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Parametric Analysis of Electric Discharge Machining for Nanocomposites

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Abstract

Multiple reinforcements can be found in nanocomposites. When compared to single reinforced composites, it offers superior mechanical and tribological qualities. Because hard materials are challenging to work with using traditional machining techniques, non-traditional machining methods must be introduced. Independent of the qualities of the workpiece material, electric discharge machining (EDM) is widely recognized and used. The primary objectives of this work are to increase material removal rate (MRR) and to investigate the ideal combination of EDM parameters. The liquid stir casting technique is used to create the nanocomposites. The trails are taken on electrode using L27 orthogonal array. With the help of the Taguchi method, the study provides the ideal combination of machining parameters for recently created advanced materials used in nanocomposites. Confirmatory tests are used to validate the experimental data.

Keywords

Multiple reinforcements, Nanocomposites, Liquid stir casting technique, Electric discharge machining parameters

Introduction

Different reinforcements, including as silicon carbide (SiC), alumina, graphite (Gr), etc., can be added to nanocomposites to significantly improve their mechanical and tribological characteristics. By using unconventional machining techniques, particularly EDM, it can be decreased the efforts to cut hard materials such as nanocomposites, ceramics, etc. During the machining of composites, authors discovered the effects of control parameters on the machining characteristics [1-5]. The parametric combination of control factors was studied by the authors to increase MRR and reduce electrode wear [6]. The EDM of the Al-Mg2-Si composite was analysed by the authors using response surface methodology. They have found that machining settings have a significant impact on the profile and microstructure of machined surfaces [7]. The authors demonstrated that powder addition to EDM produced superior experimental outcomes than traditional EDM [8-10]. It was discovered by authors SiC's weight fraction increases have a detrimental effect on MRR while having a beneficial effect on TWR and surface roughness [11]. The author successfully machined an Al-SiC composite after analyzing the effects of the input parameters and obtaining superior outcomes to a stationary electrode [12]. In comparison to traditional heat treatment, the author demonstrated the effectiveness of microwave heat treatment [13]. To determine the ideal parametric combination of control elements, the author used Taguchi design of experiment methodology [14-17]. In contrast to taper city, radial overcut, and surface quality, the MRR increased with larger current and pulse on time settings [17-19]. The goal of the study is to analyse control variables affect and to affects the machining parameters of nanocomposites.

Methodology

Production of nanocomposites

The samples of nanocomposites with a weight of 70 - 90% alloy and a reinforcement of 5 - 15% SiC and 5% - 15% Gr are made using the liquid stir casting method. In a Gr crucible, the reinforcing elements are heated separately before being introduced to the molten metal matrix material. To create a homogeneous mixture, a mechanical stirrer is used.

Control and machining parameters

The control factors are considered, including a combined volume of SiC and Gr equal to %, current, and pulse duration with three levels of each: low, medium, and high. The MRR is used to evaluate the machining properties. The ratio of the weight difference between the material's prior and post-machining weights to the machining time is used to assess the MRRs.

Executing experiments

EDM, a non-traditional machining technique, is used to carry out the experimental trials. Copper, which has high mechanical and electrical qualities, is used to make electrodes. It is the best material for a tool used for machining nanocomposites. By using the Taguchi technique and the machining setup, the trials are carried out. The orthogonal array L27 is used to arrange the experimental trials, and the weights of the work piece and electrode are used for determining the MRRs. For better results, each experiment is conducted twice, and average values are used for analysis.

Results and Discussion

The effect of current, pulse on time and combined equal weight percentage of SiC and Gr on MRR of nanocomposites is seen in figures 1, figure 2, and figure 3.

The MRR of the composites is seen to grow linearly with increasing current value, as shown in figure 1. The higher spark discharge energy makes it easier for melting, evaporation, and the advancement of the strong impulsive force in the spark gap, which leads to an increase in MRR.

It can be seen in figure 2 how the MRR is affected by pulse and time. With a higher value of pulse on time, more metal is removed at a faster pace. Longer application of the same heating temperature results from an increase in pulse frequency. As a result, there will be more gas bubbles and an increase in the pace at which it evaporates.

