Performance Analysis of Removal Rate of Material and Roughness of a Surface By Electric Discharge in Wirecut Machine on En-19a Material

Dhoni Srinivas [1], S.Madhu[2]

[1]MtechScholar, [2]Professor, Department Of Mechanical Engineering,

MLR Institute Of Technology, Hyderabad.

Email:dsrinu9493@gmail.com

Abstract:(WIRE EDM) has turned into an imperative non-customary machining process as it gives a successful answer for creating segments to machine hard materials like zirconium,titanium and mind boggling shapes done by regular machining techniques. This paper surveys various reaction process like Surface roughness, Removal of Material Rate on process parameters like heartbeat onservo voltage (sv), pulse-on-time (TON), pulse-off-time (TOFF). The principle of destinations this exa mination research and assess the impact of various information parameters like (servo voltage(sv),beat-on-time, beat-off-time,) on material e xpulsion rate, surface harshness as reaction parameters have been considered for every Experiment. Experiments done on according to Taguchi's method amid machining of EN-19A work material which is High Carbon and High Chromium Die Steel (HC-HCR). 0.15mm Diameterof Metal wire cathodetaken as Experiments. The exa mination of difference (ANOVA) strategy. This parametric examination (ANOVA) demonstrates the rate commitment of parameters exc lusively. Advance numerical models are produced utilizing Box-Behnken outline of trials of reaction surface procedure to streamline the procedure parameters utilizing condition of craftsmanship improvement methods for future investigations.

Keywords: W EDM, TON, TOFF, ANOVA , Taguchi method

1. Introduction

1.1 Selection of Material

The material EN-19A steelis a high carbon- high chromium steel performed as an experiment. These steels hold their hardness up to a temperature of 4500c.

Table 1. Chemical Composition OfEN-19A Steel

Element	Content (%)
C	1.50
Mn	0.52
Si	1.3
Cr	0.22
Ni	0.33
Mo	0.06
P	0.05

Table 2. Mechanical Properties of an EN-19A steel

ELEMENT	METRIC
Yield Stress	470N/mm2
Elongation	0.3
Tensile Strength	810N/mm2
Area of Reduction	0.45

Table 3. Physical Properties of EN-19

Thermal Conductivity on material (w/m-k)	Density (Kg/m3)	Melting point (^{0}c)
46.6	781	154

1.2 Applications of EN-19A

Dies stamping, metal cutting tools have a heavyweight and high strengthfounded as a typical applications. Aerospace industry, Punching dies, Spinning tools Ball and Roller Bearings

1.3 Wire Electric-Discharge Machining (WEDM)

(WEDM) selection is a one of the ordinary EDM process.It has a fundamental CNC controller, worktable, metal wire, tank of liquid. Wire cathodewidth 0.03-0.20 mmis ametal molybdenum, thin copper, or tungsten which transforms electrical vitality into warm vitality, is used for cutting on the materials.At 1500rpmon a wire drum the wire can be twisted and can be pivoted.

Figure 1. Different intricate shapes on(WEDM)

2. Literature Review

Prohaszka et al. (1996) studied the prerequisites of the materials that can be utilized as (WEDM) anodes and will prompt the change of (WEDM) execution. He talked about the material necessities for creating (WEDM) terminals for enhancing (WEDM) execution[1].Tang et al.(1998) defined a neural system to reproduced tempering calculation as to anticipate cutting speed of (WEDM) processto improve the surface finish while machining stainless steel of SUS–(304) materials[2].Gokler et al. (2000) investigated relative machining parameters for the (WEDM) process and surface roughness can be achievable for 2379 steel,1040steel, 2738 steel materials[3].Kruth et al. (2001) of Katholieke University, Belgium examined and tentatively tried a few pieces of wires, with high elastic Centre and a few coatings. They have discovered that, while cutting with model wires, a critical ascent in exactness is acquired, particularly in corner cutting, while the cutting rate is at a similar level as business reference wire [4].Puri et al. (2011) investigated on geometrical inaccuracy caused on various machine control parameters due to wire lag process[5]. Ramakrishnan et al. (2013) using the response developed surface methodology by a mathematical model [6].

3. Design of Experiment

3.1 Response Variables and Parameters by (WEDM) Process

Fundamental objectives of (WEDM) to get a superior soundness and with increased profitability. Nonetheless, because of countless in (W EDM), it is hard to accomplish the ideal execution of (WEDM) forms and the successful method for taking care of this issue is to build up the connection between the reactions factors of the procedure and its controllable info parameters.

