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Materials Today: Proceedings 4 (2017) 1065–1073

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5th International Conference of Materials Processing and Characterization (ICMPC 2016)

Experimental studies on material removal rate, tool wear rate and surface properties of machined surface by powder mixed electric discharge machining.

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Abstract

Among the non-conventional machining processes, electric discharge machining is mostly used to manufacture dies of complicated shapes at nominal cost of manufacture. In this study, effects of various parameters such as workpiece material, dielectric fluids, powder and other machining parameters have been studied. Material removal rate increased with increasing the current input and powder mixing in electric and tool wear rate has been achieved significantly with powder mixing. X-ray diffraction has carried out to check the deposition of powder on surface after machining. Surface properties analyzed by SEM for cracks on the surfaces.

Selection and peer-review under responsibility of Conference Committee Members of 5th International Conference of Materials Processing and Characterization (ICMPC 2016).

Keywords: Electric discharge machining; tool wear rate; material remaoval rate; surface properties;

1. Introduction

Due to complexity of job profile with low manufacturing cost to achieve high surface finish is major problem of the industry. Even with development of latest manufacturing process small scale industries cannot afford the cost of manufacturing of the small dies.Production ofcomplex shapeswith better surface finish, precise tolerances and higher

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Selection and peer-review under responsibility of Conference Committee Members of 5th International Conference of Materials Processing and Characterization (ICMPC 2016).

production rates in such materials by traditional methods is even more difficult. For these difficulties of manufacturing, electric discharge machining is most popular method to manufacture the dies of very hard materials which are impossible or difficult to manufacture with conventional machining process.

Nomenclature

EDM	Electric discharge machining
Dof	Degree of freedom
MRR	Material removal rate
TWR	Tool wear rate
A	Workpiece material
B	Dielectric
C	Electrode material
D	Pulse off time
E	Pulse on time
F	Current
G	Powder
Gr	Graphite electrode
W-Cu	Tungsten-copper electrode

In electric discharge machining material form the conductive work piece removed by the spark generated between the tool and workpiece in dielectric fluid such as kerosene oil, transformer oil etc. Thesparkisinitiatedat thepointofsmallestinter-electrodegapby highvoltage,overcomingthestrength ofthe dielectricthusbreakingdown dielectric and erosion of metal takes place from electrode (tool) and workpiece. There are the number of the parameters which effect the tool wear rate, material removal rate and surface finish of electrode and of workpiece and these few parameter pulse on/off time polarity (positive or negative), pulse wave form, gap between the tool and workpiece, type of dielectric and flushing type. With advancements of technology several methods of modification of machined surface have been reported.[1] Among these methods powder mixed dielectric is one method to enhance the properties of machined surface. [2] Higher wear resistance can be achieved with powder mixed in dielectric. [3] Optimize machining rate has been achieved with mixing of silicon powder in the dielectric while machining. [4] Material removal rate increased with addition of aluminum powder in dielectric.[5] Material removal rate and tool wear rate increased with graphite powder mixed in kerosene oil [6]. Near mirror surface finish of the steel can be achieved in powder mixed EDM with maintain the inter-electrode gap and other parameters while machining[7]. While machining with EDM, material is transferred from electrode and powder to machining area [8, 9]. Powder mixed EDM have significant effects on the MRR and surface finish when powder has been mixed in different dielectric with different concentrations.[10]. In the machining of titanium alloy with EDM phase change of the machined surface and micro cracks has been observed. And formation of titanium carbide found with XRD analysis [11]. Various parameters i.e. pulse on, pulse off, current have great impact on material removal rate [12].

2. Experimental set up and procedure

In this study, High-carbon(HCHCr) Hot Die Steel (H13) and EN31 (composition given in table 1) and two electrode materials graphite (more than 99% purity) and Tungsten-Copper (79.36% W, 19.462% Cu, 0.121% Ni, 0.047% Z, 0.014% Ti)of diameter 20mmhas been used. Before the start of experimentation, the chemical composition of work piece and electrode material was measured on an Optical Emission Spectrometer DV-6.

The dimensionofeachworkpiece100×50×10mmhas been selected. Each work piece has been grinded on surface grinding machine to level the machining surface. Before and after the machining of work piece has shown in the fig.1. The experiments have been conducted on the electrical discharge machine available in the university lab. Various parameters such as polarity, machining time and open circuit voltage kept constant throughout the experimentation. To ensure that the suspended powder particles do not clog the filtering system special mild steel tank ofsize330×180×187 mmwasmadeof3mmthickmildsteelandhadcapacity of9liters. Schematic diagram of complete setup for the experimentations has shown in the fig.2.