

Experimental Findings of the EDM Process Parameters for Metal Matrix Composites

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Abstract

The process of electrical discharge machining (EDM) shapes hard metals and creates intricately formed, deep holes in a variety of electro-conductive materials by arc erosion. With regard to material removal rate (MRR) in metal matrix composite EDM, this study intends to examine the impacts of operational factors. The material removal rate generated is used to assess the efficacy of the metal matrix composite EDM process. It has been noted that the best metal to employ as the tool electrode in metal matrix composite EDM is copper. Trials on metal matrix composite are performed in this study to see how characteristics like current, voltage, and pulse on time effect on MRR.

Keywords: ANOVA analysis, EDM Parameters, Material Removal Rate

INTRODUCTION

An electrode tool and the component to be machined are repeatedly electrically discharged in the presence of a dielectric fluid using a non-traditional manufacturing technology. These discharges are produced at short intervals by electric pulse generators. Currently, all kinds of metal matrix composite, including metals, metallic alloys, graphite, and even some ceramic materials, may be highly precisely machined in industry using the EDM technology. In die-sinking electrical discharge machining (EDM) of conductive steel, one of the most crucial factors to consider is the appropriate selection of manufacturing circumstances, since these variables will affect such crucial characteristics: electrode wears (EW) and surface roughness.

The mathematical simulation of EDM using aluminum-silicon carbide particulate composites was presented [1]. The current (I), the pulse duration (T), and the percent volume fraction of SiC (25 μ size) were considered along with the influence of MRR, TWR, and SR with process parameters.[2] There were three levels in the entire factorial design. The ANOVA was used to determine the models' significance at the end. [3] Using the Taguchi technique, the machinability of the Al composite was

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investigated [4]. The feasibility and optimization of a rotary EDM with ball burnishing were investigated. Immediately after EDM, three ZrO₂ balls that are affixed as extra parts behind the electrode tool provide burnishing.[5] Copper ring-shaped EDM was used in the tool electrode design. The impact of the tungsten carbide EDM machining parameter on the machining characteristics was demonstrated [6]. Better machining performances were generally obtained with the electrode acting as the cathode and the work piece acting as the anode in the EDM process using tungsten carbide. [7] Tools with negative polarity provide better surface polish, less tool wear, and faster material removal. When assessing the impact of electrode rotation, electrode polarity, pulse length, and EDM current

on TWR, metal removal rate, and SR [8] also looked at the EDM of Al-SiC with 20–25 vol. % SiC, electrode polarity, and SiC volume present. They found that the MRR increased with increased discharge current and that specific current decreased with increased pulse duration. [9] Examined how, in recent years, EDM surfaces have been modified to increase wear and corrosion resistance using electrodes created using powder metallurgy techniques using unique powders.[10] Electrodes were produced in a hot mounting machine at 200 °C and 20 MPa of pressure. The machined surface had fewer cracks and the recast layer was thinner. [11]. When milling as-cast Al with 10% SiCp, the effects of the EDM current (C), pulse ON-time (P), and flushing pressure (F) were examined in terms of their evolution on MRR, TWR, taper (T), OC, and surface roughness (SR) [12]. They examined the impact of the EDM machining parameters (MRR, TWR, and SR) on the high-speed steel machining properties. Taguchi approach was utilized in experimental design. [13] Additionally, an analysis of variance and the F-test were used to establish the signal-to-noise ratios related to the experimentally obtained values. With peak current during the experiment, MRR rises. [14] Al–4Cu–6Si alloy–10 weight percent SiCP composites were used in their investigation of the MRR, TWR, and OC of EDM. The effects of current (c), pulse-on time (p), and air gap voltage (v) were investigated. [15] Using the ANOVA technique to determine the models' significance, it was discovered that the MRR, TWR, and OC increased considerably and non-linearly with an increase in current. In [16] When machining cemented tungsten carbide, an electrolytic copper electrode was used in the Electrical Discharge Energy experiment. [17]. In order to examine how electrical discharge energy affects machining characteristics like MRR, EWR, and surface roughness, the EDM machining parameters [18] showed how to use Al–Cu–Si–TiC composite, a tool electrode material created using powder metallurgy (P/M) technology, as work piece material made. [19]

The central composite second-order rotatable design was used to arrange the experiments, and RSM was used to create the experimental models. [20] Peak current, power supply voltage, pulse on time, and pulse off time were among the variables whose impacts were examined [21]. In this experiment, a mathematical method was used to determine the electrode wear (EW) and material removal rate (MRR). [22] After then, STATISTICA was used to compile and analyze the experiment's data. [23] To do this, the design of experiments (DOE) approach and ANOVA analysis were applied. [24] Research was done on the impact of duty factor, pulse on time, and intensity on machining characteristics such material removal rate, electrode wear, and surface roughness. [25]

LABORATORY TEST

Electric discharge machines, namely the die-sinking type Model ELECTRONICA-ELECTRAPULS PS 50ZNC with a constant gap servo head and positive polarity electrodes, are used during the entire experiment, as Figure 1 illustrates. Commercial quality EDM oil with a specific gravity of 0.763 and



Figure 1. PS 50ZNC die sinker EDM model [18].

a freezing point of 94°C is used as a dielectric fluid. In an experiment, the electrode is positively polarized. There are distinct phases to the application of the pulsed discharge current in positive mode. The experiments are carried out using an electrical discharge machine (EDM). This machine is a die-sinking type, ELECTRONICA-ELECTRAPULS PS 50ZNC model with a constant gap servo head.

