Experimental Investigation on the Effect of Process Parameters in Die-sinking EDM of EN8 Steel

D. Shiva Kumar[1], Rahulji Dala[1], B. Swamy[1]
[1]Department of Mechanical Engineering, Sree Dattha Institute of Engineering and Science, Hyderabad, India

ABSTRACT

The objective of the present work is to investigate the effects of the various DEDM process parameters on the machining quality and obtain the optimal sets of process parameters so that the quality of machined parts can be optimized. Experiments are conducted on the pieces varying parameters. The work piece and electrode materials used for machining are EN 8 steel and copper tungsten. The process parameters considered are Pulse Time on, Pulse Time off, and peak current. The range of values varied are Time on – 100µsec, 200 µsec and 500 µsec, Time off – 200 µsec, 500 µsec, 900 µsec, Input power –7amp, 15amp, 22amp. The optimization is done by using TAGUCHI technique by considering L9 orthogonal array.Optimization is done using Minitab 19 software.

Keywords: Die sink EDM, optimization, Taguchi method.

1. INTRODUCTION

Die-sinking EDM: Die Sinker EDM Machining process, what in it happens, firstly the two electrodes are fitted on their places on the machine parts which is work bench and tool holder. Both the electrodes should be electrically conductive. After that both the electrodes are immersed in an insulating liquid dielectric with the help of pump.

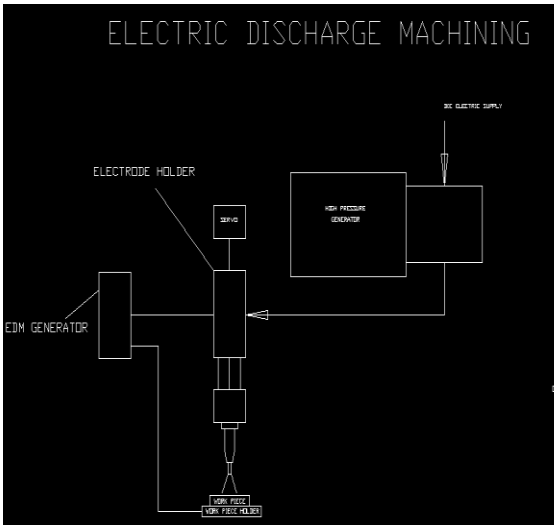

Fig. 1 schematic of EDM.

The dielectric is EDM oil/ kerosene/transformer oil. Then set the machining parameters on the CNC controller for machining on the work piece to get the required shape and size. The applied voltage initiates the current to discharge on to the work piece in the pulse form otherwise in continuous form it produces arc which is harmful for machining. Each spark energy is discrete and controlled enough to melt and vaporize within a thin gap from the work piece surface. In this period the discharge current is varied within range of 0.5 to 400 A, at 40-300 V applied voltage range and pulse duration can be varied from 2 to 2000 microsecond. Different type of flushing method is applied to remove and prevent from accumulation of melted material from the work piece and smoothen the process.The objective of the current work is to investigate the Optimal Process Parameters of EDM. EN 8 steel is selected as a work piece material with Copper tungsten as a Tool (Electrode) Material. The Input Parameters such as peak Current (A), Pulse on Time (T_{ON}) & Pulse off Time (T_{off}) are selected for the experimental work. Effects of these Input Parameters on Output Response as surface roughness and Material Removal Rate (MRR) are studied. Analysis is carried out using Taguchi Technique and an attempt has been made to estimate the optimum machining conditions to get the best possible response within the experimental constraints.

Surface Roughness:Commonly shortened to roughness, could be a live of the feel of a floor. It is quantified by the vertical deviations of a real floor from its perfect type. If those deviations place unit large, the floor is rough; if they may be little the surface is graceful. Roughness is normally idea of to be the excessive frequency, short wavelength element of a measured surface (see floor metrology). However, in practice it is commonly essential to understand the amplitude and frequency to verify that a floor is appropriate purpose. Roughness performs a important position in identifying however a real object can act with its surroundings. Rough surfaces on occasion wear extra quick and have higher friction coefficients than graceful surfaces (see tribology). Roughness is normally an honest predictor of the performance of a mechanical detail because irregularities inside the floor would possibly kind nucleation sites for cracks or corrosion. On the opposite hand, roughness might promote adhesion.

