A STUDY ON DRY ELECTRICAL DISCHARGE MACHINING

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Abstract

The dry Electrical discharge machining is one of the new developed methods in material removal mechanism. It replaces liquid dielectric by the gaseous one. This helps to reduce the health issues and the environmental pollution. This paper reviews about the performance measures of the dry electrical discharge machining.

***Keywords—** Dry EDM, Air Dielectric, EDM*

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1. INTRODUCTION

Dry electrical discharge machining (Dry EDM) plays major role in the manufacturing industries due to its environmental friendly nature. The hydro carbon oil in the conventional EDM decomposed and gives rise to fumes which produces health hazards. In dry EDM, it replaces liquid dielectric medium (hydro carbon oil) by the gaseous dielectric medium. The gases mostly used are oxygen, nitrogen etc. The material removal rate has also been increased when compared to liquid dielectric medium of die sinking EDM.

1.1 Mechanism

In dry EDM, thin walled pipe has been used as an electrode material. A high velocity air or gas has been entered in to the tool electrode pipe and strike the workpiece through the discharge gap. When small voltage is applied to the electrode gap, high strength electric field has been set up which ionizes the air dielectric present between the electrodes. Strong heat has been generated between the tool and workpiece which causes the breakdown of air [2]. During the breakdown of air, plasma channel has been formed between the electrodes and a high discharge of about 10000° C has been taken place at a least resistance point. This causes both the tool and workpiece melts and forms a crater.

The lower dielectric constant of air media enhances the plasma formation. This unlimited plasma enhancement leads to the poor process stability [20]. The tool rotation enhances not only the flushing of material and also promotes the stability of EDM by reducing the arcing between the tool and workpiece. The compressed air has been dried before entered in to the tool electrode to remove the water vapour present in the air to enhance the machining characteristics.

1.2 Functions of High Velocity Air

The high speed air, flows between the gap, prevents the adherent of removed materials from the tool and workpiece and thus removing debris faster and efficient. This high speed air not only facilitates the fastest debris removal from the gap but also reduces the excessive heating of electrodes. This faster material removal could not be reached by the conventional EDM. The compressed air in the gap also helps to blow of the plasma created by the previous discharge and thus ensuring the quick recovery of the dielectric strength of the air gap.

1.3 Advantages of Dry EDM

The dry EDM achieves zero tool wear and no corrosion of workpiece [13], lower residual stress, and narrow discharge gap length [12].

1.4 Disadvantages of Dry EDM

A thin recast layer has been produced on the workpiecec surface which causes poor surface roughness. Lower productivity is the major disadvantages of dry EDM [10].

2. LITERATURE STUDY

The first dry EDM effort is made on 1985 using inert gas to drill small holes. They have used helium and argon gases as a dielectric medium. Later on Kunieda et al. [16] started research on EDM by using oxygen as a dielectric medium and they have found that the dry EDM is environmental friendly and it increases the material removal rate than conventional EDM. After that they have used compressed air with tubular electrode [12]. They have developed 3D milling of Dry EDM and tried the best combination of tool and workpiece with air as dielectric medium [13]. After that many researchers made researches on dry EDM to improve the performance. Some authors attempted near dry EDM process [14], [15] where air and liquid were mixed.

ZhanBo et al. [17] researched on machining of difficult to cut materials by using dry EDM. They have used cemented carbide for machining on dry EDM. Few researchers have incorporated ultrasonic vibration and magnetic fields in dry EDM. Govindan et al. [18] analysed the micro cracks on the machined surface in dry EDM and also studied the material removal phenomena in magnetic field assisted dry EDM [19]. Murican et al. [5] conducted the experiments on SS316L by considering discharge current, pulse on time and spindle speed of the system. They have achieved the maximum MRR of 9.94 mm3/m. Joshi et al. [20] examined the machining characteristics of dry EDM in pulsating magnetic field. They have achieved 130 % improvement in the productivity. They have stated that the magnetic field helps to improve the material removal rate as a result of higher transfer of thermal energy due to higher ionization.

