Parametric Optimization of Graphite Plate by WEDM

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Abstract - *Wire electrical discharge machining is an emerging technology in the area of machining to very complex micro products. WEDM is a completely complex technique regarding the distinct method. Experimental investigation has been carried out in multi process micro EDM machine. WEDM technique is a highly complex, time varying & stochastic system, which is used in the fields of dies, moulds, precision manufacturing and contour cutting etc. It is especially used for the aerospace and medical industries. The complex shape can be generated with high degree of accuracy and surface finish using CNC WEDM. Hence suitable selection of input variable for the WEDM process depends heavily on the operator's technology & experience. The literature survey has revealed that a little research has been conducted to obtain the optimal levels of machining parameters to machine on graphite material. The objective of optimization is to attain the minimum surface roughness and maximum material removal rate. In this present study the work piece of graphite plate is used. The Brass wire of 0.25mm diameter is used as a tool and distilled water is used as dielectric. The experimentation was planned as per Taguchi's L9 Orthogonal array for machining of graphite material. For each experiment surface roughness and MRR is determined by using contact type surface coder and display screen of machine directly.*

Key Words: WEDM,MRR,SR,RA,TON,TOFF

1.INTRODUCTION

The Wire electrical discharge machining is one of the important non-traditional machining processes. There are various materials having high hardness that can be easily machined by generating sparks at every few microseconds. There is sparking mechanism which generates the spark between wire electrode and work piece, where the temperature reaches to about 12,000°C. The dielectric fluid acts as medium for passing of spark current from electrode to the work piece. Typically the gap between wire and work piece for WEDM varies from 0.025 to 0.05 mm and this gap is constantly monitored by a computer controlled system. Now days the numerical control is mainly used according to the customer requirement for machining. It is widely used in the aerospace and automotive industries. However, the selection of cutting parameters for obtaining higher cutting efficiency or accuracy in wire EDM is still not widely focused, even with the most up-to date CNC WEDM machine. The main aim to optimize the process parameter is to overcome irregularities and to achieve the surface roughness and metal removal rate.

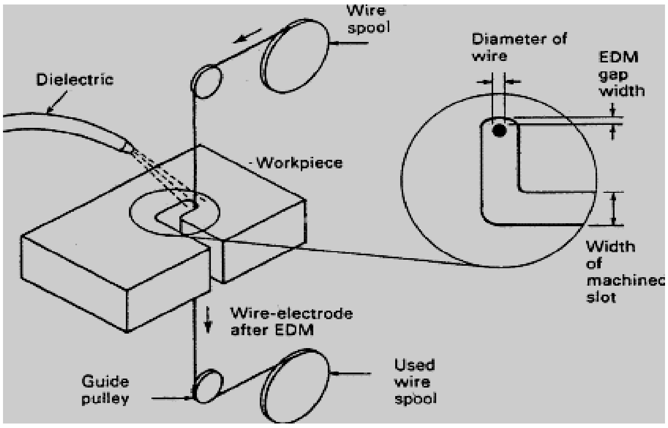

Fig -1: Schematic diagram of WEDM

2. LITERATURE REVIEW

Ashish Srivastava et al [1] have studied on composite material of Al2024. They selected three levels of each parameters like current, pulse on time and strengthening proportion on surface finish and MRR. The response surface methodology (RSM) process was applied to optimize the machining parameters for minimum surface roughness and most MRR. It was determined that surface roughness increase in peak current and pulse on time.

Neeraj Sharma et al [2] have highlighted in nursing improvement of eight management factors on MRR, surface roughness and the width of cut made by saw (kerfs) in WEDM technique for steel D2. It has been found that pulse on-time is the foremost vital parameter on roughness, kerfs and material removal rate.

P.K. Jain and N.K. Jain [3] have studied the impact of parameters on cutting speed and dimensional deviation for WEDM exploitation High-strength low-alloy steel. Response surface methodology was utilized to optimize the strategy parameter. It was seen that the foremost distinguished issue for cutting speed, pulse-on time.

M. Dura raj and N. Swaminathan [4] optimize the strategy parameters throughout machining of SiCp/6061 Al metal matrix composite (MMC). They have selected Four input technique parameters of WEDM namely servo voltage (V), pulse-on time (TON), pulse-off time (TOFF) and wire feed rate (WF). highlight of ANOVA results that the voltage and wire feed rate are very vital parameters and pulse-off time could be a least vital.