Material Removal Rate (MRR): This is one of the performance measures. Material Removal Rate of the work piece is the volume of the material removed per minute. It is usually measured in the unit as mm3 /min. Maximum of MRR is an important indicator of the efficiency and the cost effectiveness of the EDM process.

2. METHODOLOGY

Taguchi's strategy is an effective method for the plan of a brilliant framework. It gives a productive as well as an orderly way to deal with improves plans for execution and quality. Moreover, Taguchi parameter configuration can lessen the change of framework execution. The experiment is governed by the following steps are:

- Select the appropriate orthogonal array and assign these parameters to the orthogonal array.
- Perform the experiments based on the arrangement of orthogonal array.

Analyze the experimental results using TAGUCHI and S/N Ratios

Table: 1 Input Parameters

CONTROL PARAMETERS	UNITS
PULSE TIME ON	(µsec)
PULSE TIME OFF	(µsec)
PEAK CURRENT	(Amper)

Levels	PULSE TIME ON	PULSE TIME OFF	PEAK CURRENT
Level 1	100	200	7
Level 2	200	500	15
Level 3	500	900	22

Table:2 The L9 orthogonal array for input parameters Pulse on time, pulse off time and peak current is shown in table below:

EXPERIMENTS	TIME		Peak current(IP)
	On	off	
1	100	200	7
2	100	500	15
3	100	900	22
4	200	200	15
5	200	500	22
6	200	900	7
7	500	200	22
8	500	500	7
9	500	900	15

3. EXPERIMENTAL SETUP

EDM is a thermo electric process in which heat energy of spark is used to remove the material from the work piece .The work piece and tool should be made of electrically conductive materials. In this process electrical spark is created between an electrode and a work piece. The EDM process usually does not affect the heat treat below the surface with EDM the spark always takes place in the dielectric fluid.Experiments have been performed in order to investigate the effects of one or more factors of the process parameters on the surface finish of the wire cut machined surface.The main aim of the project is to determine the influence of time on, time off, and input power. The investigation is based on surface roughness during machining of stainless steel.

Fig. 2: Raw material

An electrode tool with a diameter of 12.5 mm has been used as a tool electrode (positive polarity) and work piece materials used are Copper tungsten, Stainless steel 316Land materials rectangular plates of dimensions 70 * 40 mm and of thickness 8 mm.

Fig. 3: electrode

Fig. 4: Die Sink EDM Process

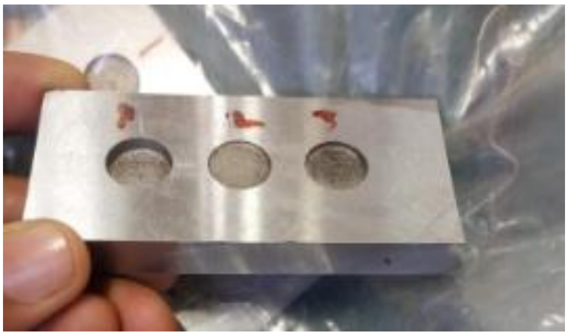

Fig. 5: final work pieces

4. RESULTS AND DISCUSSION

4.1. SURFACE ROUGHNESS RESULTS

In this project most important output performances in DEDM such as Surface Roughness (Ra) is considered for optimizing machining parameters. The surface finish value (in µm) was obtained by measuring the mean absolute deviation, Ra (surface roughness) from the average surface level using a Computer controlled surface roughness tester.

EXPERIMENTS	TIME		Peak current(IP)	Surface Roughness (Ra)
	On	off		
1	100	200	7	6.517
2	100	500	15	6.905
3	100	900	22	7.391
4	200	200	15	6.668
5	200	500	22	9.482
6	200	900	7	8.226
7	500	200	22	10.168
8	500	500	7	9.895
9	500	900	15	9.743

4.2. Material Removal Rate

MRR can be defined as the ratio of volume of material removed to the machining time.

$$MRR\ (mm^3/min) = \frac{Volume\ Loss}{Time} \quad (1)$$

$$Volume\ loss = \frac{(Wi - Wf)}{\rho} \quad (2)$$

EXPERIMENTS	TIME		Peak current(IP)	MRR (mm^3/min)
	On	off		
1	100	200	7	1.375
2	100	500	15	5.125
3	100	900	22	2.375
4	200	200	15	6.125
5	200	500	22	7.375
6	200	900	7	2.25
7	500	200	22	3.625
8	500	500	7	2.75
9	500	900	15	10.825

4.3. TAGUCHI TECHNIQUE

Taguchi defines Quality Level of a product because the Total Loss incurred with the aid of society due to failure of a product to carry out as preferred once it deviates from the delivered target performance ranges.This includes charges related to negative overall performance, in operation expenses (which modifications as a product a while) and any in addition prices because of dangerous issue effects of the products in use.

