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Evaluation of Surface Roughness and Material Removal Rate of En-18 Steel Tool in EDM Process

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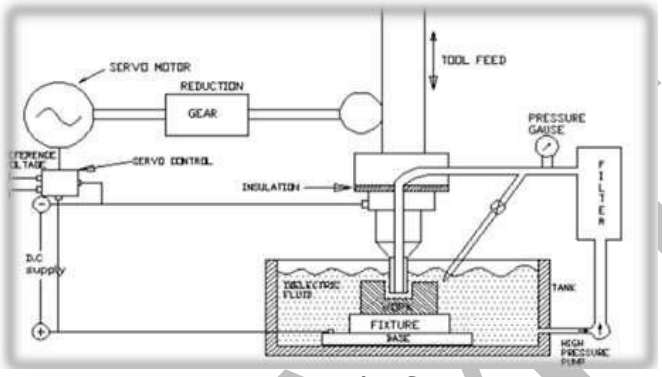
ABSTRACT:
Electrical discharge machining also known as EDM has been proven as an alternating process for machining complex shapes from conductive ceramic compositions. it is used for machining of very tough and brittle material. In this experiment EN18 steel is used as work piece and copper is used as tool. There are three input variable parameters used which are current, pulse time and duty cycles. Taguchi method is used to create L9 orthogonal array of input variables.MRR and Surface roughness is find out the effect of the input variables on this characteristics are studied in this experiment .the EDM machine used in this experiment is ELECTRONICA ELECTRA PLUS PS 50ZNC die sinking type EDM.

After the result have studied it is find out that the current is more significant value followed by pulse time and duty cycle is least significant for both MRR and surface roughness, both MRR and surface roughness increases nonlinearly with the increase in current as pulse time increases, MRR decreases slightly and with increase in duty cycle it increases insignificantly. But surface roughness first increases with increases in pulse time but after 500µs it decreases, for duty cycle also surface roughness increases up to 65 percent then started decreasing
Keywords: Tau=Duty cycle, T off=Spark of time, Ton=pulse on time, MRR=material removal rate

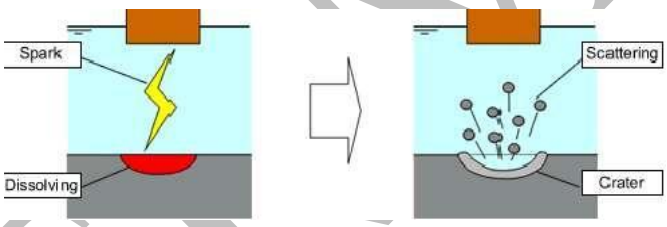
1. INTRODUCTION

It is a conventional machining method. In electrical discharge machining process electrical energy is used to cut the material to final shape and size. Effort is made to utilize the whole energy by applying it to exact spot where the operation needs to b carried out. There is no mechanical pressure existing between the work piece and electrode and there is no contact between them. Any type of conductive material can be machined by using EDM irrespective of the hardness or toughness of material.
When a potential difference is applied between two conductors emerge in a dielectric medium the fluid will ionized. If the potential difference is reaches a high value a spark will occur. the control erosion of material is achieved by rapidly recurring spark. Discharge occurs in electrode, the tool and the work piece. The tool is made as cathode and the work piece made as anode.
The material removal rate and the surface integrity vary as I vary the pulse energy, pulse time, pulse current and many other factors.
If the both the electrodes are made of the same material then it has been found that the greater erosion takes place on the positive electrode. Therefore in order to remove maximum metal and minimum tool wear the tool is made as cathode and the work piece made as anode. The two electrodes are separated by dielectric medium such as paraffm oil, white spirit, and decolonized water.

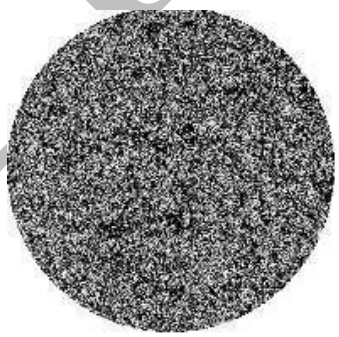
The EDM is also called machining method copying as the work piece takes the shape and size of the electrode which is generally made of material like copper.



