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Research paper

Influence of Power Additives in Liquid and Gaseous Dielectric Fluids on Electrical Discharge Machining with Aerospace Sector Applications-a Review

Lalit Yadav[1], Abhishek Sharma[2*], Yashvir Singh[3], Nishant Kumar Singh[4], V.R. Mishra[5], S. P. Dwivedi[6]

[1,3]Department of Mechanical Engineering, Sir Padampat Singhania University, Udaipur, Rajasthan, INDIA
[4]Department of Mechanical Engineering, Hindustan College of Science and Technology, Mathura, UP, INDIA
[2,5,6]G. L. Bajaj Institute of Technology & Management, INDIA
**Corresponding author E-mail: absk2001@gmail.com*

Abstract

In nonconventional material removal process power mixed electrical discharge machining (PMEDM) the recent trend for the enhancement of machining physiognomies such as Material Removal Rate (MRR), Surface Roughness (SR) and Tool Wear Ratio (TWR) when the commercial power additives in liquid and gaseous dielectric fluids are used in process. Through electrolysis created the pre-breakdown phase in water is categorised by the formation of many small hydrogen bubbles. In a gaseous medium, the buntings circulate more easily and then these bubbles can enable the breaking process. In oil, no bubbles are observed. So, in the gap of electrodes and workpiece some particles boosted due to the break process in oil

Keywords: *PMEDM; dielectric fluid; thermal erosion; Material Removal Rate; Surface Roughness; Tool Wear Ratio.*

1. Introduction

In Manufacturing industries EDM is enormous used in many application for precise material and wear out the materials from surface of workpiece by using thermal energy through generating a spark between electrode and workpiece , such as tool preparing ,automotive, aero-space and many other fields because of its machinability of conductive material, and also its strengthen properties, it also suitable for new engineering materials (composite) and ceramics which having excellent mechanical properties. But on other hand machining rate is slow and surface finishing is poor, therefore its restricted in some of industries. The recent advancement in EDM process for greater machining rate and good surface finish is PMEDM in which select the appropriate powder particles for dielectric for better result.

2. Principle of EDM

In EDM controlled the electric spark exonerations on the electrodes through the eroding effect. This is a thermal erosion process. The sparks are generated in the presence of dielectric liquid, mostly water or oil, between the workpiece and an electrode (cutting tool) and during the entire process no contact between the electrodes. As workpiece and cutting tool are electrically conductive then erosion is produced by electrical discharges, [1] When voltage discharge arises in the gap between the electrode and workpiece, and then vaporisation of heat with small quantity of the metal, which are eroded by constant stream of dielectric liquid . During EDM processing the temperature reach upto or more than 12000 °Celsius.

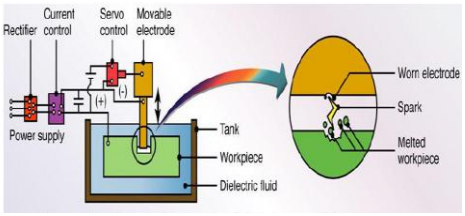

Figure 1: Principle of EDM.

The produced plentiful of hydrogen bubbles through pre- breakdown phase in water is characterized by electrolysis. If streamers proliferate more easily in a gaseous medium, these bubbles may collapse the procedure. In oil medium, no bubbles are detected [2].

3. Types of EDM

(i) Die sinking EDM or Sinker EDM or cavity type EDM or Volume EDM are mentioned by these different names. This system consists of electrode (cutting tool) and workpiece which flooded in the dielectric liquid and connected with electrical circuit to the power supply [3].

