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Performance Investigation of Powder Mixed Electro Discharge Machining of Hypoeutectic Al-Si Alloy Using Brass Electrode

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ABSTRACT

The aim of this study is the multi- objective optimization of process parameters of Al- Si alloy in powder mixed electrical discharge machining for obtaining minimum surface roughness, minimum tool wear rate, and maximum material removal rate. The important machining parameters were selected as discharge current, voltage and pulse-on time. Experiments were conducted by selecting different operating levels for the three parameters according to Taguchi's Design of Experiments. The multi-objective optimization was performed using Grey Relation Analysis to determine the optimal solution. The Grey Relation Grade values were then analysed using analysis of variance to determine the most contributing input parameter. On analysis it was found that peak current, pulse-on time, and voltage had an influence of 94.73%, 3.32% and 0.36%, respectively, on the multi-performance characteristics.

KEYWORDS

Analysis Of Variance, Grey Relational Analysis, Multi-Objective Optimization, Powder Mixed Electrical Discharge Machining

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1. INTRODUCTION

In the conventional methods of machining, the basic principle of metal removing is the use of tool which is harder than workpiece material and material is removed by the compression shear chip formation. On the other hand, in advanced machining methods, there is not any direct contact between the workpiece and the tool and thus harder tool than workpiece is not needed.

EDM is a non-conventional machining process being largely used in tool and die making, aerospace, automobile and surgical instruments. EDM process utilizes thermal energy for machining all electrically conductive and high temperature high strength materials. In this process the material is removed from the workpiece due to erosion rapidly recurring spark discharge taking place between the workpiece and tool (Ojha et al., 2014).

PMEDM is a recent innovation in the EDM sector having more complex mechanism than conventional EDM (Talla et al., 2014). The powder fills up the spark gap between two electrodes under the influence of high electrical potential. Due to applied potential, these powder particles get energized and act as conductors which form chains in the sparking gap. This bridging of spark gap causes the reduction in the insulating strength of dielectric fluid and increases the gap size between tool electrode and workpiece. Due to easy short circuiting and hence more frequency of discharging, the material removal rate increases. The powder particles which are added into the dielectric also change the shape of channel carrying the discharge energy. The enlarging and widening of the discharge channel carry a more uniform discharge energy among the powder particles. This produces large number of small and shallow craters and reduces the surface roughness (Talla et al., 2014).

In the past a lot of work has been carried out to investigate the effect of EDM and PMEDM process parameters on the various response characteristics. Murugesan and Balamurugan (2012) determined an optimal EDM parameter settings for drilling a blind- hole in Al-15% SiC MMC by using a multi-hole electrode. Pulse on time, pulse off time, discharge current and dielectric pressure were optimized with consideration of multi-response characteristics, viz. electrode wear, machining time and surface roughness. From the experimental results it was cleared that the optimal machining conditions were negative electrode polarity, discharge current 4 amps, pulse on time 400 μs, pulse off time 10 μs and dielectric pressure 0.5 $kg.cm^{-2}$. Under these machining conditions electrode wear rate, machining time and surface roughness were found to be 9 $mg.min^{-1}$, 8.64 min and 4.78 μm, respectively. Pradhan (2012) evaluated and estimated the effect of machining parameters on the responses by proposing a new combination of response surface methodology (RSM) and grey relational analysis coupled with principal component analysis (PCA). He selected material removal, tool wear rate and radial overcut as response variables and pulse current (Ip), pulse duration (Ton), duty cycle (Tau) and discharge voltage (V) as input parameters. He has determined the optimal parameter setting by using the grey relational grades. The results revealed that Taguchi was the most influencing parameter having 28.57 of