EXPERIMENTAL SETUP



THE SURFACE BY DISCHARGE MACHINING



IMPORTANT PARAMETERS

T_{on}:-It is also known as spark on time or pulse width. It means duration of spark. Its unit is µs(micro second),range is 0-1000µs.

T_{off}:-It is also known as sparking of time or down time it means the time in between the spark generated. In this time the molten metal is removed. It is set in the range between 0-1000µs.

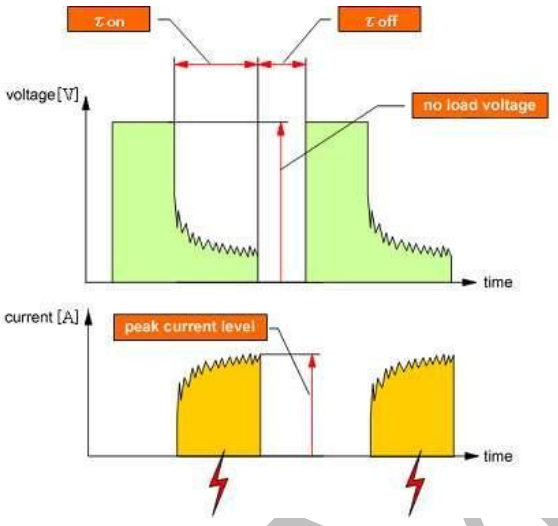
Voltage:-the potential difference is applied between the electrode and the work piece. it is set the range of 40-200V.

Discharge current (Ip):-It means the electric current value of the spark it is shown in the unit of amp (A). It is set in the range of 0.5-400amp.

Duty cycle (T_{au}):-is the ratio of Ton and total cycle time, it is denoted by Tau.

$T_{au} = T_{on}/(T_{on}+T_{off})$

THE GRAPH BETWEEN VOLTAGE V/S TIME AND CURRENT V/S TIME



EXPERIMENTAL SETUP

The whole experiment was conducted on electrical discharge machine which is a die sinking type EDM of model ELECTRONICA ELECTRAPLUS PS 50ZNC.the voltage set as 40V.the polarity of workpiece set as positive and electrode as negative ,EDM oil is taken as dielectric fluid.

The EDM consist of following parts:-

-Power generator and control unit

-working table

-Dielectric reservoir ,pump and circulation table

-The tool holder

-Working tank with work holding device

SELECTION OF MATERIAL

EN-18 steel tool is a part of popular EN series steels. EN steel are mixture of carbon and alloys.EN series came during the world war time and it is the out come of British standard(BS970) steels.this steel generally contain carbon,magnesium,silicon,sulphur,phosphorus,chromium,Nickel and Molybdenum.

The chemical composition of EN-18 steel (by weight).

Carbon- 0.4%

Silicon- 0.2%

Magnesium- 0.75%

Sulphur- 0.04%

Chromium- 1.01%

SELECTION OF TOOL

COPPER TOOL

There are variety of material can be used as tool for EDM process like copper,brass,Aluminium alloys,Silver alloys etc. the electrode used in the experiment is copper.the shape of copper is cylindrical With diameter 21mm

EVALUATION OF MRR (MATERIAL REMOVAL RATE)

MRR is the rate at which the material is removed from the work piece. Its unit is mm3/s. the material is removed from the work piece because os series of recurring spark between the two electrodes.The MRR can be defined as the rate of material removed per second or the ratio of change in volume of workpiece during machining devided by duration of machining.

MRR= (Wi-Wf)/t×ƿ

Where-

Wi= initial weight of material

W_f= Final weight of material after experiment

t= machining time = 5 min.

ƿ= density of material=7.84gm/cc3

EVALUATION OF SURFACE ROUGHNESS

Surface roughness is the measure of surface texture.its unit is µm.it can be defined as vertical deviation of real surface from ideal surface. If the deviation is more ,it is said as rough surface and if deviation is less it is said as smooth surface. surface rough generally measured using portable type profilometer, talysurf.

DESIGN OF EXPERIMENT ANALYSIS

I have used Taguchi method. Dr.Genichi Taguchi of Nippon Telephones and Telegraph company,Japan developed this method which is based on orthogonal Array experiment to improve to quality of manufactured product and nowadays used in engineering.Taguchi method can be defined as the quality control methodology that combine control charts and process control with product and process design to achieve a good design.It aims to reduce product variability with a system for developing specifications and designing them in to product or process.the design of experiment is used to find the best combination of parameters used as input values in an orthogonal array.

