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ELECTRO CHEMICAL MACHINING AND ELECTRICAL DISCHARGE MACHINING PROCESSES MICROMACHINING METHODS-A REVIEW

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ABSTRACT

Nowadays, necessity of small components is a common trend. These requirements encourage the researchers to develop very minutest size components to fulfill the demand. The manufacturing of these type of components is a difficult obligation and for that various machining methods are develop to manufacture such components. In this article the Electro Chemical machining and Electrical Discharge Machining is reviewed. We tried to summarize the work of various researchers. The study shows that this type of machining processes gives good alternative.

KEYWORDS: Electro Chemical Machining, Electrical Discharge Machining.

INTRODUCTION

The automotive, aerospace, electronics, optics, medical devices and communications industries always demand for the macro and micro components. Generally these components are made up of difficult-to–machine materials such as tool steel, carbides, super alloys and titanium alloys. The machining of these type of components need to develop new machining methods as the machining of these type of materials is not possible or economical with conventional methods. Two methods Electrical Discharge Machining (EDM) and Electrochemical Machining (ECM) offer a better nonconventional method for these materials. This paper presents a brief review of the state-of-the art research and developments in modeling, surface integrity, monitoring and control, tool material and tool wear and hybrid processes.

Sharifa S. et al .investigate the influence of Electrical Discharge Machining (EDM) input parameters on characteristics of EDM process. Stainless steel 3161 and copper imbued graphite which is used as electrode is considered for this study. The 2levels of full factorial method in design of experiments is used to carry out the test. In this study the Analysis of variance (ANOVA) and mathematical modeling were established for the process and material related parameters like material removal rate (MRR), electrode wear rate (EWR), surface roughness (SR) and dimensional accuracy (DA).The first order model is required to fit dimensional accuracy linear model. However, second order model are required to fit MRR,EWR and SR quadratic models respectively. The result shows that the peak current was the most significant factors to all variable responses. Based on confirmation run, all the results are less than 15% error, thus, indicating the model that were developed for MRR, SR, EWR and Dimensional Accuracy are reasonable accurate. The experimentation is performed on Sodick AM3L die sinking EDM machine. Copper imbued graphite (EDM-C3) was chosen as the electrode and stainless steel 316l as the workpiece material. The process parameters selected were peak current, servo voltage pulse ON-OFF time.

The depth of machining was set to 3mm and the machining time is recorded. The result of study shows that the peak current, pulse on time and pulse off time are significant factors. Whereas the servo voltage does not have significant effects to the machining. The authors made some recommendation to get better results as the depth of cut should set at least 5mm instead of 3mm prior, to get more specific data for electrode weight. Also Workpiece surface integrity such as recast layer, heat affected zone (HAZ), microstructure and micro cracks should be investigated also for better understanding of EDM phenomenon. The future scope of the study to investigate the parameters like jet flushing, dielectric fluid.

Das M.K. et al .carry out the investigation of conductive difficult to machine material like super alloys, Ti-alloys, alloy steel, tool steel, stainless steel, etc. The investigating parameters for this study are the material removal rate (MRR) and surface roughness

characteristic. Use of optimal ECM process parameters can significantly reduce the ECM operating, tooling, and maintenance cost and will produce components with higher accuracy. Milan Kumar Das et al. studies the effect and parametric optimization of process parameters in ECM of EN31 tool steel usin**g grey relation analysis. Experiments are conducted based on Taguchi's L27 orthogonal**
array (OA) with four process parameters like electrolyte concentration, voltage, feed rate and inter-electrode gap. ANOVA is performed to get the contribution of each parameter on the performance characteristics. Experiments are conducted on the METATECH (ECMAC) electrochemical machining equipment. Rectangular block of 20mm X 20mm and 25 mm height made of EN31 tool steel which is a high carbon alloy steel with high degree of hardness, compressive strength and abrasion resistance is chosen as work-piece. They conclude that lowest level of electrolyte concentration, mid-level of voltage, mid-level of feed rate and the lowest level of electrode gap gives the better results. ANOVA reveals that electrolyte concentration has the maximum influence on metal removal rate and surface roughness characteristics. Authors reported that the electrolyte concentration is the significant process parameter. The optimal combination is electrolyte concentration 10%, voltage 10 V, feed rate 0.25 mm/min and inter-electrode gap 0.2 mm for maximum MRR and minimum surface roughness.

Rajurkar K.P. et al. reviews the Electrochemical and electro-discharge machining processes. They stated that the EDM and ECM are the only alternatives for manufacturing the complex 3D shapes and micromachining. Authors studied both the processes briefly and commented about the advantages, the applications and the research related to the processes. They summaries the work by mentioning that ECM and EDM technologies have been successfully adapted to produce macro, micro components with complex features and high aspect ratios for biomedical and other applications. These processes are also being attempted at the nano-scale.

Cardoso P. et al. Reviewed the micromachining processes as the demand for minimized components with high aspect ratios and superior surfaces is more now a days. Generally these type of components are generated from metals, polymers, composites and ceramics. Authors particularly concentrate on micro milling. The most significant inputs in the micromachining process are related to the tools, machine tools and, not least importantly, machining parameters. Also the study related with micromachining are the minimum chip thickness and size effect, the cutting temperatures and cutting forces, which influence the tool wear and its failure, which, in turn, influence the burr formation and, consequently, surface quality is carried out.

Saravanan1D. et al. In this paper, authors try to find out the optimum machining parameters for machining Super Duplex Stainless Steel using ECMM. For this purpose Taguchi L18 orthogonal array is used to find the influencing machining parameters on Material Removal Rate (MRR).Authors reported that the duty cycle is the most significant parameter in deciding the MRR. More the duty cycle, more is the MRR. Authors concluded their work by identifying the duty cycle as the most significant process parameter. They also mentioned that the influence of electrolyte concentration, voltage and current also depends on the duty cycle.

SUMMARY

In this paper current developments in various aspects of electrochemical and electro-discharge machining is presented in this paper. ECM and EDM technologies have been successfully adapted to produce macro, micro components with complex features and high aspect ratios for biomedical and other applications. These processes are also being tried at the nano-scale.

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