FINDINGS AND DISCUSSION

Figure 2 illustrates that the value of the MRR of metal matrix composites increases with increasing current. The relationship between an increase in voltage and the MRR's growth is seen in Figure 3. In addition, Figure 4 illustrates the graph's conclusion, which indicates that an increase in pulse on time will cause an increase in MRR. The experimental results have been shown by graphs, as seen in Figures 2–4.

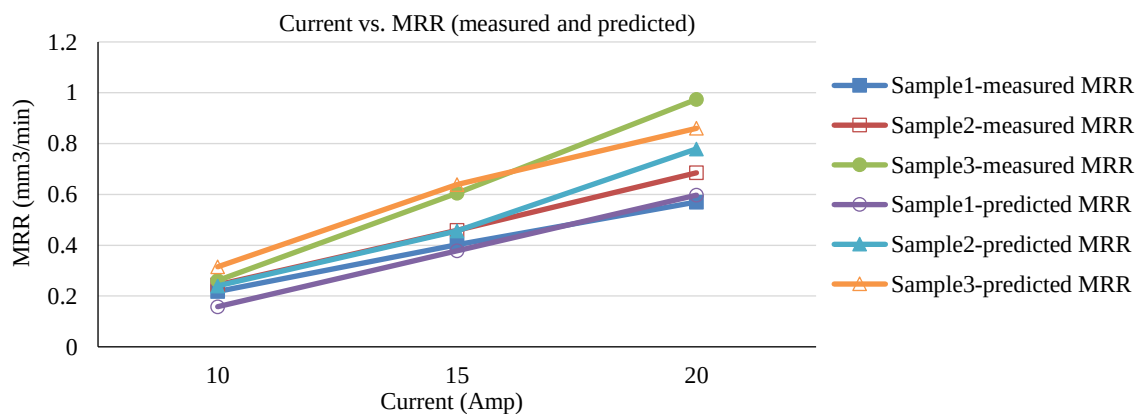


Figure 2. Impact of current on MRR.

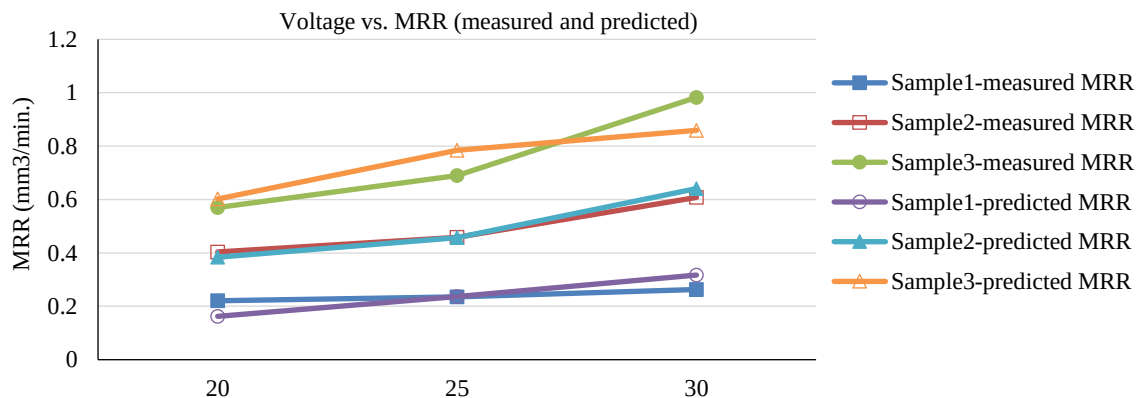


Figure 3. Impact of voltage on MRR.

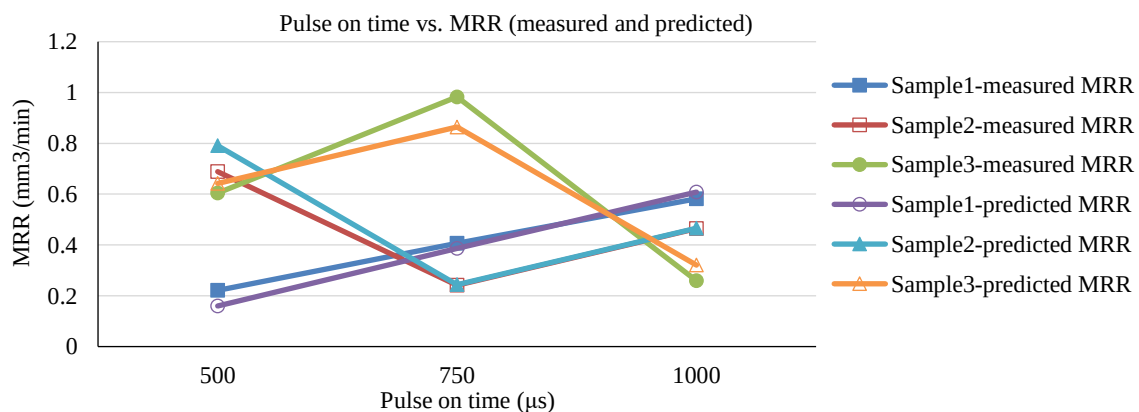


Figure 4. Impact of pulse on time on MRR.

CONCLUSION

The study has essentially succeeded in achieving its goal and produced a satisfactory result. The machining of metal matrix composite using a copper electrode is assessed in this experiment. The Taguchi method Design of Experiment (DOE) is a highly helpful tool for determining the ideal set of parameters, the primary effect, and the relative importance of each parameter to the rates of material removal. The current factor was shown to have the greatest influence on the rate of material removal, with voltage and pulse on time coming in second and third. High current and voltage values should be used in the metal matrix composite scenario in order to achieve a high material removal rate within the work interval taken into consideration in this investigation.

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