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Electrical Discharge Machining Characteristics of ECAP Copper Electrode

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Abstract. Enormous research work has done on the electrode wear in spark erosion machining such as hybrid electrical discharge machining process, introducing various methods such as ultrasonic vibration in electrode, rotating the electrode, developing new electrode material (alloys and composites) and surface coated electrode etc,. Equal Channel Angular pressing is one such technique which makes tool material harder through grain refinement and ultimately enhances the tool life. The work material is AISI H13. For this research work, two copper electrodes are prepared, out of which one copper electrode has undergone equal channel angular pressing process. The most influencing parameters of spark machining like current, pulse on time and pulses off time are chosen for this study. The experiments are conducted using bare copper electrode and equal channel angular pressed copper electrode based on the box Behnken approach. The observations are analyzed for the machining characteristics in terms of rate of machining, rate of tool erosion and surface coarseness. Finally, it is found that ECAP processed copper electrode has lesser wear rate and better surface finish than bare copper electrode.

Introduction

The past research papers explored the techniques to improve the machining characteristics of electrical discharge machining (EDM). Cherng Lin et al. integrated the mechanisms of EDM and ultrasonic machining to improve the efficiency of machining. They have found that the performance of EDM/USM is higher than conventional EDM in terms of rate of machining (ROM), rate of tool erosion (RTE) and surface coarseness (SC) with distilled water [1]. Lin Gu et al. compared the performance of EDM process using solid electrode and bundled electrode with multi hole. They have concluded that the bundled electrode shows higher ROM with lesser tool wear as it can endure high peak current. Also, they have found that the flow velocity of fluid is increased from centre to outer radially [2]. Sony and chakraverti, has tried to improve the machining performance by giving the orbital motion to the electrode. They have concluded that rate of machining is increased significantly at constant wear ratio with the rotating electrode [3]. Ghoreishi and Atkinson has combined the rotation and vibration to the electrode. They have developed a model through stepwise linear integration and found significant variables. The combination of high frequency vibration and electrode rotation brings high rate of machining with specified roughness [4]. Xu et al. have proposed ultrasonic vibration assisted EDM in a gas medium in machining cemented carbide, also proposed metal removing mechanisms such as melting and evaporation, oxidation and decomposition, spalling, the force of high pressure gas and the affection of ultrasonic vibration [5]. Samuel and philip has analyzed the powder metallurgy electrodes. It is limited to certain machining conditions as it deposits the powder on the work instead of machining [6].Thangadurai and asha has used the copper electrode to machine aluminum boron carbide composite. They have designed the experiment based