IJRSET November 2015 Volume 2, Issue 12 Pages: 12-18

ISSN 2394-739X

International Journal for Research in Science Engineering and Technology

SELECTION OF BEST METAS FOR TOOL AND DIE STEEL

[1] Bipen deep, [2] Harvinderlal,

[1]Student, [2]Assistant professor (Department of mechanical department),

[1, 2] Ramgarhia institute of engineering & technology satnampura, phagwara, Punjab, India.

Abstract:-

The main purpose of this study is related to selection the best metals for tool and die steel applications. The investigation work is performed on two metals (H-13) and (D-3) metal. C.N.C electrical discharge machining is used to machining on metals with the help of copper electrode. The E.D.M machine process parameters current, pulse on time, pulse off time values are varied to performing the experiments. The responses of the experiments are measured in the form of M.R.R and S.R. The box-Beheken design of response surface methodology is used to generate the design of experiment. The experiment result is reveals that current is most important factors which affect on S.R and M.R.R for metals.

Keywords: - Response surface methodology, Electric discharge machine, Material removal rate, Surface roughness, Box- Beheken design.

1. INTRODUCTION

Due to some special applications requirements of hard metals it is very essential to use these metals. The fabrications of the products from these metals are very uneconomical by conventional machining methods. So the unconventional machining processes are used for the machining of these metals. Similarly the hard metals tool &dies are fabricated by the unconventional machining process. In the present days we are used the electric discharge machines and electro chemical machines mainly to making the tools and dies for various products. The experiments are performed on the E.D.M machine to investigation the response of metals. The main advantage to use the E.D.M machine is no barrier related to hardness of metals to machining. But main disadvantage to use this machine is the material removal rate of process is very small as compare to conventional methods.

2. LITERATURE REVIEW

Neeraj Sharma ,Rajesh Khanna, Rahuldev Gupta had performed experiment on wire electrical discharge machine(W.E.D.M).They had studied the effects of various process parameter on material removal rate (M.M.R).They considered peak current ,pulse on time ,pulse off time ,servo voltage and wire tension are as process parameters. In his experiment they used brass wire as cutting tool and high strength low alloy materials as a work piece .After experiment they investigated that surface roughness and material removal rate directly proportional to peak current and pulse on time and inversely proportional to pulse off time and servo voltage .They conclude wire tension, pulse off time and servo voltage had negligible effected on surface roughness as compare to other parameters [1].In 2013 Amit joshi ,S.S.Samant,&K.K.S.Her had

work on the surface roughness. Pulse on time, pulse off time and gap voltage had considered process parameters for experiment. High carbon and high chromium material used for performing the experiment .After the experiment they conclusion that surface roughness value decrease by increasing the value of pulse on time and gap voltage [2]. Priyaranjan sharma, Sujit Singh, Dhananjay R Mishra worked on the electrical discharge machine .They investigational the optimum condition between Pulse current, Pulse off time and dielectric pressure as process factors for minimum tool wear rate and maximum material removal rate. They also observed effect of taper angle in hole which was generated by electrical discharge machine. They had comparison between copper and brass materials electrodes. They find that copper gave better surface than brass and on the other hand brass material electrode rapidly wear then copper electrode [3].In 2014 the author work on the electrical discharge machine with EN-24 material as work piece . They had used box-behnken design of response surface methodology for getting optimum condition betweens pulse on time ,pulse off time and peak current process parameters .The author considered Material removal rate, Electrode wear rate and surface roughness in the role of response parameters. They had successfully negotiate that Material removal rate ,Electrode wear rate and Surface roughness directly proportional to Peak current and Pulse on time [4]. S.Ben Salem ,W.tebni and E.Bayraktor had researched on the metals 50CRV4 and X200CR15.They analyzed the arithmetical roughness of work piece in the result. The experiment design had planned by full factorial design. The current intensity, Electrode tool materials were considered process characteristics. After the investigation they found copper material tool was gave better surface finish then graphite material tool with same discharge energy. And current intensity was main factor for better surface finish [5]. In 2013 authors researched on E.D.M machine with considering process parameters were polarity change, peak current, pulse on time, properties of dielectric fluid, duty cycle and gap voltage .The Taguchi method used to plan the experiment procedure .They try to evaluate the surface finish of H11 steel by using the copper rod as a electrode of machine .For improving the surface finish of work piece they added aluminum powder in the dielectric fluid .In his conclusion they notice that to achieve better surface finish negative polarity had given to the machine tool. And high value of peak current produces more surface roughness [6]. In 2013 Singaram Lakshmanan, Prakash Chinnakutti and Mahesh Kumar Namballa were performed experiment on electrical discharge machine for optimize the surface roughness modeling .Response surface methodology was used to optimization the process. The experimental process was planned by central composite design method. The work piece used for experiment was EN-31 and copper rode was used as tool materials. Pulse on time, pulse off time, pulse current, pulse voltage were used as process parameters for experimental work. They analyzed that the value of root mean square was directly proportional to discharge and pulse on time. And other parameter Pulse current was affected the mean peak line spacing and skewness value [7].