Figure 3 demonstrates that when SiC and Gr are present in greater weight percentages, the MRR of nanocomposites appears to be high. As the weight proportion of SiC and Gr particles increases, the MRR also increases. It has been claimed that adding SiC to the metal matrix makes the alloy harder and more tensile.

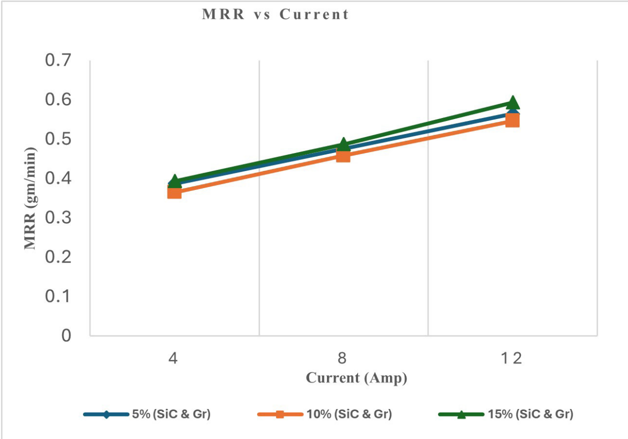

Figure 1: Relationship between current and MRR.

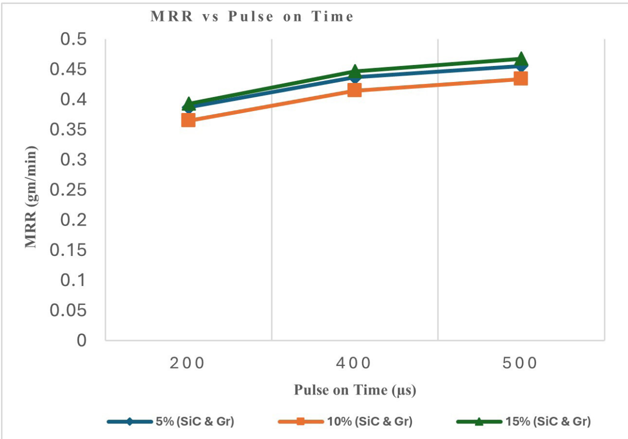

Figure 2: Relationship between pulse on time and MRR.

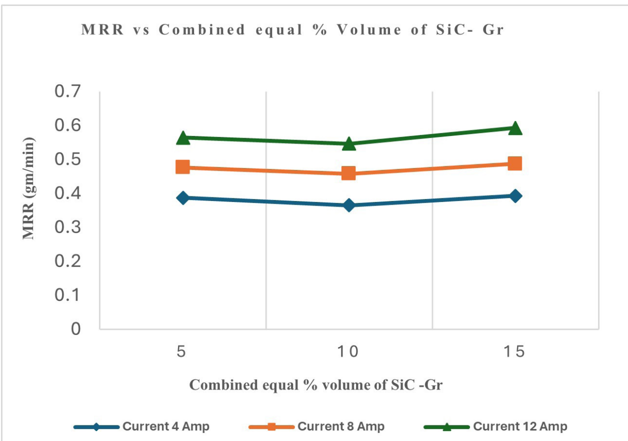

Figure 3: Relationship between combined equal percentage of SiC-Gr and MRR.

Conclusion

In comparison to other samples, the nano alloy reinforced with 15% weight SiC and 15% weight Gr sample exhibits higher MRR. Using the best settings for the control variables, such as current 12 A, pulse on time 500's, and combined equal% volume of SiC and Gr (15%), the maximum MRR may be achieved. High current levels cause increased thermal stress on the tool electrode and the work piece, which results in a high rate of metal loss. It has been noted that an increase in current causes a rise in the MRR. When the discharge stops, these gas bubbles erupt with a powerful blast that removes more molten metal from the system. As a result, it appears that the MRR is inversely related to the pulse on time. A lower MRR was therefore produced by a larger SiC weight %. In comparison to ceramic particles reinforcement, the composite of Gr particles removes material more quickly.

Acknowledgments

None.

Conflict of Interest

None.

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