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A Review on Recent Research Development on Electric Discharge Machining (EDM)

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ABSTRACT

Out of all the machining processes used worldwide, Electrical discharge machining (EDM) is one of the most commonly used processes for material removal from a surface. It is a process for shaping hard metals and forming deep holes by subsequent erosion, which can be done in all kinds of materials which can conduct electricity. In this process, erosion occurs when electric discharge takes place in a small gap between the work piece and the electrode; this removes the unwanted material from the parent metal through melting and vaporizing in presence of dielectric fluid. In recent years, researchers have explored a number of ways to improve Electrical Discharge Machining process parameters such as Electrical parameters, Non-Electrical Parameters, Tool based parameters & Powder based parameters. This paper reviews and outlines the research work carried out in the recent years and also discusses the scope for future research work in the field.

Keywords: *EDM, Parameters, MRR, Dielectric, Powder, Performance, Spark Gap.*

1.0 Introduction

Electric discharge machining (EDM) is a non conventional machining process and has found its wide application in numerous industries. The process is based on removing material from a part by means of a series of repeated electrical discharges between tool called the electrode and the work piece in the presence of a dielectric fluid. The electrode is moved toward the work piece until the gap is small enough so that the impressed voltage is great enough to ionize the dielectric. Short duration discharges are generated in a liquid dielectric gap, which separates tool and work piece. The material is removed with the erosive effect of the electrical discharges from tool and work piece. EDM machining does not involve direct contact of tool and work piece. Material of any hardness can be cut by EDM only condition it should be electrically conductive. In this review paper, various trends in electric discharge machining has been considered involving powder mixed electrolyte used for EDM, incorporating tool vibration , treatment of electrode used for EDM, and validating EDM performance using modelling technique

2.0 Existing Research Work

Reddy C. Bhaskar .et al.,[1] discusses the history of electric discharge machining process. During the year 1770, discovery of the erosive effect of the electric discharges took place. The method was later used for machining during the second world war. The paper discusses the various developments made in the field of EDM for different materials, increasing the material removal rate and decreasing the tool wear and cost of machining. It also discusses the process parameters affecting the EDM process.

Daneshman Saeed .et al., [4] (March 2013) investigated the impacts of input parameters of electro discharge machining process including the voltage, pulse current, pulse on time and pulse off time on the output parameters of material removal

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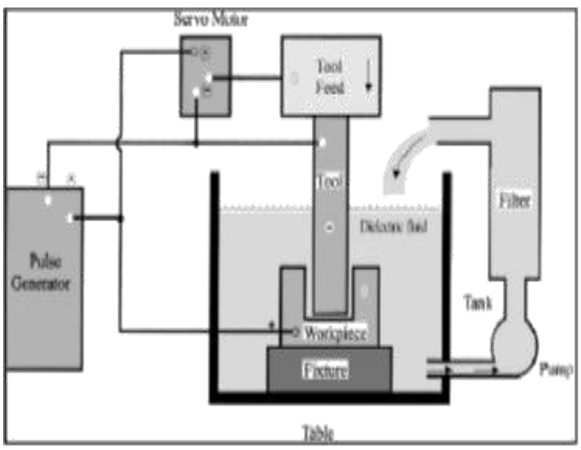
rate, tool wear rate, relative electrode wear and surface roughness were investigated for the machining of NiTi smart alloy using copper tools and de-ionized water as the dielectric.

Choudhary Sushil Kumar .et.al., [6] studied the various types of edm introduced recently for increasing mrr and decreasing tool wear rate. Different mechanisms like vibration, rotary and vibro-rotary mechanism makes the equipment simple and increases the material removal rate, provide better surface finish ejection from work piece. It also shows the various researches done to find the effect of different parameters on different material workpiece using different material tool.

Chhaniyara Pratik N. et al., [7] reviews the experimental investigations carried out to study the effect of EDM parameters on material removal rate (MRR), electrode wear (EWR), surface roughness (Ra) and diameteral overcut in corrosion resistant stainless steels. This paper reviews work related to EDM and ECM processes applied to stainless steel materials such as AISI 304, AISI 302B, 316 L and 17-4 PH.

Raut Trupti G. et al., [8] gives a study on optimization of various machining parameters on EDM. 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.

Figure 1: Working Principle of EDM[8]



Singh & Singh et al.,[2] (Nov 2012) discusses the variation in material removal rate with changes in pulse off/on time in case of brass electrode and decrease in cooper electrode. Pulse on time is defined as the time during which the machining is performed while Pulse Off-time is the time during which re-ionization of the dielectric take place. An insufficient off time can lead to erratic cycling and retraction of the advancing servo thereby slowing down the operation cycle.