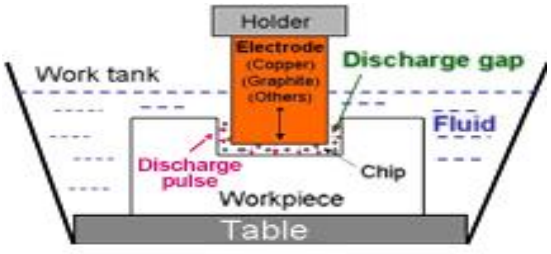

Figure 2: Mechanism of die-sinker EDM

3.1 Wire Cut EDM :

In this thin continuous single element wire (Copper or Graphite) is fed onto the workpiece flooded in the dielectric fluid such as deionized water.

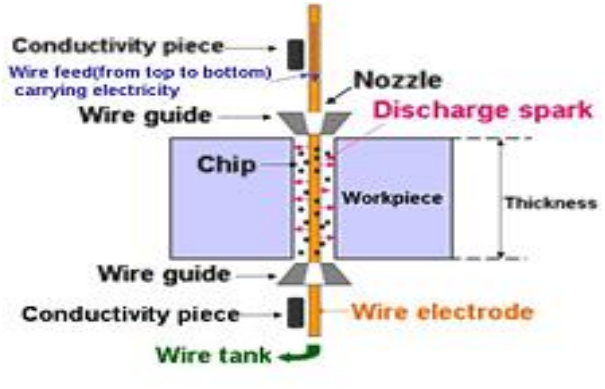

Figure 3: Mechanism of wire EDM

3.2 Dry EDM:

Tubular shaped tool is used and gas is supplied through it into the discharge gap as the tool rotates, high velocity. Gas plays a significant role in the gap as a dielectric medium required for electric discharge. Also gas force is flushing out waste particles away from the gap by nonstop flow of new gas into the gap. During machining tool rotation flushing and reducing sparking between the electrodes also increases the process stability [4].

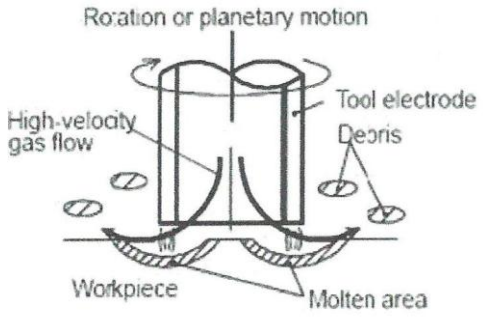

Figure 4: Dry EDM.

Overview of research in EDM Piezoactuated (PZT) Tool Feed System The basic of ultrasonic vibration testing is the mechanical vibrations convert into electrical pulses and again mechanical vibrations convert back into electrical energy. Piezoelectric actuator always used in a high precision and these actuators show performances in quick response, great toughness, and less wear and tear and has compact design. The maximum movement of the piezo actuator is 445 mm at 150V [5].EDM using Ultrasonic Machining

New challenges in micromachining is that it always increasing demand for minor, more precise erections in new, emerging materials. Hard materials can be machining easily by Electro discharge machining.

To enhance procedure in application of hybrid processes through prompting the blushing and discharge gap shows excessive potential in the machining of conducting materials. For deep or precise work speed up the micro EDM and also used the ultrasonic superposition which provide stability.

By the combination of the assisting electrode procedure, can machining extreme hard materials, like biocompatible ceramics and engineering materials that are available for fresh applications which desire geometries and characteristic ratios that the current procedures cannot provide.

Relating above two methods, new potentials for the design and manufacture of highly complex, high precision micro parts in extraordinary concert engineering materials can be employed.

3.3 EDM Using Water & Powder Additives

In recent year's huge enhancement in machining process through EDM have remained achieved. The ability of machining of complicated parts and tough to cut material have made EDM as one of the most prevalent machining progressions. The involvement of EDM in manufacturing such as cutting new tough materials make EDM technology remains essential. Use of water and powder additives during machining process on EDM is the review of the recent research. Though, numerous more problems necessity to be examined before the process can be officially recognized by the manufacturing industry.

