Optimization of EDM Process Parameters: A Review

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ABSTRACT

This work represents the overall survey on Electric Discharge Machining. The investigation of new materials need a development of new machining process regarding high hardness of material and make an effective machining process. So Electric Discharge Machining is commonly used for those materials which are very difficult to machine with conventional machining process. In today's competitive environment, the industries around the world are trying to increase their profits without increasing the sales price of their products. This can only be done through minimizing the losses that are occurring during production. The minimizing in production time, step up profits an optimization of process. Parameters have a very major role for enhancement of productivity. Therefore, the work for the optimization of parameters can solve the problems. In last decade, the researcher has found different way to improve the parameters of EDM process. So, this work reviews the different effective research in field of EDM process to find optimum parameters for machining process with different Design of Experiments technique.

Keywords- *Electrical Discharge Machining, Process Optimization, Response Surface Methodology.*

1. 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 the 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 molds, parts for aerospace and automotive industry and surgical components.

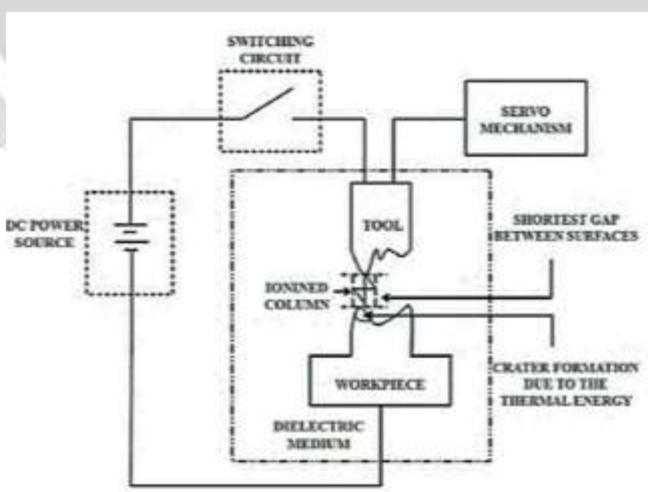

Fig 1. Mechanism of electric discharge machining (EDM)

EDM has been replacing drilling, milling, grinding and other traditional machining operations and is now a well-established machining option in many manufacturing industries throughout the world. And is capable of machining geometrically complex or hard material components, that are a precise and difficult-to-machine such as heat-treated tool steels, composites, superalloys, ceramics, carbides, heat resistant steels etc. being widely used in die and mold making industries, aerospace, aeronautics and nuclear industries. Electric Discharge Machining has also made its presence felt in the new fields such as sports, medical and surgical, instruments, optical, including automotive R&D areas [1].

2. LITERATURE REVIEW

In this chapter, we have to discussed and mentioned about various literatures, which have applied different method for solving the problems.

Chabbi et. al., [1], The present paper focuses on the determination of the optimum cutting conditions leading to minimum surface roughness as well as cutting force, cutting power and maximum productivity, in the case of the turning of the Polyoxymethylene polymer POM C using cemented carbide cutting tool. The optimization is based on the response surface methodology, RSM, (desirability function approach). Furthermore, the analysis of variance (ANOVA) is exploited to establish the statistical significance of the cutting parameters on different technological ones studied. The results revealed that the surface roughness is strongly influenced by feed rate with a large contribution, followed by cutting depth, whereas, the cutting speed has no influence. Regarding cutting force, it is found that depth of cut and feed rate are the most significant terms. The RSM allowed the optimization of the cutting conditions for minimal surface roughness, cutting force, cutting power and maximal material removal rate.

Ribeiro et. al., [2], The preparation of quality surfaces is very important process in the surface engineering. The surface roughness will influence the quality and effectiveness of the subsequent coatings for protection against corrosion, wear resistance and finishes quality of decorative layers. For these reasons, the authors of the present work have focused in manufacturing parameters that influence the surface quality of hardness metallic materials. In this work, the effects of varying four parameters in the milling process, namely cutting speed, feed rate, radial depth and axial depth. The influence of these parameters on the surface roughness are analyzed individually and also the interaction between some of them for the milling machining of hardened Steel (steel 1.2738), being used the Taguchi optimization method. For this purposed was built a L16 orthogonal array and for each parameter were defined two different levels, corresponding to sixteen experimental tests. From these tests were retrieved sixteen surface roughness measurements the influence of each parameter in surface roughness were then obtained by applying the analysis of variance (ANOVA) to experimental data. It is noted that the minimum roughness measured was 1.05μm. This study also serves to determine the contribution of each machining parameters and their interaction for surface roughness. The results show that the radial cutting depth and the interaction between the radial and axial depth of cut are the most relevant parameters, being their contributions for the minimization surface roughness about 30% and 24%, respectively.