Chengmao zhang et al [5] have Investigation on stainless-steel (SS304).They use brass wire of 0.25mm diameter as conductor. It was a levels that optimized input parameter from result show that minimum surface roughness square measure 40V gap voltage, 2mm/min wire feed, six microsecond (µs) pulse on time, 10 µs pulse off time and equally optimized conditions to urge the minimum kerfs breadth square measure 50V gap voltage, 2mm/min Wire Feed, four µs pulse on time, six µs pulse off time.

M. Ghasemi Babbly et al [6] have Highlighted the investigation on Tin/Si3N4 ceramic, the dependence of surface texture, surface roughness, and materials removal rate square measure take into consideration as output parameter. From this paper it was finished that the material removal rate increase and pulse off time shows a finish lower material removal rate.

P. Venkata Ramaiah et al [7] The influence of machining parameters on surface roughness (SR) and material removal rate (MRR) of high strength armour steel. It was concentrate the Results show that pulse-on time, pulse-off time, and spark voltage square measure were vital variables to MRR and surface roughness.

Yongfeng Guo1 et al [8] Taguchi technique was applied to experimental results of (WEDM) on Inconel 825. The Taguchi technique is most ideal and applicable for the constant improvement of the wire cut EDM technique, once exploitation of the multiple performance characteristics like MRR, surface roughness, and spark gap, for machining the Inconel 825.

L. Karunamoorthyb et al [9] have investigated gap voltage, capacitance, feed rate, and wire tension on metal alloy (Ti-6AL-4V). Analysis of variance (ANOVA) was performed to identify the numerous factors. From this paper it was show that maximum MRR and minimum surface roughness need to be the input parameters are gap voltage (113 V), capacitance (0.26 µF), feed rate (9 µm/s), and wire tension Gm. Highlighted the WEDM applications in many areas like metal 718 by CNC WEDM process.

3 EXPERIMENTAL DETAILS

A WEDM machine, developed by ITRI (Industrial Technology Research Institute) and CHMER company Taiwan, is used for the experiment. In the Brass wire with graphite Work-piece specimens having thickness 6 mm and square pieces of 10 mm a side were cut by WEDM. Specification of WEDM the work material, specification of electrode and the other machining conditions were taken as follows:

Fig -2: WEDM Machine

Table -1: Specification of WEDM

work piece (anode)	Graphite Plate
electrode (cathode)	00.25 mm brass wire
Dielectric fluid	Distilled water
X,Y axis mm	400×300
U,V,Z TRAVEL	60×60×220
maximum size of work piece (W×D×H)mm	720×600×215
Motor	AC servo motor
wire dia. mm	0.15- 0.3
Max. wire feed	300
wire tension (gm)	300-2500

According to the Taguchi design method L9 Orthogonal array was chosen for the optimization of the process.
Four control factors were chosen at three levels-
I. Current, Pulse on time, Pulse off time , Wire Tension.

Two response parameters were measured.
I Surface Roughness and MRR
Input process parameters and their levels are given below.

Table -2: WEDM process parameters and their levels

Process Parameter	Units	Level
Current	A	5,10,15
Ton	µs	3,5,7
T off	µs	20,25,30
Wire tension	GM	8,10,12

3.1 Design of Experiment:

Orthogonal arrays are special standard experimental design that requires only small number of experimental trials to find the main factor an effect on output.

Table -3: L9 array table for DOE based on Taguchi method

No. of runs	Current(a)	T on	T off	Wire Tension
1	5	3	20	8
2	5	5	25	10
3	5	7	30	12
4	10	3	20	12
5	10	5	25	10
6	10	7	30	8
7	15	3	20	8
8	15	5	25	12
9	15	7	30	10

4 EXPERIMENTATION

Fig -3: The cutting of graphite plate by WEDM

Table -4: Measurement of Response

Sr.No.	Current	Ton	T off	wire tension	MRR	Surface roughness
1	5	3	20	8	5.475	0.194
2	5	5	25	10	6.78	0.148
3	5	7	30	12	7.183	0.107
4	10	3	20	12	9.794	0.140
5	10	5	25	10	7.966	0.153
6	10	7	30	8	4.853	0.191
7	15	3	20	8	6.381	0.149
8	15	5	25	12	7.246	0.187
9	15	7	30	10	7.335	0.122

