A Review on Machining Parameters of En-36A Alloy Steel

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Abstract:- The main objective of today's manufacturing industries is to produce low cost, high quality product in short time. The selection of optimal cutting parameters is very important issue or factors for every machining process in order to enhance the quality of machining products and reduce the machining cost. Machining of hard metal is difficult by conventional methods to get high accuracy. Electrical discharge machining performance is generally evaluated on the basis of material removal rate (MRR), tool wear rate (TWR) and surface roughness (SR). The important EDM machining parameters affecting to the performance measures of the process are discharge current, pulse on time, pulse off time, arc gap and peak current voltage.

Keyword:-Material removal rate (MRR), Tool wear rate (TWR), Surface roughness (SR), Pulse on time, Pulse off time, Arc gap and peak current voltage, Dischargecurrent.

I. INTRODUCTION

Today, Electrical Discharge Machining (EDM) is one of most popular technique in the manufacturing process. It is the most widely used non-tradional machining process. Electrical discharge machining are generally used to achieve very complex shapes in extremely hard metals such as tungsten carbide, titanium, and hardened tool steel alloys. The main principle of Electrical Discharge Machining (EDM) is a controlled metal removal process that is used to remove metal by means of electric spark erosion. In this process an electric spark is used as the cutting tool to cut (erode) the workpiece to produce the finished part to the desired shape.

Both tool and work piece are submerged in a dielectric fluid .Kerosene/EDM oil/deionized water is very common type of liquid dielectric although gaseous dielectrics are also used in certain cases.

EN36A alloy steel is an important tool and dies material, mainly because of its high hardness, strength and wears resistance over a wide range of temperatures. It has a high specific strength and cannot be easily processed by conventional machining techniques.

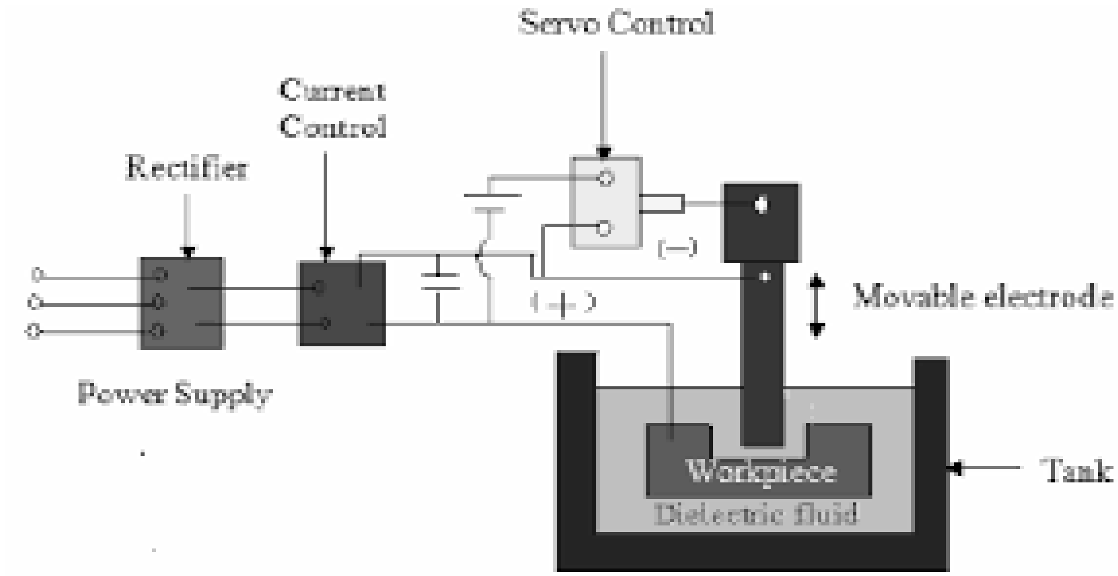

Figure (1)-working principle of EDM [1]

II. Machining Parameters Effect

2.1 Material Removal Rate

A number of experiments were conducted to study the effects of various machining parameters on EDM process. These studies have been undertaken to investigate the effects of pulse on time (T-on), pulse off Time (T-off), current (Ip) and voltage (v). The work piece material for the work is EN36.In the experiment they calculated the MRR and EWR and for the calculation of MRR we have to measure the weight of work piece after every run of experiment. Every time the material is removed from the work piece due to heat generated by the arc, the remove debris from the work piece as a result of that the weight of the work piece decreases.