Due to the miniaturization of parts, the dry micro EDM plays a major role in the machining of micro parts and miniature holes. Kanmani et al. [21] characterized the plasma of the dry micro electric discharge machining by optical emission spectroscopy. They have analyzed the various parameters of the EDM plasma on machining characteristics. They also have analyzed the crater produced by the dry micro EDM at different energy levels. They have noted that the plasma achieved is idle in dry micro EDM. The material removal rate of dry wire EDM (DEDM) has been a lowest one. Yoshida et al. [22] developed the gap control mechanism by using piezo electric actuator for dry EDM. Therefore the material removal rate of dry die sinking EDM has been improved to that of conventional die sinking EDM [26]. Dry wire EDM (WEDM) has been an added advantage of WEDM. As there is no dielectric liquid between the electrodes, the discharge column expands and spreads the diameter results in shallower discharge crater leading to an improved surface roughness [24].The surface roughness of dry WEDM has been better than that of conventional WEDM. Kunieda et al. [23] carried out his research in dry EDM for milling operation. They have achieved higher material removal rate than conventional EDM by increasing the concentration of oxygen in the gas jet and obtained even high MRR by using pure oxygen.

Uhlmann et al [1] carried their research by comparing the process of micro holes in Si3N4-TiN in dry EDM and conventional EDM. They have used oxygen and organ gases in dry EDM. They have found that the dry EDM has higher pulse frequency and shorter relative motions between the electrodes than conventional EDM. Jahan et al [2] studied the ability of dry nano Electro machining for the fabrication of arrays of nano-holes. To achieve better material removal rate and good surface finish simultaneously, Deshmukh et al. [4] tried out the optimization of the near dry electrical discharge machining. Masahiro Fujiki [25] tried to achieve high material removal rate on SS316l in the near dry EDM using tubular electrode with lead angle. Liqing et al. [6] exercised a new technique by using oxygen-mixed EDM with cryogenically cooled workpiece. They have obtained the increased MRR and decreased surface roughness by using this new technique.

Shen et al. [8] used the mist dielectric to the machining process of EDM. They have used deionized water in the high speed air to form a mist. This near dry EDM improves the cooling and flushing capacity of the dielectric system. They have also studied the effect of air pressure, current, droplet size and droplet density on the material removal rate and surface roughness. They have realized that, greater material removal rate, lesser surface roughness and thinner overcut width have been achieved by this high speed near dry EDM.

Huang et al. [9] investigated the surface properties of $Ti_{50}Ni_{50}$ and$Ti_{50}Ni_{49.5}Cr_{0.5}$ SMAs in dry EDM. They have used nitrogen gas as a dielectric. The material removal rate, electrode wear rate and surface roughness of $Ti_{50}Ni_{49.5}Cr_{0.5}$ have been lowered when compared to $Ti_{50}Ni_{50}$.

Skrabalak and Kozak [10] derived the mathematical model for the profile of the machined surface in dry EDM. They have applied compressed air as a dielectric and used single hole and two channel copper electrodes and compared the results of material removal and tool wear rate. Better results have been achieved in the case of dry EDM when compared to that EDM in kerosene. Jahan et al [7] developed a nano scale dry electro machining. They have analyzed the mechanism, possibility of machining. The erosion phenomena of dry the EDM under different breakdown mechanism has been explained by Macedo et al. [3].

Wang et al. [11] developed a new technology that uses gas as dielectric medium in wire EDM. They have studied the discharging mechanism of single pulse in dry wire EDM. The crater generated in the dry WEDM has wider diameter and lesser in depth when compared to that of kerosene dielectric EDM.

3. CONCLUSION

The various views on dry EDM have been learned. A comparative study on the conventional EDM and dry EDM has been made. The effect of process parameters on dry EDM has been analyzed.

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