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An Experimental Study of Process Parameters for Nanocomposites

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Abstract

In this investigation, nanocomposites combined with silicon carbide and graphite are made using casting method. T6 heat treatment is applied to nanocomposites to improve their mechanical properties. The material is machined using an electrical discharge method. To determine effectiveness of electrical discharge machining (EDM) method the material removal rate (MRR), tool wear rate (TWR), and surface roughness (SR) are all measured. It has been found that copper is the best material for EDM process. The L27 Taguchi technique is used to complete the experimental trails. The signal-to-noise (S/N) ratio is used to calculate the optimal machining parameters, such as MRR, TWR, and SR.

Keywords

Signal-to-noise ratio, Stir casting technique, Electrical discharge machining, Taguchi, Nanocomposites

Introduction

Improved metallic materials, composite materials, and advanced ceramic manufacturing have been found new advancements in the field of material science. These materials can't be easily processed using conventional methods because of their excellent mechanical, thermal, and electrical conductivity. The non-conventional machining techniques have been used to cut these advanced engineering materials. These materials are commonly utilized in the aircraft industry, defence, medical and all other relevant fields [1].

The impact of several machining parameters was evaluated for MRR and SR and the longer spark was found [2]. When cutting carbon composites, the process parameters should be set as efficiently as possible for the EDM, which results in a dramatic rise in MRR [3]. MRR, electrode wear ratio, and SR have all been affected, according to research on the effects of process factors and how they interact. This scientific information is useful for the aerospace or automotive sectors [4]. The surface analysis method used to study EDM of Al-Mg2-Si composite and significant impact on the profile and microstructure of the machined surface was discovered [5]. The PMEDM process has greatly increased the roughness, hardness, and corrosion resistance [6]. MRR, TWR, and SR are three features of EDM that can be quantitatively optimized [7]. The Al 10% SiC_p metal matrix composites were machined using a powder mixed electric discharge technique, which performed better than EDM [8].

Experimentation

Fabrication of nanocomposites

Stir casting is used to combine aluminum nanocomposites with equal parts silicon carbide and graphite. The graphite and silicon carbide are added to strengthen the material. In this procedure, AC2B alloy is first superheated over it smelting point then it is brought down to the liquids temperature and keep up the semi solid condition of the composite. The warmed graphite and silicon carbide particles are added to the slurry and mixed homogeneously. Afterward, it is mixed by mechanical stirrer. This strategy is created homogeneous nanocomposites. The material is subjected to T6 heat treatment in electric resistance furnace to acquire great mechanical properties (Figure 1).

Machining parameters and output responses

The machining parameters are the combined equal percent volume of silicon carbide and graphite, the current, and the pulse on time. The MRR, TWR, and SR are used to assess the machining process.

Conduct of experiment

Trials are conducted in this experiment using an EDM with a servo head. Dielectric fluid is industrial-grade EDM oil. The electrode used in the studies is positively polarized. The pulsed discharge current is applied in steps in positive mode.

Results and Discussion

It has been discovered that the MRR, TWR, and SR of nanocomposites are all directly proportional to current. If current is increased from 4 to 12 A, then MRR, TWR, and SR increase significantly. In nanocomposites, the pulse on time is inversely related to TWR but directly proportional to MRR and SR. TWR values drop as pulse on time increases; however, MRR and SR values increase. The optimal process parameter selection for optimum MRR, substantial surface roughness, and TWR is based on the S/N ratio. According to experiment no. 15, it has a greater S/N ratio for MRR as compared to other characteristics (Figure 2 and table 1).

Figure 1: Set up of stir casting process.

Conclusion

The examination has been achieved the desired outcome. This investigation looks at the effectiveness of aluminum nanocomposites with a positive polarity tool. The methodology is useful in carrying out the experiments. To maximize MRR, reduce SR, and reduce TWR, the S/N ratio has been successfully employed to analyze the best possible condition of parameters.

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Conflict of Interest

None.

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Figure 2: Die sinker EDM model: PS 50ZNC.

Table 1: Experimental outcomes.

Exp. No.	Factor A	Factor B	Factor C	MRR (S/N)	SR (S/N)	TWR (S/N)
1	1	1	1	-8.24578	-11.777	28.1787
2	1	1	2	-7.19037	-12.77	30.1728
3	1	1	3	-6.8207	-13.236	31.3727
4	1	2	1	-6.44786	-13.006	27.7443
5	1	2	2	-5.64659	-13.875	29.6297
6	1	2	3	-5.304	-14.27	30.752
7	1	3	1	-4.97442	-14.083	26.9357
8	1	3	2	-4.27918	-14.696	28.8739
9	1	3	3	-3.98566	-15.208	29.897
10	2	1	1	-8.75414	-12.298	27.535
11	2	1	2	-7.63904	-13.122	29.3704
12	2	1	3	-7.25021	-13.516	30.4576
13	2	2	1	-6.78269	-13.312	27.1309
14	2	2	2	-5.91699	-14.168	28.8739
15	2	2	3	-5.61337	-14.518	29.897
16	2	3	1	-5.25615	-14.436	26.3752
17	2	3	2	-4.52427	-15.133	28.1787
18	2	3	3	-4.20839	-15.446	29.1186
19	3	1	1	-8.11215	-11.411	28.636
20	3	1	2	-6.99385	-12.486	30.752
21	3	1	3	-6.59508	-12.928	32.0412
22	3	2	1	-6.24942	-12.75	28.1787
23	3	2	2	-5.40051	-13.786	30.1728
24	3	2	3	-5.02074	-14.083	31.3727
25	3	3	1	-4.53891	-13.945	27.3306
26	3	3	2	-3.80881	-14.567	29.3704
27	3	3	3	-3.50447	-15.072	30.4576

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