4. Types of Powder Additives and their Applications

4.1 Graphite and Surfactant Powder

The functional advantage of utilizing Graphite and surfactant powder added a substance is that the utilization of acquired ideal condition enhances the material removal rate, diminishes surface harshness and less recast layer of Titanium alloy [7].

4.2 Silicon and Silicon Carbide Powder

The utilization of SiC powder gave fatigue stresses at 106 cycles as 275 MPa, which is higher by 14.58% when working without additive powder. SiC powder also yielded test fatigue safety factor higher by 14.61% and 18.61% when contrasted and aftereffects of utilizing the kerosene dielectric alone with copper and graphite terminals, separately.

4.3 Aluminum and Alumina Powder

Adding Al powder particles of size 45 micro meter in dielectric increases the MRR with maximum at 4 g/l and it decreases the surface roughness for minimum value at 6 g/l for a single response. Adding of alumina or aluminum oxide increases the material removal rate by 50% with peak current at 40A and powder concentration at 4 g/l. It is able to cut through one of the most difficult to machine materials i.e. Inconel 718 but at the same time electrode wear rate (EWR) is increased with high peak current.

Aluminum when compared to copper, chromium and silicon carbide gives the best surface roughness on work specimen taken as SKD-11 also known as die steel.

4.4 Chromium powder

Chromium powder as an additive increases the surface roughness by values such as 3-4 micro meters with concentration levels high at 2 g/L. The highest machine removal rate is when chromium of size 70-80 nm is used as additive in EDM.

5. Effect of Liquid Dielectric Fluids

EDM is one of the first non- conventional process of machining and it has been optimized by many factors especially a lot of work is done in the field of finding and optimizing the best dielectric medium.The main function of a liquid dielectric medium is to form a barricade between tool and work piece, regulate the temperature in the machining area and remove debris particles from the machining gap. Hydrocarbon oils have been used since the

beginning as dielectric fluids in EDM but concerns about the hazardous fumes released while working, health of the operator and in general making the process sustainable has caused the need for substitution. Substituent's such tap water, deionised water, tap water, distilled water, vegetable oil, glycerin, oil in water and powder additives have been used and in many cases the machine removal rate(MRR), tool wear rate (TWR), surface finish, white layer thickness, recast layer etc. have been optimized. For e.g. using pure copper electrodes with water results in almost zero TWR but it results in formation of micro cracks. The effect of dielectric fluids in EDM process is vital and optimization in productive measures can be improved even further.

6. Effect of Gaseous Dielectric Fluids

Q.H. Zhang, R. Du, J.H. Zhang & Q. Zhang reflected on the ultrasonic EDM in gas. [8] Using of gaseous dielectric fluid in EDM is also known as DEDM or green machining. The use of gaseous dielectric has given good results for MRR and TWR but at the same time it results in lower surface quality due to thermal stresses as compared to hydrocarbon oils as dielectric. From the gasses used by far nitrogen has given the best dimensional accuracy but fails to provide a sufficient MRR.

Investigations on EDM using nitrogen, argon, oxygen and compressed air, by means of quenched copper tube for the tool electrodes and 45 carbon steel for the workpieces. In between all four gases, achieves highest MRR by oxygen and when oxygen-mixed dry EDM was exposed to progress MRR more than 200% while without oxygen effects at our selected experimental settings. [9]

Enhance the machining performance of EDM through 3-phase movement of dielectric medium uses liquid - powder mixture and gas as the dielectric medium. The boosted of process parameters, with pulse on time, pulse off time, peak current, flow rate, and proportion of powder particles, on such concert parameters, including TWR, MRR, and SR, are initiate out based on the orthogonal design testing and the signal-to-noise proportion investigation.

7. Conclusion

Replacement in conventional fluid based on EDM by dry electrical discharge machining (EDM) technique that has the probable, due to its less tool electrode dress, shrill recast layer, and eco-friendly. Thus, the major challenges of dry EDM are create in its material removal rate (MRR) and an insufficient surface finish that results from debris reattachment on the EDM surface.

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