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Experimental investigation of process parameters on EN-5 Steel using EDM drilling and Taguchi Method. .

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***Abstract*—En-5 is a medium carbon steel , it have widely applications in the Axles, Connecting Rods, Guide Rods, Hydraulic Shafts, Motor Shafts, Rams, Spindles, Studs etc.as the en5 steel has widely applications so it is chosen for the present study. Presents works shows the effect of various process parameters like peak current, Pulse on Time,and Jet pressure on Matirial Removal Rate. EDM Drilling and taguchi technique is used for the optimization of response variables.**

***Index Terms*—EN-5 steel, EDM Drilling, Process Parameters (Ip,Ton,Jp), Response Variable (MRR).**

I. INTRODUCTION

A EDM machine (S-35, Sparkonix) was used as the experimental machine in this study. A Copper Tool with a diameter of 5 mm was used as an electrode to erode a work piece of EN-5 (flat plate). The gap between work piece and electrode was flooded with a moving dielectric fluid. Machining Experiments for determining the optimal machining parameters for optimizing response characteristics were carried out by using EDM oil as a dielectric fluid. Fig. 1.1 shows the mechanical set up and electrical set up and electrical circuit for electro discharge machining. A thin gap about 0.025mm is maintained between the tool and work piece by a servo system. Both tool and work piece are submerged in a dielectric fluid. Kerosene/EDM oil/de-ionized water is very common type of liquid dielectric although gaseous dielectrics are also used in certain cases.

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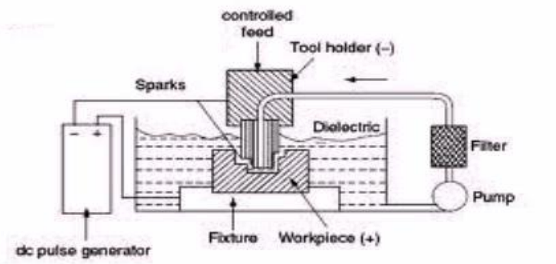

Fig 1.1: Set up of Electric discharge machining

II. LITRETAURE REVIEW

S.Akaslan et.al (2002) investigated the variaton of tool electrode edge wear & machining performance outputs namely MRR, TWR & relative wear, with the varing machining parameters. The edge wear profile obtained are modeled by using the circular arcs, exponential & power function. The variation of radii of the circular arcs with machining parameters is given. It is observed that the exponential function models the edge wear profile of the electrode very accurately. The variation of exponential model parameters with machining parameters is presented. **Tosun et al. (2003)** studied the variation of work-piece surface roughness with varying pulse duration, open circuit voltage, wire speed and dielectric fluid pressure was experimentally investigated in WEDM. Brass wire with 0.25 mm diameter and SAE 4140 steel with 10 mm thickness were used as tool and work-piece materials in the experiments, respectively. It is found experimentally that the increasing pulse duration, open circuit voltage and wire speed, increase the surface roughness whereas the increasing dielectric fluid pressure decreases the surface roughness. The variation of work-piece surface roughness with machining parameters is modeled by using a power function. The level of importance of the machining parameters on the work-piece surface roughness is determined by using analysis of variance (ANOVA). Biing **Hwa Yan et al. (2005)** investigated the influence of the machining characteristics on pure titanium metals using an electrical discharge machining (EDM) with the addition of urea into distilled water. Additionally, the effects of urea addition on surface modification are also discussed. In the experiments, machining parameters such as the dielectric type, peak current and pulse duration were changed to explore their effects on machining performance, including the material removal rate, electrode wear rate and surface roughness. **Kansal et al. (2007)** studied the effect of silicon powder mixing into the dielectric fluid of EDM on machining

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characteristics of AISI D2 (a variant of high carbon high chrome) die steel has been studied. Six process parameters, namely peak current, pulse on time, pulse-off time, concentration of powder, gain, and nozzle flushing have been considered. The process performance is measured in terms of machining rate (MR). **Katsushi Furutani et al. (2008)** studied the influence of the discharge current and the pulse duration on the titanium carbide (TiC) deposition p 0rocess by electrical discharge machining (EDM) with titanium (Ti) powder suspended in working oil. Although the influence of the electrical conditions for removal EDM has been investigated, **R.K. Garg et al. (2011)** studied the parametric optimization for Material Removal Rate (MRR) and Tool Wear Rate (TWR) study on the Powder Mixed Electrical Discharge Machining (PMEDM) of EN-19 (AISI-4140) steel has been carried out. Response Surface Methodology (RSM) has been used to plan and analyze the experiment . Peak current, duty cycle, angle of triangular electrode and concentration of micro nickel power added into dielectric fluid of EDM were chosen as process parameters to study the PMEDM performance in terms of MRR and TWR. **R.Chaudhary et.al (2013)** studied the EN5 is medium strength mild steel so it is widely used in various machineries parts like shafts, racks, pinions, studs, bolts, nuts, rollers etc. Wire Electric Discharge Machine (WEDM) seems a good option for machining the complicated shapes on medium strength steel. this paper, identify the effects of various process parameters of WEDM such as pulse on (Ton) ,pulse off (Toff), peak current (Ip), servo voltage (Sv) for analysis the material removal rate (MRR) while machining EN5 mild steel material.

In the present study the effect of various process parameters on response variable like material removal rate is investigated and the effect of these parameters on mrr is plotted in the separate graphs.