Modi et al. [3], studied EDM process parameters so that the whole process is affected by the electrical and non-electrical. The project work rotating equipment metal removal rate (MRR) to improve and to monitor its impact on the surface finish is used. RSM and Taguchi's method are used to optimize the design.

Muthuramalingam and Mohan [4], discussed having an overview of the EDM process, modeling of process parameters, and influence of process parameters such as input electrical variables, pulse shape, and discharge energy on performance measures such as material removal rate, surface roughness, and electrode wear rate. From the review results, it has been observed that the efficacy of the machining process can be improved by electrical process parameters, and only less attention has been given to enhancing such parameters.

Venkatesh et. al., [5], discussed the effect of an increase in pulsed current on MRR, TWR, SR in alloy steels viz., EN31, EN8, HCHCr. The electrode materials viz. copper, brass, chromium copper. Results of the study suggested that SR increases with increases in pulse current. Chromium Copper electrode has been preferred for highest MRR, Dimensional accuracy and surface finish.

Vikas et. al., [6], investigated comparison of MRR for EN19 and EN41 in die sinking EDM machine using discharge current and voltage as input processing parameters. Taguchi method with S/N ratio and ANOVA suggested that discharge current in case of the EN41 material and EN19 material had a larger impact as compared to other processing parameters on the MRR.

Kant et. al., [7], In this study different forces acting on tool have been experimentally found using a dynamometer. Based on the experimental data a second-order empirical model for prediction has been developed for turning of AISI 1045 steel with tungsten carbide tools by response surface methodology coupled with factorial design. The developed empirical relation agrees well with experimental data. Therefore, the proposed model can be utilized to predict the corresponding forces at different parameters in turning without actual experimentation at a very small cost. This can also be used for metal cutting process optimization, increasing productivity and reducing manufacturing costs. The established equation clearly revealed that the feed is main influencing factor on cutting force components as compared to others. It has been shown that increasing feed rate and depth of cut lead to an increase in forces. A good combination among the cutting speed, feed rate, depth of cut can generate minimum forces during turning of AISI 1045 steel. Response surface methodology coupled with factorial design of experiments actually save a lot of time and cost of experiments.

Singh et al. [8], studied the impact on operating parameters such as pulse-time workpiece and cryogenic and non-cryogenic DM electrode using steel such as metal removal rate (MRR) and tool wear ratio (TWR) as a response to copper content and pulse time. Cryogenic treatment is increasing material removal rates and tool wear is used to reduce the rate. It was found that the tool wear rate increase with the pulse treatment cryogenic and the non-cryogenic copper electrode, both electrodes is decreased. Tool wear rate increases with increasing pulse off time. With the increase in time for the 100 µs pulse of 50 µs and 20 µs to 15 µs pulse of time with increasing, material removal rate increased material removal rate has decreased.

Singh et. al., [9], investigated comparison of machining characteristics of D3 Steel, EN8 Steel, and EN31 Steel materials, before and after deep cryogenic treatment using Taguchi L18 array in EDM. Results of the study suggested that best improvement in tool wear and surface roughness was reported by D3 Steel followed by EN8 and then by EN31.

Singh and Singh [10], compared MRR using AISID3 Steel as workpiece and tool materials as copper and brass with a pulse on /pulse off as parameters. The experiment showed that MRR is increased with increase in pulse off time and MRR decreased with increase in pulse on time in case of the brass electrode and a decrease in the copper electrode.

Singh et al., [11], MRR achieved material different than the material work equipment, such as copper and brass D3 mainly achieved using electrodes. The parameters are chosen for the study / off time pulse to pulse. They concluded that the MRR brass electrodes increase with increasing pulse on time. He also found time to MRR copper electrode decreases significantly with the decrease in the pulse.

Choudhary et. al., [12] performed the experiments by using copper silicon carbide (CuSiCp) composite tool electrode on an EDM with selected input parameters on AISID3 die Steel workpiece. Microstructure analysis reveals the presence of micro-holes and cavities on the machined surface. The depth of re-solidified layer increases with increase of gap current.

Ponappa et al. [13], investigated that EDM well geometrically complex parts that are extremely hard materials or traditional machining processes for machining difficult-to-machine building have established election. Regardless of machine stiffness electrically conductive thermal energy into the soil using its unique feature, die, and the automotive, aerospace and manufacturing of components for surgery has its distinct advantages.

3. CONCLUSION

From the above literature survey, it was concluded or observed that the many works by using the various optimization techniques like Taguchi, RSM, GA, FEM etc., have been used in order to optimize the various parameters in Electrical Discharge Machining process (EDM). The Design of Experiment (DOE) analysis-based Optimization is the evolutionary algorithms which were used by positively by the various investigators. However, these optimization techniques have not been used in the optimization of the Electrical Discharge Machining (EDM) process parameters where the optimal setting is required for a better performance. The main objective of the future work is to maximize the Material Removal Rate (MRR) and minimize the Surface Roughness (SR) value.

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