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A Review on Optimization of Machining Parameters in EDM

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ABSTRACT: Electro Discharge Machining or EDM is a machining method primarily used for hard metals or those that would be impossible to machine with traditional techniques. So, Electro Discharge machining (EDM) is one of the important non-traditional machining processes which is used for machining difficult to machine materials like composites and inter-metallic materials. EDM spark erosion is the same as having an electrical short that burns a small hole in a piece of metal it contacts. In the EDM process both the work piece material and the electrode material must be conductors of electricity. Intricate profiles used in prosthetics, bio-medical applications can be done in EDM. Also Electro Discharge Machining (EDM) find a wide range of applications for production of complicated shapes, micro holes with high accuracy in various electrically conductive materials and high- strength temperature-resistant alloys. This paper reviews the various notable works in the field of EDM. And also gives future scope in the EDM.

KEYWORDS: Electro Discharge Machining, MRR, EWR, Surface Roughness, Taguchi method.

I. INTRODUCTION

Electro Discharge Machining is a non-conventional or non-traditional machining process which is used for machining hard materials which are difficult to machine by conventional machining process. EDM can be used in machining difficult cavities and contours.There are various types of products which can be produced using EDM with high precision and good surface quality, such as dies and moulds, parts for aerospace and automotive industry and surgical components.

Working Principle of EDM

EDM is a thermoelectric process in which there is spark production takes place in between tool electrode and work piece. In this process, there is no physical contact between work piece and tool electrode. And for this spark production both tool electrode and work piece should conduct electricity. The electrode is the cutting tool for the EDM process and cuts the work piece with the shape of the electrode. The electrode and work piece are connected to a suitable power supply. The tool (electrode) and the work piece are separated by a small gap and submerged in a dielectric fluid. As the electrode is charge up, it brings near to the work piece. As these two conductors come near enough, the spark will be produced in between these two and the material is removed from work piece due to spark erosion. This process is continued until the shape of electrode is formed into the work piece. The basic components of Electric Discharge Machine are electrodes, work piece, dielectric fluid, power supply and servomechanism. There are various types of electrodes are used in research work such as copper, brass, tungsten etc. The work pieces used for research work are Stainless Steel, Die Steel, Carbide, Inconel etc. Kerosene, EDM oil is generally used as dielectric fluid in EDM. A servomechanism maintains a space of about the thickness of a human hair between the electrode and the work, preventing them from contacting each other.

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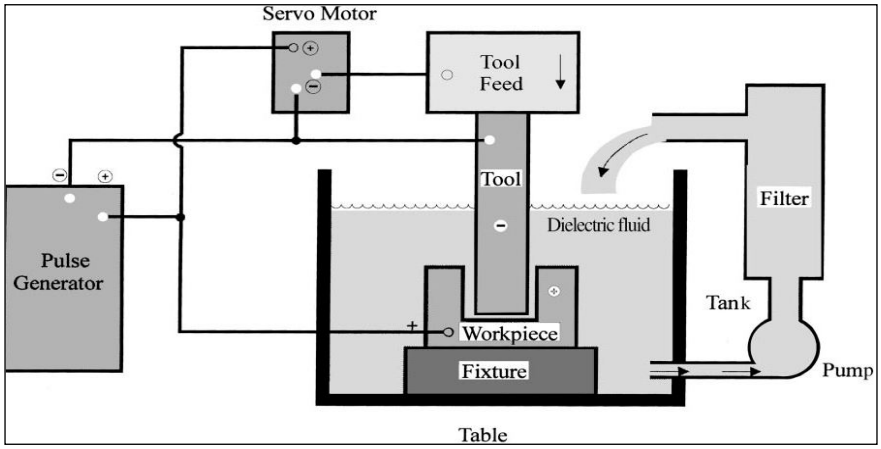

Fig. 1 Electro Discharge Machining

II. LITERATURE SURVEY

P. Kuppan, A. Rajadurai, S. Narayanan et al.(2007) carried out a study on influence of EDM parameters in case of Inconel 718. In this work, the parameters such as peak current, pulse on-time, duty factor and electrode speed were chosen to study the machining characteristic and electrolytic copper tube is used as a electrode. The output responses measured were material removal rate (MRR) and depth averaged surface roughness (DASR). The results obtained from this investigation was, MRR gets more affected by peak current, duty factor and electrode rotation whereas DASR was strongly affected by peak current and pulse-on time.