Signal to Noise Ratio: Taguchi method stresses the importance of studying the response variation using the signal–to–noise (S/N) ratio, resulting in minimization of quality characteristic variation due to uncontrollable parameter. The surface roughness is considered as the quality characteristic with the concept of "the smaller-the-better". The S/N ratio for the smaller-the-better is:

$$\mathbf{S/N = -10 * \log(\Sigma(Y^2)/n))}$$

Where n is the number of measurements in a trial/row, in this case, n=1 and y is the measured value in a run/row. The S/N ratio values are calculated by taking into consideration above Equation. with the help of software Minitab 15.

The surface roughness measured from the experiments and their corresponding S/N ratio values are listed in Table

Response Table for Signal to Noise Ratios

Smaller is better

Level	TIME ON	TIME OFF	PEAK CURRENT
1	-16.81	-17.64	-18.16
2	-18.11	-18.74	-17.68
3	-19.94	-18.48	-19.02
Delta	3.13	1.11	1.34
Rank	1	3	2

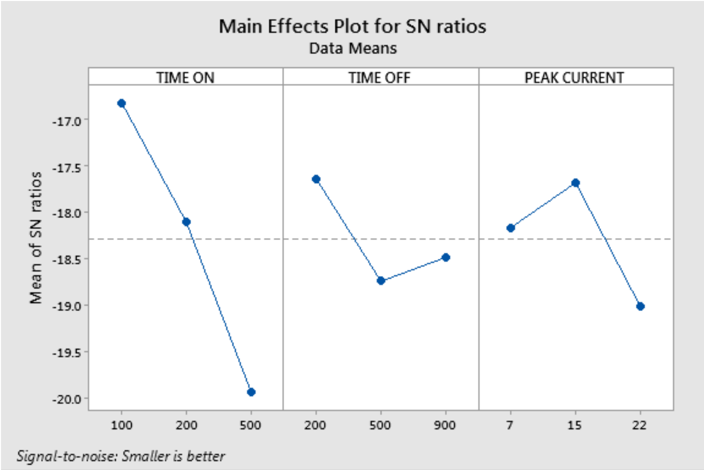

Fig. 6: S/N ratio

Selection Of Optimal Parameter Combination For Better Material Removal Rate In Edm Using Taguchi Technique

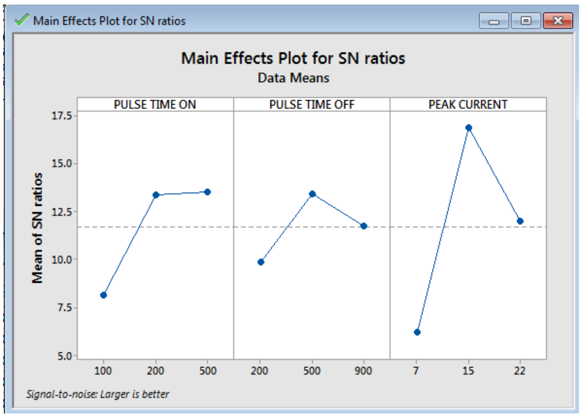

Fig. 7: S/N Ratio for MRR

5. CONCLUSION

The objective of the present work is to investigate the effects of the various DEDM process parameters on the machining quality and obtain the optimal sets of process parameters so that the quality of machined parts can be optimized. Experiments are conducted on the pieces varying parameters. The materials used for machining are EN8 STEEL. The process parameters considered are Pulse Time on, Pulse Time off, and peak current. The range of values varied are Time on – 100µsec, 200 µsec and 500 µsec, Time off – 200 µsec, 500 µsec, 900 µsec, Input power –7amp, 15amp, 22amp. The optimization is done by using TAGUCHI technique by considering L9 orthogonal array. Optimization is done using Minitab software.

- We can conclude that at Time on -100µsec, Time off – 200 µsec and Peak current-7 amp to get better surface finish values.
- By observing the MRR results, to get better MRR values at Time on -500µsec, Time off – 900 µsec and Input power-15amp.

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