Table 4: Parameters in WEDM process

Serial. No.	Parameter by a Machining process	Level-1	Level-2	Level-3
1.	Pulse-on-Time (micro seconds μs)	115	120	130
2.	Pulse-Off-Time (micro seconds μs)	45	55	65
3.	Servo Voltage (volt)	20	30	40

3.2 Steps to perform Taguchi design of the experiment

1. Recognize the principle work, symptoms, and disappointment mode.
2. Recognize the quality attributes common factorsand testing conditions at different levels.
3. Recognize target capacity to improve.
4. Observecontrol factor levels.
5. Choosegrid test of orthogonal cluster.
6. Conduct test on framework.
7. Analyze the levels of ideal information, and lastly for execution.

8. Investigate and plan the future activity. Principle work must beRecognize, symptoms, and disappointment mode.

3.3 Key terms used in DOE

Investigation made on these variables have performance characteristic of direct influence on product or process as mentioned.

3.3.1. Factors

Two different typesofFactors:

(i) Factor of *Discrete* - values are known or level of statusAssumeshere. Example: Container, Vendor,etc.

(ii) Factor of *Continuous*–It can be assume that any workable value for the factor Levels. Example: Temperature, Pressure, Thickness, etc.

3.3.2. Levels for the factors

This is the values or descriptions that define the condition of the factor held while performing the experiments.

3.3.3 Levels value for factors

Sr. No.	**Parameters fixed**	**Set Value obtained**
1	Wire material	Brass (0.32milli meters)
2	Peak-current (A)	234
3	Pulse peak-voltage (V)	2
4	Wire feed rate (m\min)	4
5	Flushing Pressure (kgf/cm2)	12
6	Wire Tension (kgf)	9

4. Experimental Work Setup and Measurement

The setup for the experiment and examines at the Vinayaka wire cut at old Airport Road Hyderabad. The work is completed in wire cut electro release machine of EN-19A HC-HCR material by differentparameters for the machining.

Figure 2. Sprint cut Wire Cut EDM

Figure 3. Control Cabinet

Table 5. Work Table

Layout Design	**Moving table fixed column,**
Size of a Table	420 x 630 ×300 mm

Table6. Max.Dimension for Work Piece

Max. height of a work piece	**200 (mm)**
Max. weight of a work piece	500 (kg)
traverse position of Main table (X,Y)	250 x 400 (mm)
traverse position of Auxiliary table (U,V)	60 x 80 (mm)
Wire electrode diameter	0.25 (mm) [std.] 0.15, 0.20(mm) [opt].

Table7. PULSE-GENERATOR

Pulse-Generator	ELPULS-40 A DLX
Pulse-peak voltage	1 Step
CNC Controller	EMT 100W-5
supply of Input power	8.3 phase, AC, 415 V, 50 Hz
Load applied	10 (kVA)
Avg power consumption	6 to 7 (kVA)

5 .ANOVA ANALYSIS

5.1 Introduction

ANOVA table taken for the exanimating the values, obtained controlparameters

Table 8. Control parameter

Exp No	**T-on (micro seconds)**	**T-off (micro seconds)**	**SV(V)**	**M.R.R (mm^3\min)**
1	110	45	20	0.0320
2	110	45	30	0.0325

3	110	45	40	0.0299
4	110	55	20	0.0339
5	110	55	30	0.0330
6	110	55	40	0.0325
7	110	65	20	0.0345
8	110	65	30	0.0338
9	110	65	40	0.0331
10	120	45	20	0.0540
11	120	45	30	0.0579
12	120	45	40	0.0669
13	120	55	20	0.0488
14	120	55	30	0.0475
15	120	55	40	0.0520
16	120	65	20	0.0472
17	120	65	30	0.0445
18	120	65	40	0.0535
19	130	45	20	0.0640
20	130	45	30	0.0683
21	130	45	40	0.0655
22	130	55	20	0.0618
23	130	55	30	0.0698
24	130	55	40	0.0668
25	130	65	20	0.0575
26	130	65	30	0.0670
27	130	65	40	0.0645

Total number of exp.values = n = 27 Total values for degree of freedom = f_T = (n-1) = 26

6. OPTIMIZATION OBTAINED BY MULTI RESPONSE

6.1 Grey relational analysis obtained by multi response

Table 9. Graph plot for Grey relational grade

Sr. No.	Machining process parameter	Level-1	Level-2	Level 3
1	Pulse-On-Time (micro seconds)	115	120	130
2	Pulse-Off-Time (micro seconds)	45	55	65
3	Servo Voltage (volt)	20	30	40

6.2 Grey relational grade Response table

Table 10. Machining process parameter levels

parameters by Machining	**Average values of Grey relational grade for different factor level**			**Main effect** [Max-Min]	**Rank**
	Level-1	Level-2	Level-3		
Pulse-On-Time, A	0.372461	0.609508	0.882459*	0.509938	1
Pulse-Off-Time, B	0.650298*	0.618361	0.595769	0.054529	2
Servo Voltage,C	0.591199	0.627601	0.645629*	0.054430	3