A. *Taguchi method.*

Taguchi method is applied for the current study for experimental investigation of the response variable i.e MRR. Professor Taguchi developer of robust designs and advocates a philosophy of quality engineering that is broadly applicable. The fundamental principle of robust design is to improve the quality of a product by minimizing the effect of the causes of variation without eliminating the causes. Professor Genichi Taguchi introduced his approach using experimental design for

- Designing products or processes so that they are robust to environmental condition.
- Designing/developing products so that they are robust to component variation.

B. *Workpiece*

The work piece used during machining is EN5 steel having as shown in figure. The diameter of the drilled hole by using edm drilling is 5mm. and depth of the drilled hole is 2 mm.

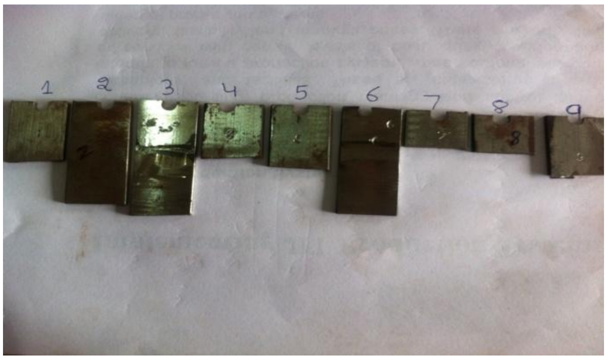

Fig 1.2: work piece drilled during Experimentation

III .DESIGN OF EXPERIMENTATIONS

A scientific approach to planning and conducting of experiments was incorporated in order to perform the experiments most effectively. Taguchi approach was taken as the basis for planning and conducting the experiments so that the appropriate data is collected which may be analyzed to obtain valid and objective conclusions. Table 3.1 shows the c L-9 orthogonal array sheet. In which there are three control factors (Peak current, Pulse on Time, Jet pressure). In this there are nine runs, mean to say nine experiments will take place on different parameters.

Table 3.1 L9 Orthogonal Array

RUN	Control factors and Levels		
	Ip	Ton	JP
1	8	5	5
2	8	7	10
3	8	9	15
4	12	5	10
5	12	7	15
6	12	9	5
7	16	5	15
8	16	7	5
9	16	9	10

IV. EXPERIMENTATION AND RESULT ANALYSIS

In finally results and analysis of MRR is expressed as the ratio of the difference of weight of the work piece before and after machining to the machining time. It is being measured in terms of mg/sec.

$$\mathbf{MRR = (M_i\text{-}M_f) / t}$$

Where,

Mi is the weight of the work piece before machining i.e. initial weight,

Mf is the weight of the work piece after machining i.e. final weightt is the machining time

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S.No	Ip	T ON	JP	Work Piece wt (g)		W Loss (g)	Time Taken T (S)	MRR (mg/s)
				M_i	M_f			
1	8	5	5	49.32	49.18	0.14	765	0.18
2	8	7	10	49.18	49.04	0.14	736	0.19
3	8	9	15	49.04	48.89	0.15	734	0.20
4	12	5	10	48.89	48.75	0.14	432	0.32
5	12	7	15	48.75	48.60	0.15	417	0.35
6	12	9	5	48.60	48.46	0.14	386	0.36
7	16	5	15	48.46	48.33	0.13	399	0.32
8	16	7	5	48.33	48.18	0.15	376	0.39
9	16	9	10	48.18	48.04	0.14	335	0.41

Now, after analyzing the experimental data from the test, graphs are plotted by using minitab software showing influence of various parameters with material removal rate as discussed under.

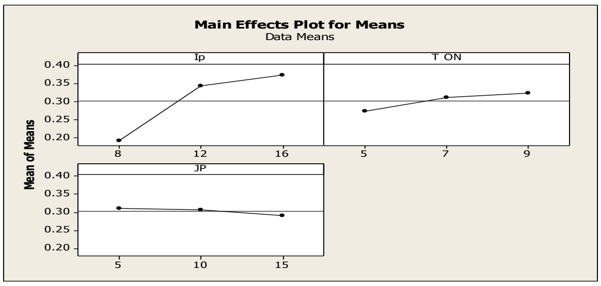

Figure 1.4 : Effect of Parameters on Mean MRR

V. Discussion On Influence Of Parametrs On Mrr

Effect Of Peak Current On Mrr : From the figure, it is observed that the mean value of MRR is increase by increasing the peak current This is due to the fact that MRR increases with an increase in peak current because increase in discharge energy and impulse force as the peak current increased and large impulsive force repel debris from the centre of the crater Hence, an increase in peak current produces a higher MRR.

Effect Of Pulse On Time On MRR :
MRR Increase with increase pulse duration because longer pulse duration produce bigger creater due to the increase of input energy in high pulse on time duration and this result in higher MRR with poor surface quality.

Effect Of Jet Pressure On MRR:
MRR decreased by increase the jet pressure because flow of dielectric blocks the formation of ionized bridges and reduces the material removal rate.

VI. Conclusion

1. It is observed that MRR is increase by increasing the peak current. Because increase in discharge energy and impulse force as the peak current increased
2. MRR rises by increasing the value of pulse on time because longer pulse duration produce bigger creator due to the increase of input energy in high pulse on time
3. MRR decreased by increase the jet pressure. Because flow of dielectric blocks the formation of ionized bridges and reduces the material removal rate

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