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Investigation on the response parameters in electric discharge machining of developed aluminium metal matrix composites

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Abstract

The present research work shows the influence on process parameters of electric discharge machining in newly developed aluminium composites. The Molybdenum Disulphide (MoS2) particulate was added in various proportions of 2%, 4% and 6% on mass fraction and also added Tungsten carbide particulates at 3%, 6% and 9%.The prepared samples were fabricated through stir casting technique. On the response parameter of MRR, Machining timing, and surface roughness, pulse on time, pulse off time, and gap voltage (Ra). According to the findings of the experiments, the best surface finish and machining time was achieved by using a moderate level pulse on time, a higher level pulse off time, and a smaller gap voltage. MRR was achieved by using a relatively low level pulse on time, maximum pulse off time and a medium voltage.

Introduction

Recent manufacturing industries have demonstrated the progressive rise in material strength with year-by-year by developing advanced materials in the aircraft and automobile industry. This industrial revolution is concentrated on the usage of new techniques and new types of energy, as its been in the past. As a result, novel production techniques for material removal, shaping, and connecting, known as non-traditional manufacturing procedures, have been introduced. Rajneesh kumar et al., were the targeted responses are maximum MMR and minimum surface roughness, according to the research. Pulse on time, pulse off time, strain, and flushing rate are all regarded process control factors. Using Response Surface Methodology, experiments are performed and numerical simulations linking the intended responses and parameter estimates are developed in this research work [1]. Satyanarayana et al. investigated the best set of input parameters for EDM in Mild Steel IS 2026 utilising copper electrode, including current, pulse ON and OFF time. GRA, a Taguchi approach, was used to analyse the results of the trials on the L9 orthogonal array for the matrix. The observed results demonstrate that Taguchi GRA is a useful technique for optimising EDM machining parameters [2]. Cao Fenghong investigated an experimental work on Al6061/SiC/WC, the composites was fabricated through stir casting process and the mechanical properties of developed composites were analyzed.Due to the presence of tungsten carbide and SiC the tensile and hardness increases with increase in hard particulates present in matrix [3]. Ajith et al studied the effect of different weight percentage and particle size of silicon carbide particulates.SiC particles were taken as 10,20 40 μm and the weight fraction is 5%,10% and 15. The molybdenum disulphide is fixed as 2%.The influence of MoS2 on SiC plays an effective role on improving the tribological aspects in aluminium composites [4]. The use of fuzzy logic in the Taguchi method to optimize Electro Discharge Machining (EDM) process with multiple quality characteristics. Rough machining with EDM gives poor surface finish and has micro cracks and pores. Finish machining gives better surface finish but with very poor machining speed (MRR). Taguchi method has become a powerful tool in the design of experiments as it improves performance characteristics by optimizing the process [4]. Response surface methodology (RSM) was employed by P.B Wagh to explore the effect of four adjustable input parameters on surface roughness: discharge current, pulse repetition, pulse off time, and gap voltage. RSM is used to model the reaction based on experimental data. ANOVA at the 95% confidence level yielded the factors that affect the quality. The discharge current and pulse duration are determined to be important determinants [5].

Wire EDM was used to analyse S.S.304, and the cutting tools was copper and brass at varied levels of quality. As the electrolyte, DEF-92 was used. With the use of ANOVA,

the studies yielded the best MRR, TWR and surface finish values. The findings are discussed at the conclusion the pulse on time is the most influencing parameter as discussed through ANOVA results [6]. The WC substance composite is exceedingly rigid and tough to process. Industries use hexagonal structural materials for a variety of applications, including industrial components, abrasives, and cutting tools, among others. The L9 Taguchi design of trials has indeed been developed for hybrid drilling on tungsten carbide (WC) with the influence of spark erosion oil in the current study (SEO-25). Material removal rate (MRR), tool wear rate (TWR), and surface roughness are all metrics to look into (Ra). By using the essential combination of inputs such as MMR (0.0710g/min), EWR (0.0138g/min), and Ra (2.6343mm), Taguchi-based projected optimum results were (a) MMR (0.0710g/min), (b) EWR (0.0138g/min). Few researchers found that tagughi based optimization techniques are the best solution to find the optimum machining parameters [7], [8], [9].

Section snippets

Experimental setup

Al 6262 has chosen as a base material with good material properties high corrosion resistance and superior welding properties [10]. MoS2 is chosen as a reinforcement due to its self lubrication properties. The chemical composition of the base material is shown below in Table 1. The composition of the selected mixtures of base materials are Sample A: 95%AL6262 – 2%MoS2 – 3% WC,Sample B: 90%AL6262 – 4%MoS2 – 6% WC, Sample C: 85%AL6262 – 6% MoS2. – 9% WC, The hybrid composite of

Result and discussion

Fig. 2 shows the main effect plot for surface roughness and Table 4 shows the ANOVA results for surface roughness.The gap current or voltage is the major contribution for surface roughness when the voltage is at maximum condition the roughness is very increases [12]. The second influencing parameter which affect surface roughness is pulse on time. At 8µs Pulse on time the roughness value is minimum.Pulse off time is

the least influencing parameter which affects surface roughness.Pulse off time

Conclusion

The aim of the research work was to investigate the machinability of hybrid aluminum metal matrix composite using electric discharge machining. In this study three process parameters are varied viz. Pulse on time, Pulse off time and gap voltage influence on the responses MRR, Machining timing and Ra.The optimum combination for machining Al/WC/MoS2 is 10µs Pulse on time, 6µs and 12 amps gap current shows minimum surface roughness. At 12µs Pulse on time, 8µs and 14 amps gap current shows

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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