3. METHODOLOGY

The box –Beheken design of response surface methodology is used to generate the design of experiments. This is very important design to getting maximum information about response with performing minimum number of experiments. The box-Beheken design generated from the basic designs (Two –

level factorial design, fractional factorial design) of R.S.M.

4. EXPERIMENT MATERIALS

H-13 and D- 3 metal of die steels categories are used to perform the experiments as workpiece metal and pure copper rod with 99.7% purity of copper used for electrode. The workpiece metals pieces are sliced from round bars of metals. The thicknesses of H-13 and D-3 metal piece are 15mm and 11mm respectively and diameters of both piece is 154 mm. These both metals are used in the die steels applications. The main advantage to use H-13 metals in the industries is it sustains the large temperature with high pressure. This metal mainly used for making extrusion process dies. The other metal D-3 is contain one special class property is high wear – resistance.

5. SETUP

We are used the Oscar max company of Taiwan E.D.M machine to perform the work. The machine specification is given below.

Figure. 1 E.D.M machine

Figure .2 Surface roughness tester

X Travel = 600 mm, Y Travel = 450 mm, Z Travel = 400 mm, Working table dimensions= 1000mm*600mm, Flushing pressure range =400 mm The E.D.M machine process parameters current, pulse on time, pulse off time are used as input parameters of experiment and response of experiment measured in form of material removal rate and surface roughness. The experiment parameters are shown in the table I.

FACTOR	NAME	LOW	HIGH
A	CURRENT	8	12
B	PLUSE ON TIME	90	150
C	PLUSE OFF TIME	60	120

TABLE.1 INPUT PARAMETERS OF DESIGN

The constant parameters of machine are given below

Flushing pressure =0.5 kg/cm^2

Voltage = 40 V

Die –electric fluid = E.D.M oil

6. THE MEASUREMENT PROCEDURE

A) Weight Measurement

The weight of workpiece was measured by the use of electronic weight balance machine. The weight of workpiece was measure at starting and ending of every experiment. The machining time of machine is measured by the use of electronic watch. The use of given below formula values of M.R.R are fined.

$$= \frac{W_i - W_f * 60}{\text{OBSERVATION TIME (In seconds)}}$$

B) Surface Roughness

The surface roughness of machine is measured by the use of surface roughness

tester of Mitutoyo SJ-201 machine. The whole calculations work of measurement is done by the tester. The value of average surface roughness is shown on the screen. The surface roughness tester which used for measurement is shown in the fig .2. The use of given below formula values of S.R are fined.

$$R_a = 1/L \int_0^L |h(x)\, dx|$$

7. EXPERIMENTAL DESIGN

The experimental design is generated by the use of Box- beheken design of response surface methodology. The main benefit to use this design is the whole corner points of design points are lie inside the circle. Before to use this design we are consider extreme points of the design do not affect on response . The box-beheken design gives better accurate data with performing least experiments run. So this design is cheaper one than the other designs. The experiment design is generated at once and experiments are performed on both metals with same working conditions. The experimental design with response values is shown in the table below.

8. MODELING

After performing the experiments on machine the values of material removal rate are gathering by calculation work and values of surface roughness are got by the use of surface roughness tester. The mathematical models models are generated by the use of ANOVA for every response of both metals.

H- 13 (HOT DIE STEEL)

MRR = -0.0445 + 0.01437 CURRENT + 0.000312 PULSE ON TIME - 0.000478 PULSE OFF TIME

S.R = 3.750 + 0.2875 CURRENT

D-3 (HIGH CARBON HIGH CHROMIUM)

MRR = -0.0329 + 0.01356 CURRENT + 0.000437 PULSE ON TIME - 0.000575 PULSE OFF TIME

S.R = -24.83 + 4.37 CURRENT + 0.0564 PLUSE ON TIME + 0.0825 PLUSE OFF TIME - 0.1939 CURRENT*CURRENT - 0.000564 PLUSE ON TIME*PLUSE OFF TIME

A) M.R.R of H-13 metal

The main effect plot shows that by increasing the values of current and pulse on time the values of M.R.R is increased . But pulse on time is less affect on M.R.R as compare to current. The process parameters pulse off time produce the reverse affect on response (M.R.R) so when value of pulse off time increased the value of M.M.R decrease.

