The Methodologies Adopted To Improve the Machinability in Die-Sinking EDM

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***Abstract:** Electrical discharge machining (EDM) is one of the oldest nontraditional machining processes, commonly used in automotive, aerospace and ship building industries for machining metals that have high hardness, strength and to make complicated shapes that cannot be produced by traditional machining techniques. The process is based on the thermoelectric energy between the work piece and an electrode. EDM is slow compared to conventional machining, low material removal rate, high surface roughness, high tool wear and formation of recast layer are the main disadvantages of the process. Tool wear rate, material removal rate and surface quality are important performance measures in electric discharge machining process. Numbers of ways are explored by researchers for improving and optimizing the output responses of EDM process. The paper summarizes the research on die-sinking EDM relating to the improvements in the output response.*

***Keywords:** electrical discharge machining, conductive materials, electrode.*

I. INTRODUCTION

The use of ceramic materials has increased considerably in this century because of their special thermodynamic, mechanical, lightweight, electrical, optical, chemical and biological properties as compared to conventional metal matrixes. Reason for ceramic materials wide usage in current centaury applications are good chemical resistance, extra hardness and sufficient mechanical strength at high temperatures. It is proved that any material that can provide high electrical conductivity of can be machined by EDM. To machine ceramics, it is to be made conductive.

II. LITERATURE REVIEW

This study is performed on LMV JV 55 Vertical milling machine. Three The solid carbide, diamond coated, dual helix tool shown in Figure. 1 has been used for machining. The tool has geometric parameters of 6mm of diameter, 40° of helix angle shown in Figure. 1 has been used for machining. The tool has geometric parameters of 6mm of diameter, 40° of helix angle and 6 flute are shown in Fig. xx. Working table of EDM machine was altered by Chen et al. [1] for devising an advanced mechanism for cutting pipe with rotary electrode. Increased material removal rate and reduction in tool erosion observed because of this alteration. An inversion model based on least squares theory was proposed by Sanchez et al. [2] for solving machining of AISI 1045 steel with a set of response parameters. Analysis of results showed that this model can be used in future applications in EDM machining. Shen et al. [3] used tubular graphite electrode with pressurized air as dielectric in their experiment for studying machining of AISI 304. In this process they noticed high material removal rate occurred. Torres et al. [4] used electrolytic copper electrodes for ED machining TiB_2 composites which is a sintered ceramic material. Because of high hardness, good wear resistance and excellent elastic properties TiB_2 composites are widely used in industry. These composites can be EDM machined like other ceramic materials because of good thermal and electrical conductivity. Design of experiments used to formulate the experimental table and against normal out responses MRR, EWR and surface roughness were measured. Optimum combinations of parameters were evaluated.

Kucukturk and Coguna [5] introduced a method for machining electrically non-conductive materials by introducing a conductive layer coating over the surface to be machined. After erosion of the conductive layer in order to keep machining they added graphite powder in die electric so that machining can be done. They successfully machined Al_2O_3, ZrO_2, SiC, B_4C and glass samples with this new technique. Tang and Du [6] used tap water as die electric in machining of Ti–6Al–4V material because tap water which is good for environment, non-hazardous and available in plenty. Optimization process was carried out by combining grey relational analysis and Taguchi method and showed it can be used in other processes.

Optimization of process parameters in machining of Al–B_4C composite was done by Pares Kumar and Ravi Parkash [7]. Patel et al. [8] investigated the EDM machinability of ceramic composite material Al_2O_3–SiCw–TiC with process parameters discharge current, pulse-on time, duty cycle and gap voltage.

Using the response surface methodology, Chiang [9] investigated the performance of EDM on Al_2O_3+TiC mixed ceramic. Interaction effect of each process parameter was evaluated separately.

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Si3N4-TiN ceramic composite, which can be used in high-temperature environments, has been EDM machined by Selvarajan et al. [10] and optimized by using grey relational analysis. Result showed that considerable improvement in the process by this optimization. Rahanga and Patowaria [11] used W-Cu powder in 75%W-25%Cu composition tool material to prepare the electrode by powder. It was found that the hardness of metal increased by three times. Gill and Kumar [12] manufactured (Cu-Mn) electrode and used this for machining hot die steel (H11) by EDM process. Purpose of this research is to induce manganese and carbon into the machined surface. This process can improve the micro hardness and Surface properties of machined surface. For achieving better surface finish and high micro hardness optimum level of process parameters were found using Taguchi method.