The material removal rate (MRR) mainly affected by peak current (Ip). Pulse on time (T-on) has least effect on it. For MRR Pulse-on time (100 μs.), Pulse-off time (12μs), current (14 amp) and Voltage (40V). For EWR. Pulse-on time (100μs), Pulse-off time (6 μs), Current (6amp.), and Voltage (60v). [2].

In this study EN36 Alloy Steel is used as the work material and problems formulation were carried out on the material removal rate (MRR), tool wear rate (TWR) and surface roughness (SR) using copper electrode (Cu) material and experimental parameters. current, pulse on time, pulse off time, fluid pressure) for maximum material removal rate (MRR) and minimum electrode wear rate (EWR) for EDM of hard material Stainless steel with copper as cutting tool electrode. In this paper both the electrical factors and non-electrical factors has been focused which governs MRR and EWR. The effect of various parameter such as tool dia (D), peak current (Ip), pulse on time (Ton) and pulse off (Toff) time has been studied though machining of EN36steel. It was notice that the tool diameter and pulse off time have influenced more than the other parameter considered in this study. – The confirmation experiment has been conducted. Result show that the error associated with SR is only 1.14%, MRR is 5.85% and TWR is 5.3%. [3]

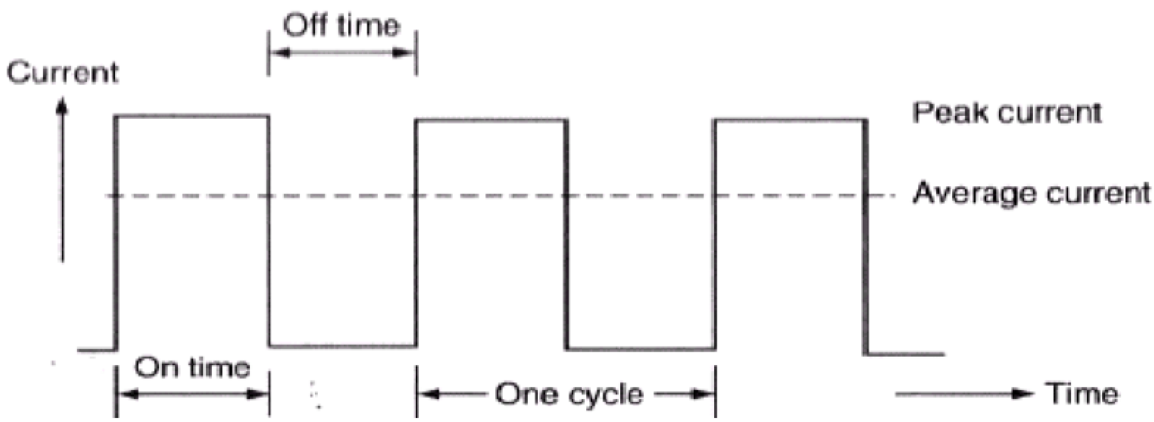

Figure (2)-Typical EDM pulse current train for controlled pulse generator [4]

In thermal erosion process modified ISO current pulse generator could produce high MRR and better surface finish over conventional pulse generator. For this study, they investigated machining characteristics of AISI 202 stainless steel with tungsten carbide electrode in thermal erosion process. Gap current, discharge current, and duty factor had been chosen as input parameters to access the machinability. The work piece machined for ten minutes for every combination parameters made in design of experiment (DOE). We calculated MRR and TWR by measuring the mass work piece and tool each time before and after the machining. The units of MRR and TWR are g/min. The weighting machine has the accuracy of 1 mg. Based on Taguchi method the combination for optimum input process parameters for maximizing the MRR are current (Ip) 12 Amp, pulse on time 200µS, duty cycle 12 and copper electrode. [5]

The tool wear rate should be minimized in EDM. The response table given below, type of electrode used has highest priority because it has the highest rank in response . In they experiment copper has minimum tool wear rate. Hence the type of electrode has the highest effect on TWR, which followed by current, pulse on time and duty cycle. On the other hand, for minimizing the tool wear rate (TWR) the combination of optimum input process parameters are current (Ip) 12Amp, pulse on time 500 µS, duty cycle 11and brass electrode[6].

