -3 Experimental Designs for Measured and Predicted Surface Roughness for Coated Wire

No.	***Pulse on time (fisec)***	***Pulse off time (usec)***	***Wire tension (kgf)***	***Servo feed rate (mm/min)***	***Ra (urn) measured***
1	105	24	5	20	3.5
2	110	24	5	20	4.15
3	115	24	5	20	4.7
4	120	24	5	20	5.29
5	120	25	5	20	4.85
6	120	26	5	20	4.1
7	120	27	5	20	2.3
8	1 20	24	6	20	5.17
9	120	24	7	20	3.94
10	120	24	8	20	2.66
11	120	24	5	30	5.93
12	120	24	5	40	6.48
13	120	24	5	50	6.91

Table -4 Experimental Designs for Measured and Predicted Material Removal Rate Model for Coated Wire

No.	***Pulse on time (fisec)***	***Pulse off time (usec)***	***Wire tension (kgf)***	***Servo feed rate (mm/min)***	***MRR (mm^3/min) Measured***
1	105	24	5	25	0.76
2	110	24	5	25	1.1
3	115	24	5	25	1.39
4	120	24	5	25	1.8
5	120	25	5	25	1.81
6	120	26	5	25	1.73
7	120	27	5	25	1.74
8	120	26	6	25	1.66
9	120	24	7	25	1.67
10	120	24	8	25	1.68
11	120	24	5	35	1.96
12	120	24	5	45	2.1

Table -5 Model Summary' For Ra (Coated Wire)

Model	***R***	***R square***	***Adjusted R Square***	***Std. Error of the Estimate***
1	0.986	0.971	0.953	0.38562

Table -6 ANOVA for Ra (Coated Wire)

Model		***Sum of Squares***	***df***	***Mean Square***	***F***
2	Regression	21.680	5	5.41	60.94
	Residual	0.80	9	0.093	-
	Total	21.80	11	-	-

Table -7 Variables Coefficients in the Multiple Regression Equation for Ra (Coated Wire)

Model		***Un standardized Coefficients***		***Standardized Coefficients***	***t***	***Sig.***
		B	***Std. Error***	***Beta***		
3	(Constant)	16.96	2.95		6.1	0.000
	A	0.15	0.03	0.53	6.71	0.000
	B	-0.98-	0.13	-0.72-	-8.90-	0.000
	C	-0.91-	0.13	-0.65-	-8.21-	0.000
	D	0.047	0.014	0.32	3.73	0.005

Table -8 Model Summary for MRR (Coated Wire)

Model	***R***	***R square***	***Adjusted R Square***	***Std. Error of the Estimate***
4	0.998	0.997	0.994	0.2731

Table -9 ANOVA for MRR (Coated Wire)

Model		*Sum of Squares*	*df*	*Mean Square*	*F*
4	Regression	1.610	7	0.196	217.3
	Residual	0.0029	4	0.001	
	Total	1.62	11	-	-

Table -10 Variables Coefficients in the Multiple Regression Equation for MRR (Coated Wire)

Model		**Un standardized Coefficients**		**Standardized Coefficients**	**T**	**Sig.**
		B	**Std. Error**	**Beta**		
5	(Constant)	21.89	12.41	-	1.77	0.149
	A	-0.353-	0.1 4	-4.69-	-3.13-	0.034
	B	-0.25-	0.72	-0.639-	-.344-	0.75
	C	-0.65-	0.189	-1.73-	-3.29-	0.029
	D	0.015	0.0119	0.44	1.41	0.24
	A2	0.003	0.0011	5.639	3.688	0.020
	B2	0.005	0.0129	0.549	0.31	0.80
	C2	0.039	0.013	1.58	3.06	0.035
	D2	-6.71 E-5	0.000	-0.149-	-0.51-	0.635

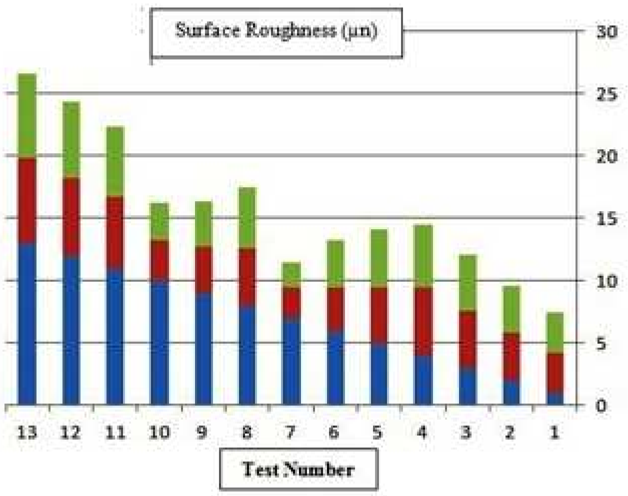

Fig.3 Relationship between measured and predicted Ra (coated wire)

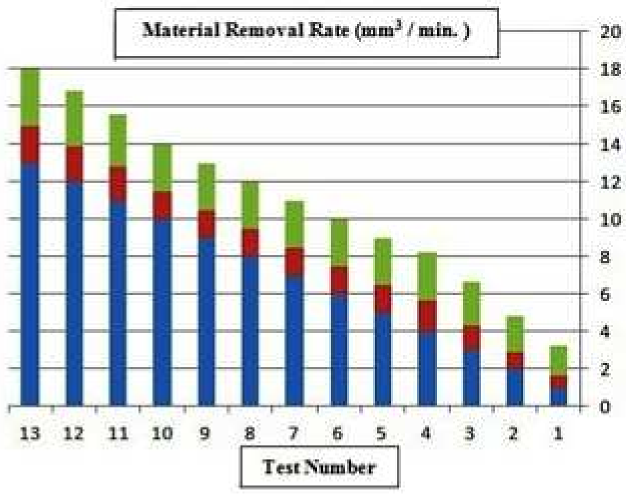

Fig.4 Relationship between measured and predicted MRR (coated wire)

CONCLUSION

- The statistical model could predict the MRR with 99.8% accuracy of the testing data set for coated wire.
- There is agreement between predicted values and experimental values for surface roughness and material removal rate.
- The statistical model could predict the Ra with about 98.7 % and 96.8% accuracy of the testing data.

REFERENCES

[1] PC Pandy and CK Singh, Production Engineering Sciences, University of Roorkee, Department of Mechanical and Industrial Engineering, India, **2006**.

[2] Scott F Miller, Albert J Shihjunqu, Investigation of Spark Cycle on Material Removal Rate in Wire Electrical Discharge Machining of Advanced Materials, International Journal of Machine Tools and Manufacture, **2004**, 44, 391-400.

[3] RK Jain, Production Technology, Khanna Publishers, Department of Mechanical Engineering, Regional Engineering College, Kurukshetra, Haryana, India, **2004.**

[4] JA Sanchez, JL Rodile, A Herrero, LN Lopezde Acalle and A Lamikiz, On the Influence of Cutting Speed Limitation on the Accuracy of Wire EDM Corner Cutting, Journal of Materials Processing Technology, **2007**, 182, 574-579.

[5] Mu Tian Yan and Pin-Husam Huang, Accuracy Improvement of Wire EDM by Real- Time Wire Tension Control, International Journal of Machine Tools and Manufacture, **2004**, 44, 807-814.

[6] YS Lia, JT Huang and YH Chen, A Study to Achieve Affine Surface Finish in Wire EDM, Journal of Materials Processing Technology, **2004**, 149, 165-171.

[7] HAG El-Hofy, Advanced Machining Processes, Mc Graw-Hill, Department Production Engineering, Alexandria University, Egypt, **2005**.