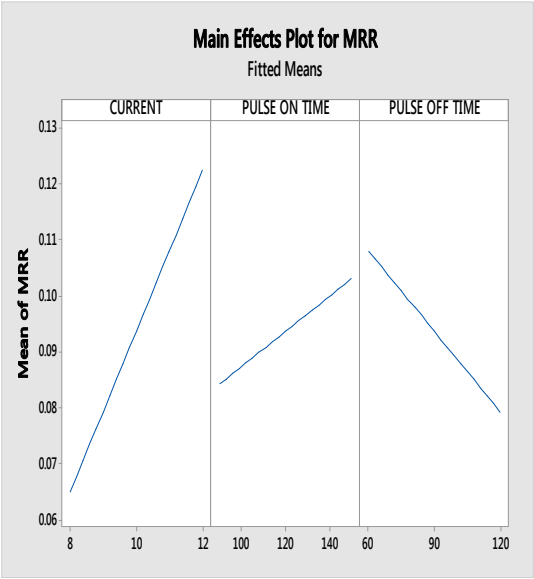

Figure .3 Main effects plot for MRR for H-13 metal

B) Surface roughness of H-13 Metal

In the case of surface roughness of this metal only one process parameters are important according to shown result which

is Current. The S.R of this metal is directly proportional to

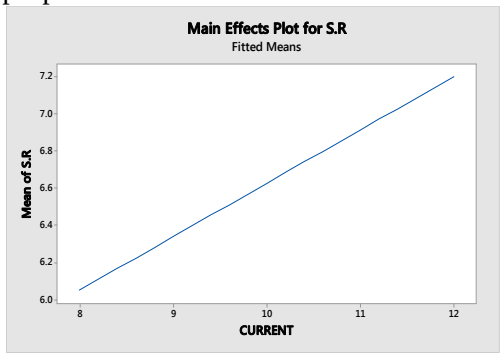

Figure. 4 Main effects plot for S.R for H-13 metal

Current it varies from 6.24 µm to 7.2 µm in the whole experimental range of current.

C) M.R.R of D-3 Metal

The main effect plot of M.R.R of D-metal are shows that response M.M.R is directly proportional to current and pulse on time. But the graph lines are more slant then H- 13 metal graphs. The pulse off time shows that similar results to H- 13 MRR case.

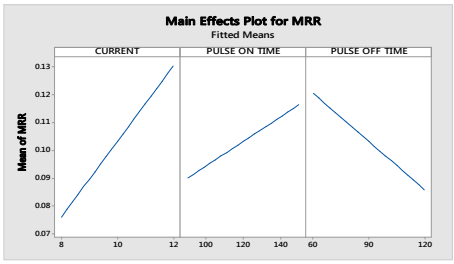

Figure .5 Main effects plot for MRR for D-3 metal

D) Surface Roughness of D-3 Metal

We are judge in the case of current. Firstly the value of S.R is increased by increasing the value of current but this was happened only until the current was 11 amp after that value of S.R decreased by increasing values of current. In case of other parameters pulse on time and pulse off time both are directly proportional to surface roughness of metals. But pulse off time is more affect on response as compare pulse on time in this case.

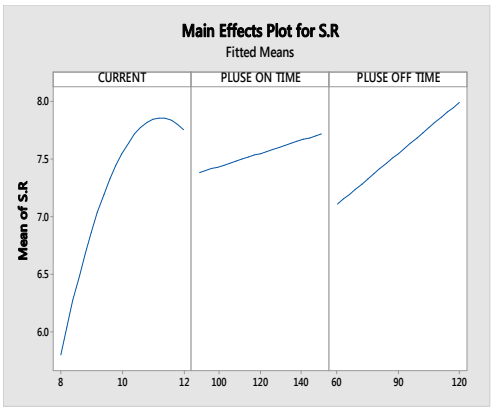

Figure.6 Main effects plot for S.R for D-3 metal

CONCLUSIONS

1. We are concluded that from results current ad pulse on time is directly proportional to M.R.R in both cases of metals. But pulse on time is more affect on response in the case of D-3 metal. The process parameter Toff is inversely proportional to MRR.
2. The response parameters surface roughness results are different for both metals. Current is most affecting parameters on S.R in the case of H-13 metal. On the other hand D-3 metal case current firstly produce direct affect on surface roughness but after the certain value it produce the reverse affect on response (surface roughness). The value of surface roughness is directly proportional to pulse on time in the case of D-3 metals.
3. The values of coefficient of determination (R^2) shown in table respectively for all response of metals.