The maximum MRR occurs at highest applied current and Offend with lowest Ton,. When the current increases, the occurring of spark also increases, thereby the higher MRR happens. When Ton increases, the rate of material removal decreases and the maximum MRR occurs only when the Ton is less and the MRR increases when off increases, as it consumes more time for the material to get removed. According to ANOVA , percentage contribution of the variables that affects the MRR were 69.7%, 6.99% and 21.53% for applied current, Ton and off respectively.[7]

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2.2 SURFACE ROUGHNESS.

The effect of various Wire Electrical discharge Machining (WEDM) parameters on the surface roughness of EN36 steel and to find out the set of parameters to optimize the surface roughness of EN36. This study based on WEDM parameters like pulse on time, pulse off time, peak current and voltage on surface roughness .They used thin brass wire (0.25mm) as cutting tool.

With the help of Taguchi method the experimental orthogonal array was designed and three levels corresponding to each of the variables was taken. It is observed that current has the maximum effect and other parameters have comparatively less effect during machining.The results were analyzed using ANOVA for identifying the significant factors affecting the performance measures. The Analysis of Variance (ANOVA) for the mean SR ANOVAthat current, pulse on time, pulses off time, voltage are the factors that significantly affect the SR.And the optimal parameters values are the current (6),voltage(70),pulse on time(5),pulse off time(3).The most predominant factor for the Surface Roughness (SR) is current, rest three factors (pulse on time, pulse off time, voltage) has less impact as compared to the current[8].

WEDM is a unique appearance of electrical discharge machining which utilizes a constantly moving electrical conductive wire electrode. Remove of material happens as a consequence of spark erosion as the wire is moving. The influence of various wire electrical discharge machine parameters were examined to determine the best surface roughness in machining EN36 alloy steel. The researchers used thin brass wire as the cutting tool in the wire cut machine and select the process parameters like pulse on time (µs), pulse off time (µs), peak current (A) and voltage (V) and they were used Taguchi design method. They were noticed that the surface roughness was more affected with current variation than other parameters the analysis of variance (ANOVA) method was utilized in order to decide the level of importance of the WEDM process parameters T-ON, T-OFF, voltage and dielectric flushing pressure were investigated on the surface roughness. When pulse duration and pulse interval increase the surface roughness increases too.

It was found with taguchi parameter design that the best machining variables of combination setting is Servo Voltage (22) volts, Pulse on time (110) µs, servo feed (450) mm/min and Pulse off time (30) µs to reach to the minimum value of surface roughness and hence better surface finish[9].

2.3 TOOL Wear Rate

The tool wear rate should be minimized in EDM. It is an importantfactor because it affects dimensional accuracy and the shape produce. Tool wear is related to the melting point of the materials. Tool wear is affected by the precipitation of carbon from the hydrocarbon dielectric on the electrode surface during sparking.

$$\text{TWR } (mm^3/min) = w_{tb} - W_{ta} / T$$

Where,

TWR= Tool wear rate

W_{tb}=Weight of the tool before machining (gm.)

W_{ta}=Weight of the tool after machining (gm.)