S.H.Tomadi, M.A.Hassan et al.(2009) studied the influence of operating parameters of tungsten carbide on the machining characteristics such as surface quality, material removal rate and electrode wear. They carried out experiment on Tungsten Carbide with Copper tungsten as tool electrode. In this work, machining parameters such as peak current, power supply voltage, pulse-on time and pulse-off time were used. The results obtained from experiments were collected and analyzed by using STATISTICA software. In this work, in case of Tungsten Carbide, the parameters which mostly influences to surface roughness were voltage and pulse-off time. For obtaining high MRR, one should use high values of peak current and voltage and for obtaining low values of electrode wear, high values of the pulse off time and low values peak current should be used.

I.Puertas, C.J. Luis, L. Álvarez et al.(2004) carried out experimental investigation on influence of EDM parameters on surface quality, MRR, EW of WC-CO. The influencing factors used here were intensity, pulse time and duty cycle. In this work, in order to obtain a good surface finish in the case of tungsten carbide, low values should be used for both intensity and pulse time. Also in case of electrode wear, it was also seen that the intensity factor was the most influential. And finally to obtain high values of MRR, one should use high values of intensity and duty cycle.

Gurtej Singh, Paramjit Singh, Gaurav Tejpal, Baljinder Singh et al.(2012) presented a work on effect of machining parameters on surface roughness of H13 Steel in EDM process using powder mixed fluid. In this work, Taguchi methodology is used for determining the effects of different machining parameters such as Polarity, peak current, pulse on time, duty cycle, gap voltage and concentration of abrasives powder in dielectric fluid on the work piece H13. The results obtained from this work were as follows: increasing peak current and pulse-on time leads to more surface roughness and by addition of powder particles in dielectric fluid, this leads to reduce the surface roughness.

Kamaljit Singh, C S Kalra et al.(2013) carried out experimental investigation of machining of OHNS Die steel by EDM process. In this work, the input parameters were chosen as peak current, pulse on time; voltage gap and flushing pressure. Taguchi method and ANOVA method were used to optimize the machining parameters. By doing experiments, it was observed that current has the largest effect on the material removal rate of OHNS steel and flushing pressure has the largest effect on the hardness of OHNS steel.

Mr.Anand N. Nikalje, Dr.Umesh V. Hambire et al.(2014) carried out the analysis of the influence of EDM parameters on surface Quality , MRR, EWR and Micro Hardness of AISI O2 (1.2842). The Objective of this work is to investigate the effect of current(I), Pulse On Time(Ton), Duty Factor(n) on Material Removal Rate(MRR), Electrode wear Rate(EWR), Micro Hardness & Surface Roughness during EDM. In this work, the most influential factor for

surface roughness was intensity and followed by duty cycle. In case of electrode wear, intensity was the most influential factor and in case of material removal rate, once again intensity was the most influential factor and followed by duty cycle factor. And finally for the case of micro hardness, pulse-on time and duty cycle were the most influential factors.

Prof. D.V.Ghewade, Mr. S.R.Nipanikar et al.(2011) studied the effect of various parameters like peak current, gap voltage, duty cycle and pulse on time on the work piece Inconel 718. The Taguchi method was used by the author to analyze the effect of machining parameters on MRR, EWR, Radial Overcut and Taper Angle. In this work, peak current and gap voltage mainly affects the MRR. Pulse-on time and duty cycle mainly causes influence to the EWR. Peak current and duty cycle have the maximum effect on ROC and the half taper angle (α°) is mainly affected by pulse on time (Ton) and duty cycle (t).

Kapil Banker, Ujjval Prajapati, Jaimin Prajapati, Paras Modi et al.(2014) carried out the Parameter optimization of Electro Discharge Machine of AISI 304 Steel by using Taguchi Method. In this work, Taguchi method is used for design of experiments with three input parameters and three levels using L9 array. Copper is used as tool electrode and AISI 304 steel is used as work piece. By using Taguchi method and MINITAB software, optimization is carried out. The machining parameters were current, Ton, Toff, Time required, Depth of cut while output parameters was material removal rate. From the experimental work, it has been observed that pulse-on time parameter has most effective parameter in case of MRR. The optimum parameter set for the MRR is Current -14, Ton -7, Toff - 8. It has also been proved that copper having high material removal rate with respect to other material like as aluminum, gun metal, brass, etc.