METAL	R^2
H-13 (M.R.R)	94.42%
H-13 (S.R)	40.18%
D-3 (M.R.R)	94.97%
D-3 (S.R)	90.07%

TABLE 2. COEFFICIENT OF DETERMINATION (R2)

S. NO	CURRENT	PULSE ON TIME	PULSE OFF TIME	M/C TIME D-3	M.R.R D-3	S.R D-3	M/C TIME H-13	M.R.R H-13	S.R H-13
1	8	90	90	21min28sec	0.0656	5.59	25min21sec	0.054	6.14
2	12	90	90	12min11sec	0.1132	8.08	14min41sec	0.100	7.50
3	8	150	90	17min37sec	0.0828	6.27	22min17sec	0.067	5.70
4	12	150	90	10min42sec	0.1429	7.71	11min25sec	0.138	8.02
5	8	120	60	16min30sec	0.0903	5.19	17min12sec	0.076	5.73
6	12	120	60	10min29sec	0.1545	7.04	11min01sec	0.138	6.57
7	8	120	120	23min49sec	0.0613	6.15	27min45sec	0.055	7.07
8	12	120	120	12min53sec	0.1063	8.20	14min48sec	0.105	7.15
9	10	90	60	14min11sec	0.0994	6.32	14min47sec	0.103	6.08
10	10	150	60	11min38sec	0.1383	7.86	13min43sec	0.110	6.69
11	10	90	120	18min49sec	0.0789	8.05	22min24sec	0.068	5.79
12	10	150	120	14min48sec	0.0979	7.56	16min54sec	0.085	6.41
13	10	120	90	15min02sec	0.0997	7.00	16min01sec	0.100	7.19
14	10	120	90	14min32sec	0.1004	8.13	16min19sec	0.094	6.41
15	10	120	90	13min29sec	0.1171	7.96	15min24sec	0.104	6.93

TABLE 3. DESIGN AND RESPONSE TABLE OF BOTH METALS

4. The optimize values of both metals are shown in the table

METAL	CURRENT	PULSE ON TIME	PULSE OFF TIME	S.R	M.R.R
H-13	11.4944	150	60	7.0550	0.1388
D-3	12	111.81	60	7.1290	0.1440

TABLE 4. OPTIMIZE VALUES

REFERENCES

[1] Neeraj Sharma[a*],Rajesh Khanna[b] Rahuldev Gupta[b] "Multi quality characteristics of WEDM process parameters with R.S.M"Procedia engineering,pp:710-719,(2013)

[2] Amit joshi[1],S.S.Samant[2],&K.K.S.Her[3] "Modelling surface finish in WEDM using RSM"International journal on theoretical and applied research in mechanical engineering(IJTARME),PP:74-78,(2013)

[3] Priyaranjan sharma[*],Sujit Singh[1],Dhananjay R Mishra[2] "Electrical discharge machining of AISI 329 stainless steel using copper and brass rotary tubular electrode"Procedia Materials science ,pp:1771-1780,(2014)

[4]N.Annamali[1+],V.Sivaramkrishan[2],N.Baser[3] "Response Surface Modeling of Electrical discharge machining process parameters for EN 24 Low Alloy Steel"5th International &26th All India Manufacturing Technology ,Designed Research Conference (AIMTDR),pp:150-1-150-6,(2014)

[5] S.Ben Salem[a,b],W.tebni[a,c],E.Bayraktor[c,*] "Prediction of surface roughness By experiment design methodology in Electrical discharge machining [E D M]"Journal of Achievements in Materials and Manufacturing Engineering,pp:150-157,(2011)

[6] Baljinder Singh[1], Paramjit Singh[2], Gaurav Tejpal[3], Gurtej Singh[4] "AN EXPERIMENTAL STUDY OF SURFACE ROUGHNESS OF H 11 STEEL IN E.D.M PROCESS USING COPPER TOOL ELECTRODE" International Journal of Advanced Engineering Technology, pp: 130-133, (2012)

[7] Singaram Lakshmanan[1],Prakash Chinnakutti[2],Mahesh Kumar Namballa[3] "Optimization of Surface Roughness using Response Surface Methodology for EN 31 Tool steel EDM Machining" International Journal of Recent Development in Engineering and Technology,pp:33-35,(2013)