6.3 Confirmation test

Table 11. Table for confirmation experiment

LEVEL	A1B2C3	A1B2C3	A1B2C3
Removal of Material Rate(mm /min)	_	0.0698	0.0783
Roughness of a Surface (µm)	_	3.4925	3.5014
Grey Relational Grade	0.9353	0.9987	_

ANOVA for GRG of metal wire terminal shows Toff and SV are most critical parameters and contributes with 30.9894% and 29.9966% separately, SV is inconsequential parameter and contributes24.9449%.The blunder between Gray hypothesis forecast configuration utilizing programming and experimental esteems utilizing Gray social examination for GRG is 0.14999% which demonstrates that huge model is created

7. RESULT

After obtaining values from 27 experimental values and output parameters like removal of material rate and roughness of a surface for EN-19A HC-HCRon wire cut EDM.

7.1 (Input Parameters V/S Output Parameters) Main Effect Plots

Figure 4. Graph of (input parameters v/s material removal rate)

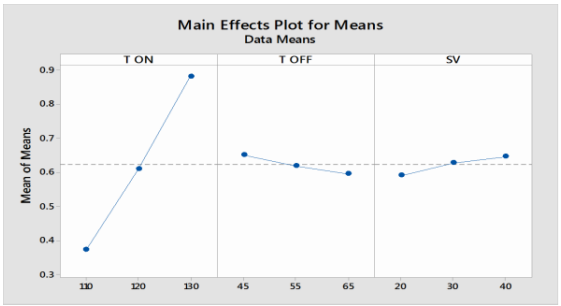

Figure 5. Graph of (inputparameters v/s surface roughness)

7.2 MATHEMATICAL MODELDELOPMENTS

Results obtaining from the experiment of mathematical model between process parameters v/s machining outputs. Mathematical modelcoefficients are computed by method of multiple regressions. Study of S.P.S.S (Software Package for Statistical Solutions) Minitab17.For the regression analysis custom made software created by the author was mostly used. Powerseries, linear, exponential are several models used in this software. High coefficient of multiple determination (R^2) value is taken. The relationship between response for the variable(s) and parameters by the process can be expressed as

Table 12. Box-Behnken design of experiments

EXP.NO	Ton	Toff	SV	MRR	SR
1	110	55	20	0.0339	3,1970
2	130	55	40	0.0668	3.4692
3	110	65	30	0.0338	3.0250
4	120	45	40	0.0669	3.3808
5	120	45	20	0.0540	3.3575
6	120	65	20	0.0472	3.2907
7	120	55	30	0.0475	3.2907
8	130	65	30	0.0670	3.4890
9	130	55	20	0.0618	3.4578
10	120	55	30	0.0475	3.2907
11	120	55	30	0.0475	3.2907
12	120	65	40	0.0535	3.3496
13	110	45	30	0.0365	3.1919
14	110	55	40	0.0325	3.0145
15	130	45	30	0.0683	3.4416

8. Conclusion

From exhibited work, tests been completed for expulsion material rate and unpleasantness of a surface with factors as heartbeat on time, beat off time and servo voltage. From all factors 27 explanation values are taken to increase the parametric examination.

At last, it can be done:

The (ANOVA) founded to know the rate of information on yield parameters. (ANOVA) examinerate commitment of heartbeat-on-time is 87.2%, beat-off -time is 1.81% and servo voltage (sv)is 1.81% for material evacuation rate, which demonstrates that the impact of Pulse off time is less contrast with different parameters. The rate commitment of Pulse-on-time is 74.2%, Pulse-off-time is 1.01% and Servo voltage (sv) is 15.9% for Roughness of the Surface which demonstrates that the impact of Pulse off time is less contrast with different parameters. The blunder and rate commitment of collaboration terms found in (ANOVA) investigation is 9.18% for material expulsion rate and 8.89% for surface unpleasantness. Grey social investigation is done to discover ideal parameter levels. After examination, it is found that levels of ideal parameter like beat-on-time at level 1 (110 micro seconds), beat-off-time at level 2 (55 micro seconds), servo voltage (sv) at level 3 (40 volts). The ideal parameters of material evacuation rate of 0.0698 mm3/min, surface unpleasantness of 3.4925 μm. Process parameters don't have some little impact

for each reaction. Noteworthy parameters and its rate commitment changes according to the conduct of the parameter with target reaction.

9. Future Scope

Responses like Kerf width,circularity, roundness, cylindricityand machining cost are to be considered.The scientific model created on WEDM with various work piece and anode materials.

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