In this experiment I have used three input parameters:-

1. I_p
2. T_{on}
3. T_{aus}

There are 3 variables so the design become a 3 level 3 factorial Taguchi design.L9 orthogonal array was chosen for the experiment to be conducted.

TABLE.

VARIABLE MACHINING PARAMETER AND THEIR LEVEL-

Machining Parameter	Unit	Levels		
		1	2	3
Discharge Current	A	1	5	9
Pulse on time	µs	100	500	1000
Duty Cycle (Tau)	%	50	65	85

I have fixed some of the machining parameters which are as follows:-

Voltage=40V

ASEN(anti arc senstivity)= 3

SEN(sentivity)=6

Tw(tool work time)=0.8

T(tool life)=0.6

Polarity =+ve

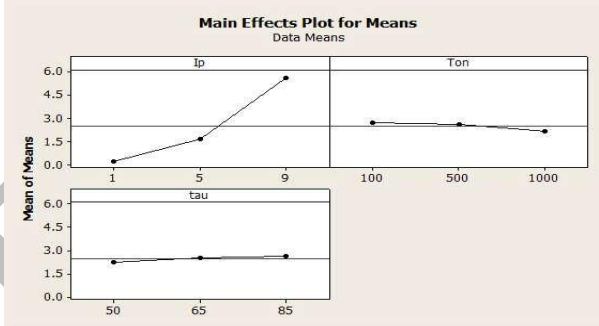
RESULT AND DISCUSSION

I have discussed the result obtained from experiment. The effect of different parameters on material removal rate and surface roughness.

OBSERVATION TABLE

Expt. no.	Pulse time I (A)	Pulse time T_{on} (µs)	Duty Cycle T_{on} (%)	MRR (mm^3/min)	Surface Roughness (µm)
1	1	100	50	0.24221	3.8
2	1	500	65	0.21685	7.13
3	1	1000	85	0.10205	6.13
4	5	100	65	2.03954	7.4
5	5	500	85	2.00242	8.26
6	5	1000	50	0.89272	7.13
7	9	100	85	5.76275	7.8
8	9	500	50	5.58673	12.67
9	9	1000	65	5.38266	12.33

ANALYSIS AND DISCUSSION OF MATERIAL REMOVAL RATE-TABLE



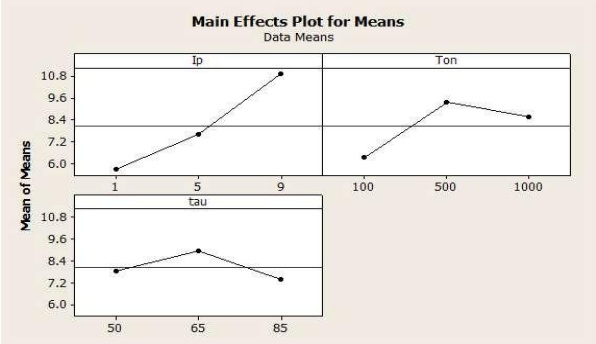
Residual plot for material removal rate

The material removal rate increases as the value of current increases. The rate of increases in value of material removal rate is more for the range of current (1A-9A) than the range of current (1A-5A).

The material removal rate decreases very slightly as I increase the value of T_{on} from 100µs to500µs.As I increase the value further from 500µs to 1000µs the material removal rate value decreases more rapidly.

Material removal rate increases as the value of duty cycle increases from 50% to 65%,but after 65% material removal rate increment is very slight.

ANALYSIS AND DISCUSSION OF SURFACE ROUGHNESS-TABLE



Main effect plot for surface roughness

Surface roughness increases with increases the value of current from 1A-5A increases with a good rate but from 5A-9A it increases rapidly.

Surface roughness increases with increasing in the values of T_{on} from 100µs to 500µs after that surface roughness decreases as T_{on} increases from 500µs to 1000µs

Surface roughness increases as the T_{au} increases from 50% to 65%. But after 65% as I increase T_{au} up to 85% the value of surface roughness decreases.

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