T=Machining time (minute)

III. OPTIMIZATION METHODS

This paper presents investigation and optimization of Electric Discharge Machining (EDM) parameters using Taguchi method. Three process parameters chosen were Pulse on-time (Ton), Duty factor and Discharge current (or pulse current). An L27 orthogonal array was selected to study the effect of main factors and interaction between factors on the response variable i.e. surface roughness. The contribution of the main factors and interaction between them to the optimal surface roughness were determined by using Analysis of Variance (ANOVA). The experimental results revealed that pulse-on time of and discharge current of i.e. minimum surface roughness. Further, results of ANOVA indicated that out of three main factors, discharge current and out of three two way interactions, interaction between duty factor and discharge Current as well as interaction between pulse on-time and duty factor contributed significantly in minimizing the surface roughness.

3.1Taguchi method

Taguchi method, developed by Dr. Genichi Taguchi, is a set of methodologies for optimization of a process or product. The application of this technique has become widespread in many US and European industries after the 1980s. This method involves three stages: system design, parameter design, and tolerance design. Out of these three stages, the second stage – the parameter design – is the most important stage as the first stage – system design – is an initial functional design and may be far from quality and cost. However, the third stage – tolerance design – is dependent of cost. Therefore, the parameter design is the key step in the Taguchi method to achieving high quality without increasing cost. Originally, Fisher was developer of classical experimental design but it is difficult to use mainly due to two reasons, first complexity, second, it needs the large number of experiments if number of the process parameters increases. This task was simplified by Taguchi by introducing a special design of orthogonal arrays to study the entire parameter space with a small number of experiments only and thus, it results in a lot of cost as well as time saving. In the Taguchi method, the experimental values are transformed into a signal-to-noise (S/N) ratio η.

The term "signal" represents the desirable value (mean) for output characteristic and the term "noise" represents the undesirable value for the output characteristic. Usually there are three categories of the performance characteristic in the analysis of the S/N ratio, that is, the lower-the-better, nominal-the-better and the higher-the-better. The S/N ratio for each level of process parameters is computed based on the S/N analysis. Regardless of the category of the performance characteristic, the larger S/N ratio corresponds to the better performance characteristic. Therefore, the optimal level of the process parameters is the level having highest S/N ratio. Furthermore, statistical analysis of variance (ANOVA) is performed to see which process parameters are statistically significant. The optimal combination of the process parameters can be predicted byS/N and ANOVA analyses. Finally, a confirmation experiment is conducted to verify the optimal process parameters obtained from the parameter design. In this study, the parameter design of Taguchi method is adopted to obtain optimal machining performance in EDM machine.

3.2ANALYSIS OF VARIANCE (ANOVA)

The analysis of variance (ANOVA) is a common statistical technique to determine the percent contribution of each factor for results of the experiment. It calculates parameters known as sum of squares SS, degree of freedom (DOF), variance and percentage of each factor. Since the procedure of ANOVA is a very complicated and employs a considerable of statistical formula. The Sum of Squares SS(tr) is a measure of the deviation of the experimental data from the mean value of the data. The Fisher's ratio is also called F value. The principle of the F test is that the larger value for a particular parameter, the greater the effect on the performance characteristics due to the change in that parameter.

IV. CONCLUSION

Based on the review of various study on machining process the following conclusions are formulated.

- The material removal rate (MRR) mainly affected by peak current (Ip). Pulse on time(Ton) has least effect on it.
- The electrode wear rate (EWR) is mainly influenced by peak current (Ip). The effect of voltage (V) is less on EWR and has least effect on it.
- Based on Taguchi method the combination for optimum input process parameters for maximizing the MRR are peack current, pluse on time.
- Electrode has the highest effect on TWR, which followed by current, pulse on time and duty cycle. On the other hand, for minimizing the tool wear rate (TWR).
- Ton increases, the rate of material removal decreases and the maximum MRR occurs only when the Ton is less and the MRR increases when off increases, as it consumes more time for the material to get removed.
- current has the maximum effect and other parameters have comparatively less effect Surface Roughnessduring machining three factors pulse on time, pulse off time, voltage has less impact as compared to the current.
- They are investigated on the surface roughness pulse duration and pulse interval increase the surface roughness increases too.
- The analysis of variation results that TWR has the highest influence onaffects dimensional accuracy and the shape produceis related to the melting point of the materials.

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