Many researchers have been conducted in machining of ceramics and machining of non-conductive materials. This is quite new and emerging area in EDM machining [13-18]. In order to avoid hazardous fumes and non bio degradable waste Valaki and Rathod [19] used waste vegetable oil as die electric than conventional die electrics. Trials proved that it can offer cleaner and safe environments than conventional machining. Puthumana and Joshi [20] used slotted electrode in EDM process. Gas was used as die electric fluid which is supplied through the electrodes. It was shown that in this method electrode wear reduced considerably.

A rotary copper -Tungsten electrode was used by Patel et al. [21] to machine Inconel 718. Commercial grade kerosene mixed with Al_2O_3 powder was used as die electric in this machining. It was found that considerable achievement in EDM performance. A comparison of conventional EDM and cryogenic cooled EDM was made by Hui et al. [22] in order to EDM machine Ti–6Al–4V alloy material. It was proved that cryogenic cooled EDM gives better performance than conventional EDM. Afzaal Ahmed [23] conducted EDM machining to provide a ceramic coating on aluminum for improving surface characteristics as per requirement. Researcher observed that coating was archived on the surface by slow erosion of composite tool.

Multi thin tool electrodes for machining micro holes with different lateral dimensions were first proposed by Habit Sameh et al. [24] for machining different diameter holes with extremely thin electrodes. They successfully machine micro holes in SKD 11 steel with thin Tungsten electrodes. Kerosene was used as die electric in this experiment. Suleiman Abdulkareem et al. [25] conducted experiments to reduce electrode wear while machining Ti-6Al-4V alloy with copper electrode by introducing liquid nitrogen for cooling the electrodes. It was found that EW reduced considerably due to this cooling effect. Anand Prakash Dwivedi and Sounak Kumar Choudhury [26] investigated the effect of tool rotation in EDM process while machining of AISI-D3 Steel using rotating electrodes. They found that MRR increased considerably than conventional stationary electrode EDM. Machining of V groove by conventional machining methods is difficult because of less accuracy and creation of burr while machining. Song and Chu [27] developed a new method called strip EDM for machining V grooves with high dimensional accuracy. They used thin conductive strip bent around electrode guide with its corner right angled. It was found that this method produced V groove with high dimensional accuracy.

Ultrasonic assisted EDM with gas as die electric was used with different electrodes was used to drill a hole and then Burr removal at exit region was studied by Kurniawan et al. [28]. They found that Burr removal was affected by capacitance mostly. Flano et al. [29] used thin foil with high tension for slicing SiC slicing. They proved that it can efficiently replace wire cut EDM and have distinct advantage. Oliveira et al. [30] used EDM machining for getting a suitable coating of Titanium perovskite ($CaTiO_3$) in ASTM B348 6AL-4V Grade 5 Ti-6Al-4V alloy by using deionized water with calcium chloride ($CaCl_2$) as dielectric and graphite electrode as tool. This found very useful in biomedical applications. Dewangan et al. [31] proposed a hybrid method of using grey based Fuzzy for optimizing EDM machining of AISI P20 tool steel with commercially pure copper as tool. Commercial grade oil was used as die electric and this method can successfully apply for improving surface characteristics. This process of optimization resulted improvement in efficacy of machining. With advent of stringent pollution control laws and requirement of highly accurate requirements in machining researchers are now focusing on environmental friendly dielectric and more hybrid type EDM machining. This will be the research areas in coming decades.

III. CONCLUSION

The die-sinking EDM is a promising machining process for machining engineering materials. Several researchers achieved a near-net shape pattern on the material. However, the surface roughness, heat affected zone, tool and material removal rate are still considered as an issue during machining. The proper selection of machining parameters can reduce the adverse effect and improve the machining quality. This paper consolidates the various methodologies adopted to prepare a defect free component using die-sinking EDM.

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