Shaaz A et al.,[5] (June 2014), reviews the research trends in EDM in water and EDM with powder additives. Electrically conductive powder reduces the insulating strength of the dielectric fluid and increase the spark gap between the tool and the work piece. The characteristics of the powder such as the size, type and concentration influence the dielectric performance.

Syed Khalid Hussain et al.,[3] presents the experimental investigations of aluminium metal powder to dielectric fluid in electric discharge machining (EDM). As more emphasis is given nowadays to the green manufacturing concept, the present investigation uses distilled water mixed with aluminium powder as dielectric fluid instead of conventional hydrocarbon-based oils. The workpiece and electrode materials chosen for the investigation are W300 die-steel and electrolytic copper, respectively. The process performance is measured in terms of MRR, EWR, surface roughness, and White layer thickness.

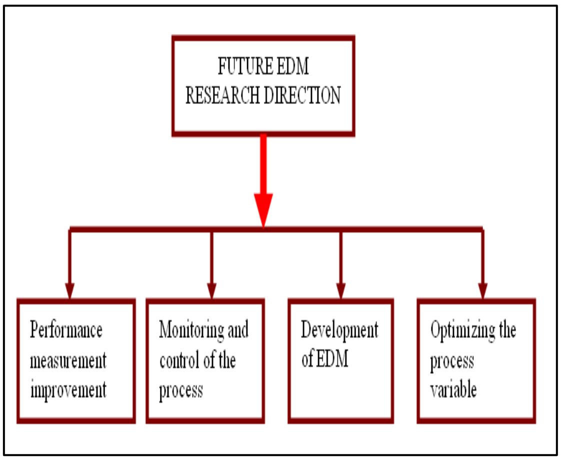
Singh Bhupinder et al., [9] research outlines the Taguchi's Parameter Design Approach which is applied to optimize machining parameters of dimensional accuracy in Electric Discharge Machining (EDM).The study shows that percentage contribution of the parameters reveal that the influence of the Pulse control in controlling both mean and variation of materials removal rate is significantly larger than that of discharge current and pulse duration.

3.0 Future EDM Research Direction

3.1. Optimizing the process variables

The EDM process has a very strong stochastic nature due to the complicated discharge mechanisms making it difficult to optimize the sparking process. The optimization of the process often involves relating the various process variables with the performance measures maximizing the MRR, while minimizing the TWR and yielding the desired SR. In several cases, S/N ratio together with the analysis of variance (ANOVA) techniques is used to measure the amount of deviation from the desired performance measures and identify the crucial process variables affecting the process responses. The process variables include not only the electrical but also non-electrical parameters, which have received quite a substantial amount of research interest.

Figure 2: Future Research Direction [10]



These research works explored new and different ways of delivering a more efficient and stabilized sparking process improving the commonly observed performance measures. In addition, the feasibility of manufacturing the electrode using the RP (rapid prototyping) technique has been extensively studied to improve the performance of tools and sparking. Therefore, with the continuous research effort made in understanding the initialization and development of sparking process, the different means of optimizing the various process variables will continue to be a major area of further development reducing the stochastic sparking characteristic.

3.2. Monitoring and control of the process

The monitoring and control of the EDM process are often based on the identification and regulation of adverse arcing occurring during the sparking process. Most of the approaches measure pulse and time domain parameters to differentiate the arc pulses from the rest of EDM pulses. The option of using emitted radio frequency signal has also been experimented but generates very little research interest. As for the adaptive control system, it mainly relies on the application of fuzzy logic to maintain the machining process. The fuzzy logic provides a control strategy that is equivalent to the expertise and experience of a skilled operator. However, it is not easy to establish the pulse discriminating function, which is based on trail-and-error means of differentiating the various EDM pulses. Therefore, there is a need to develop a highly stable EDM servo control system either to improve the current machining performance or to meet the future needs of machining advanced materials. Moreover, with the perpetual push towards unattended EDM operation, adaptive control system will continue to receive a definite amount of research attention. Such a move will in turn create considerable economic benefits for EDM in terms of training and operating costs.

4.0 Conclusions

From the above survey of past studies it can be pointed out that many research works have been reported in literature on EDM, and almost all parameters (MRR, TWR, Electrode wear, Surface Roughness etc.) are covered. There is scope of research on Dimensional accuracy and Heat affected Zones of different materials.

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