5. METHODOLOGY

Wire EDM Machining and Response Surface Methodology (RSM) are used to describe the effect of parameters on graphite Material.
Response Surface Methodology (RSM)

Response Surface Methodology is the combination of mathematical and statistical technique, used to develop the mathematical model for analysis and optimization. The major steps in Response Surface Methodology are:

1. Identification of predominate factors which influences the surface roughness.
2. Developing the experimental design matrix, conducting the experiments as per the above design matrix.
3. Developing the mathematical model.
4. Determination of constant coefficients of the developed model.
5. Testing the significance of the coefficients.
6. Adequacy test for the developed model by using analysis of variance (ANNOVA).
7. Analyzing the effect of input machining parameters on output response surface roughness and MRR.

6 Result and Discussion

Following mean Signal/Noise ratio graphs are obtained for different process parameters using MINITAB software.

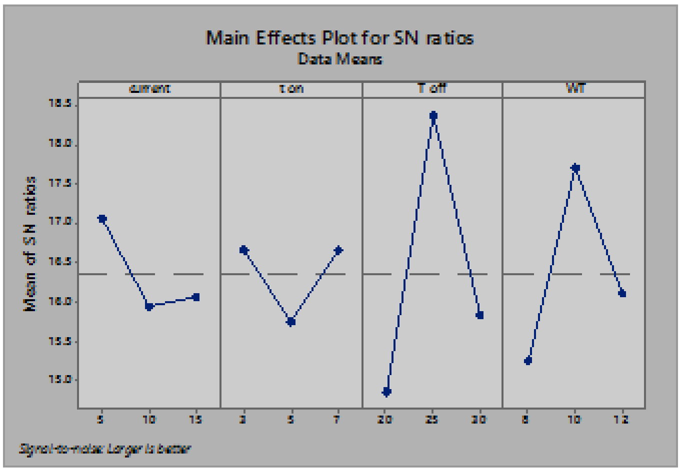

Fig -4: Graph of Main effect plot for Machining Speed

The second graph indicated the effect of pulse on time on Machining Speed its decreases and again increases. When pulse on time from the graph 4, we get the optimum value by selecting highest S/N ratio.

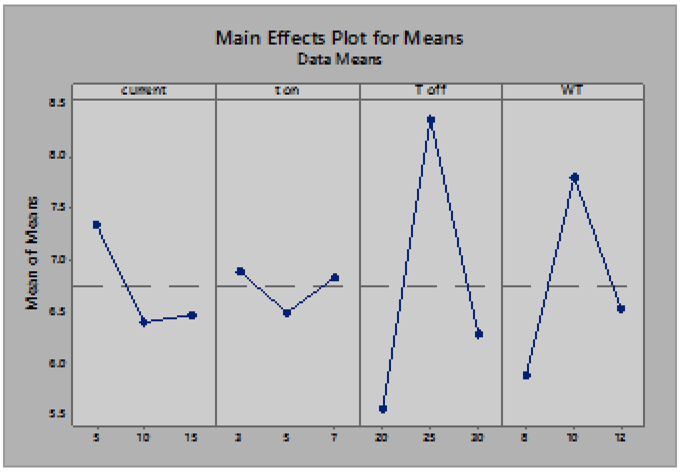

Fig -5: Main effects plots for data mean

Also from Fig. 5, we get the behavior of Input parameter on Machining speed.

1) From graph, it is clearly shown that with increase in current, Machining. When current increases from 5 to 10 µs, Machining Speed decreases and again increases.
2) Again increases from 5to 7 µs then machining speed further increases. It is clearly shown that with increase in pulse off time, material removal rate decreases.
3) The third graph shows the effect of pulse off time on machining speed when pulse off time increases from 20 to 25 µs, machining speed increases. When pulse off time again increases from 25 to 30 µs then machining speed further decreases.
4) The fourth graph indicates the effect of wire tension on machining speed. It is also observed that if wire tension increases from 8 to 10 Gms then Machining speed increases now, if wire tension further increases from 10 to 12 Gms then also there is decrease in Machining speed.
5) From the graph and signal to noise ratio optimum parameter calculated as below:

Table -5: Standard parameters

	Current(A)	Ton	T off	WT
MRR	5	5	25	10
SR(µm)	5	7	30	12

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