A review on die sink EDM process

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June 20, 2018

Abstract

Electrical discharge machining (EDM) process is nontraditional machining process used for manufacturing of geometrically complex and hard material parts which are difficult to manufacture by another conventional machining processes, widely used in aerospace industries, nuclear industries, mold making industries etc. In this process electrical energy is used to generate electrical spark between electrode and work piece and the material removal take place due to thermal energy of the electrical spark. EDM researchers have discovered a number of ways to optimize and improve the sparking efficiency, MRR and other parameters with various experimental phenomenon. This paper reviews research work carried out in past decades for the development of EDM.

Key Words: Electrical discharge machining, MRR, dielectric, machining characteristics.
1 INTRODUCTION

The EDM method establish in 1770 when the erosive effects of the electric discharges (sparks) were being studied by an English Scientist Joseph Priestly. Since then the developments started in the EDM process and for the first time in the year 1930, electric discharges were used to machine metals and diamonds, this method was then called as the spark machining or arc machining [1]. Electrical Discharge Machining (EDM) is an advanced manufacturing machining process, where electrically conductive material is removed by controlled erosion through a series of electric sparks of short duration and high current density between the electrode and the workpiece, were both workpiece and electrode are submerged in a dielectric bath. During this process thousands of sparks are generated and each spark produces a tiny crater in the material along the cutting path by melting and vaporization [2]. Generally the material is removed by erosion process. The application of this process is in press tools and dies, plastic moulds, forging dies, die castings, aerospace, automotive, surgical components, manufacturing industries etc. This process is not restricted by the physical and metallurgical properties of the work material as there is no physical contact between the tool and the workpiece. Electrical discharge machining, some times also referred to as spark machining, spark eroding, die sinking, is a manufacturing process where a desired shape is obtained using electrical sparks [3]. The main advantage of this process is that very hard conductive materials can be machined into desired complex shape and size without contact between workpiece and electrode.

2 WORKING PRINCIPAL

The EDM system consist of two type of electrode i.e. one is anode (workpiece) and another is cathode (tool) and other components like pump, filter, reservoir, power supply, servo system etc. as shown in fig.1. This process carried out within the dielectric fluid which creates a path for discharge. The principle of EDM is the electrical spark generated between the workpiece and the electrode by using electrical energy in dielectric fluid causes material removed from workpiece due to thermal energy of spark. If the
polarity of workpiece and electrode are changes it affects the per-
formance parameters of EDM process. The dielectric flushes away
the material from the melt cavity when the tool electrode moves
up during the on-time. The tool or electrode used in this process is
made of materials like copper, brass, graphite etc because this ma-
terials having properties like high MRR, easy machine ability, good
conductor of electricity. The aim is to remove the material from
the work piece by optimum utilization of the machining parameters
to get the required shape with quality surface.

3 Literature Survey

Mohammadreza Shabgard and Behnam Khosrozadeh investigated
the machining characteristics of Ti-6Al-4V alloy with oil flux with-
out additive and oil flux with MWCNT powder as the dielectrics.
They found that by adding CNT powder in dielectric, MRR is
reduce; but in long pulse duration with low current, MRR is in-
creased. Addition of the CNT particles into dielectric decreases the
length and size of cracks on the surface.

Luo found that the small erosion area machining is one of the
most problematic forms of EDM & the quality of an EDM product is
evaluated in terms of surface integrity. The effective erosion area is
large, the surface erosion rate is increased by maintaining sufficient actual off time.

Sanjay Agarwal and Syed Rizvi investigated the surface integrity of AISI 4340 steel by using copper tungsten electrode. They found that the value of MRR and SR increase for higher value of pulse current. The cracks always appear in the machined surface. Increasing the pulse current and shortening the pulse-on duration is effective reducing the surface cracks.

Gurpreet Singh and Kamaljit Singh investigated the MRR, TWR and surface properties on EN 31 and high carbon hot die steel by using powder mix dielectric. They found that increase in the input current, crater size on machined surface has been increased. The uniform particle distribution and less micro cracks on the surface has been observed when surface machined with copper powder in dielectric fluid.

Karthikeyan et. al has presented the mathematical molding of EDM with aluminum-silicon carbide particulate composites. Mathematical equation is \( Y = f(V, I, T) \) and the effect of MRR, SR with Process parameters taken in to consideration were the current (I), the pulse duration (T) and the percent volume fraction of SiC.

Lim et al. has reported that only 15% of the molten work piece material is flushed away by the dielectric. The remaining material is resolidifies on the EDM surface due to the fast cooling rate generated by the dielectric.

Chandramouli S. and Eswaraiah K. perform a experiment on 17-4 precipitation hardening stainless steel (PH steel) by using copper tungsten electrode. They uses the ANOVA method with the help of MINITAB 17 software for analysis the influence of input parameters on output parameters. From the experimentation & ANOVA results found that pulse on time has highest percentage contribution for MRR (58.37%) and SR (76.7% ).

Alberto A. Raslan, Wisley F. Sales and Ernane R. Silva investigated the use of electrical discharge generated from EDM using deionized water mixed with urea as dielectric fluid found that surface hardening of AISI 4140 steel samples. The XRD methodology uses for finding residual stresses in material. Presence of nitride was detected in the hardened region. The average thickness of nitride layer was 23 micrometer.

Raju Bhosle and S. B. Sharma optimized the process parameter
in micro EDM drilling of Inconel 600 alloy by using grey relational analysis. Optimum material removal rate, overcut and diametral variation were obtained for 175V, 1000 pF capacitance and 20m/s EDM feed rate.

Y. H. Guu, H. Hocheng, C.Y. Chou and C.S. Deng had investigated the surface characteristics and machining damage caused by EDM on AISI D2 tool steel. The X-ray diffraction technique & electron microscope were used for finding residual stresses and re-solidified layer thickness on tool steel. By experimentation they found that increase in pulse current and pulse on duration, recast layer thickness also increases. Increased in peak current there is an increased in melting of material causes severe damage in the surface and subsurface area.

Binayaka Nahak & Meghanshu Vashista proposed the assessment of surface integrity of die steel on EDM by using barkhausen noise (BN) parameters. The experiment was conducted in die sinking mode using copper electrode. By experimentation they observed that MRR, TW & SR increases with all process parameters. RMS and peak value of BN signal increases with decrease in EDM process parameters.

Y. Guo & Z. Ling introduced the structure & principle of the magnetic suspension spindle device used for micro EDM. Using incremental PID algorithm, the axial response frequency reaches 150 Hz, the radial and axial position accuracy is achieved with 5 m & 2 m which is more than the traditional mechanical transmission.

Samesh Habib & Akira Okada had experimental study of EDM machining characteristics & removal mechanism for one and two directional CFRP composites. In this CFRP composite was machined by using EDM with different condition. The MRR of two directional CFRP is higher than the one directional CFRP. The MRR and SR in EDM for one directional CFRP when the machining direction is perpendicular to fiber direction is different from in parallel machining.

4 Conclusion

EDM has brought many improvements in machining process in recent years. The potential of machining complex parts and hard
material has made EDM as one of the most accepted machining processes. From the above research shows that pulse on time, pulse off time and current have important effect on MRR, SR & TWR. The selection of proper input parameters will play a significant role in EDM.

References