Surender Kumar, Satpal Kundu, Ravinder Chaudhary et al.(2014) carried out experimental investigation of MRR On H-13 Die Tool Steel using EDM with application of Taguchi technique. In this work, various process parameters like peak current, Pulse on Time and Feed rate were used to study the effect of these parameters on Material Removal Rate. By using Taguchi technique, optimization process was carried out. And conclusions obtained from the experimental work were as follows : as pulse-on time increases, the MRR was also increases. And MRR also increases with increase in the value of current and MRR decrease with increase in the value of feed rate.

Mohammadreza Shabgard- Mirsadegh Seyedzavvar- Samad Nadimi Bavil Oliaei et al. studied the Influence of input parameters on characteristics of EDM process. The machining experiments were carried out on AISI H13 samples having a hardness of 52.7HRC by using copper electrode. The machining parameters were pulse-on time and peak current while the output factors investigated were the material removal rate , tool wear ratio, surface roughness, as well as the thickness of white layer and depth of heat affected zone of EDMed work piece. The conclusion carried out from this work was the increase in pulse on-time leads to the increase in the material removal rate, surface roughness, as well the white layer thickness and depth of heat affected zone. And also by increasing pulse-on time and peak current, tool wear ratio decreases.

C.Mathalai Sundaram, R.Sivasubramanian, M.Sivakumar et al.(2013) carried an experimental investigation on machining parameters of Electrical Discharge Machining of OHNS Steel. In this work, Oil Hardening and Non Shrinking die steel was used as work piece and copper and aluminium were used as tool electrodes. Experimental investigation was done on OHNS by using input factors like voltage and current on output parameters like MRR and EWR. From the experimental work it was observed that as the current increases, MRR also increases due to higher spark erosion. Also as the current increases, EWR also increases because higher energy is available for electrode wear. Also in case of percentage WR, it increases as current increases.

H.K. Kansa, Sehijpal Singh, Pradeep Kumar et al.(2007) carried out the study on effect of Silicon powder mixed in dielectric fluid of EDM on machining characteristics of AISI D2 die steel. Copper is used as tool electrode with 25 diameters and Kerosene is used as dielectric fluid. There were six process parameters used namely peak current, pulse-on time, pulse-off time, concentration of powder, gain, and nozzle flushing .Optimization process is done by using Taguchi method. The ANOVA analysis indicates that the percentage contribution of peak current and powder concentration toward MR is maximum among all the parameters. The confirmation runs showed that the setting of peak current at a high level (16 A), pulse-on time at a medium level (100 µs), pulse-off time at a low level (15 µs), powder concentration at a high level (4 g/l), and gain at a low level (0.83 mm/s) produced optimum MR from AISI D2 surfaces when machined by silicon powder mixed EDM.

C.J. Luis, I. Puertas, G. Villa et al.(2005) carried Material removal rate and electrode wear study on the EDM of silicon carbide. The study was made by using five design factors such as Intensity, pulse time , duty cycle , open-circuit voltage and dielectric flushing pressure on two response variables as MRR and EWR. In this work, DOE and multiple

linear regression statistical techniques have been used. n the case of MRR, the only influential design factors, for a confidence level of 95%, were: intensity and voltage .In case of EW and arranged in descending order of importance, intensity, pulse time and flushing pressure turned out to be the influential factors for a confidence level of 95%.

III. CONCLUSION

The present review paper gives a study on optimization of various machining parameters on EDM. From literature review, it is observed that, there is lot of work done on various work pieces which are difficult to be machined by conventional machining. The electrodes used are copper, aluminium etc. And for optimization purpose, mostly Taguchi technique is used. But also there are some other techniques used such as Grey Relational Analysis, Surface Response Methodology etc. So, from above literature review, it is concluded that materials that are difficult to be machined by traditional machining, can be machined by non-traditional machining i.e.by using Electro Discharge Machining process.

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