Review Paper on Effect of Vanadium Powder Suspended dielectric on process parameters in PMEDM

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ABSTRACT: Powder mixed electric discharge machining (PMEDM), has emerged as one of the advanced techniques in the direction of the enhancement of the capabilities of EDM. The objective of the present research is to study the influence of process parameters such as peak current, pulse on time, Vanadium mixing powder concentration on machining performance of different types of die steel (AISID3, AISID6, H13) with round copper electrode (20 mm diameter) on machining performance (MRR). Experiments have been designed using Taguchi method. It is expected that Vanadium powder concentration mixed in dielectric fluid significantly affect the machining performance, maximum (MRR) is obtained at a high peak current.

Keywords: PMEDM, Vanadium powder, Die steels, MRR

INTRODUCTION:

Conventional machining utilizes cutting tools that must be harder than the work-piece material. Scientifically highly advanced industries like automotive, aerospace, defense, micro-electronics, nuclear power, steam turbine, metallic molds and dies requires materials of high strength high temperature resistant alloys like stainless steels, titanium alloys, carbides, super alloys, haste alloys, dies steel etc. [1,2].

These materials are difficult to machine by traditional machining processes. This led to the introduction of the nonconventional machining processes that are well- established in modern manufacturing industries [3].

This includes the use of electrode rotating, electrode orbiting - planetary motion to tool, work-piece applications of ultrasonic vibrations, and powder mixed electric discharge machining (PMEDM) [4,5].

In this process, an appropriate material in fine powder is rightly mixed into the dielectric fluid which improves the breakdown properties of the dielectric fluid. The isolating strength of the breakdown properties for the dielectric fluid is decreased, and as a result, the spark gap distance between the tool and work-piece increased. The flushing of debris uniform is made by expanding spark gap distance [8].

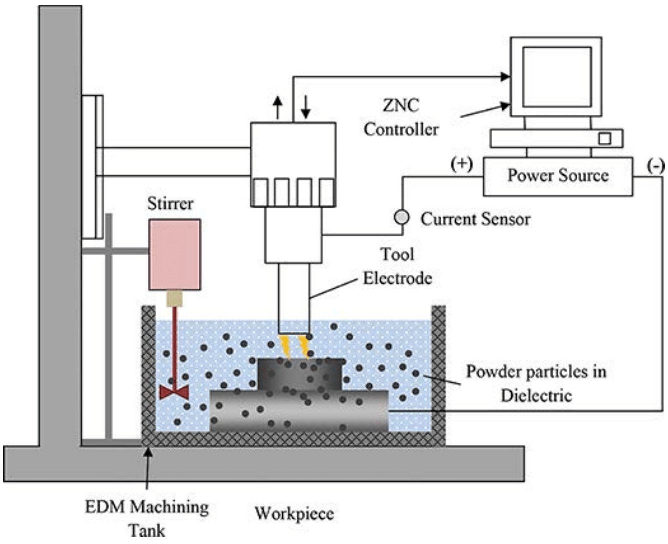

Figure 1: Schematic of PM-EDM

Literature Survey:

Zhao (2002) [5] have studied the effect of powder mixed EDM (PMEDM) in rough machining. They concluded that the machining efficiency becomes lower and the surface roughness becomes smaller in this method in comparison with traditional EDM.

Ho and Newman (2003) [6] studied (PMEDM) different mythology than conventional, which can improve the surface roughness, However , little research work has been carried out to study the PMEDM in rough machining, experimental research of PMEDM in rough machining has been conducted.

Kun (2005) [7] have studied the effect of (Al) powders added in the dielectric within the limit of (0.1 and 0.25) g/L respectively. They concluded that the optimal surface roughness (Ra) value of 0.172µm is achieved under the following parameters positive polarity, discharge current 0.3 A, pulse duration time 1.5µs, open circuit potential 140 V, gap voltage 90 V and dielectric concentration 0.25 g/L.

Kansal (2006) [8] made an investigation into the optimization of the EDM process when silicon powder is suspended onto dielectric fluid of EDM ,the predicted optimal values for material removal rate (MRR).

Kansal (2007) [9] have studied the effect of silicon (PMEDM) on machining rate of AISI D2 Die steel. Six process parameters, namely peak current (3, 6, 10 A) , pulse on time (50, 100, 150 µs), pulse off time(15, 20, 25 µs), concentration 2176 of powder (0,2,4 g/L), gain (0.83, 0.84 and 0.85 mm/s) and nozzle flushing (yes, no) have been considered.

Sukhpal S. (2010) [10] have studied the impact of different concentration of TiO2 into the dielectric fluid of EDM on H11die steel to modify the surface characteristics, material removal rate , and hardness.

Devdatt R. Vhatkar, (2013) [12] have reported the potential of silicon powder as additive in enhancing machining capabilities of PMEDM on EN31 was realized by peak current(3, 12, 21, 30)A, Pulse on time(20, 35, 55, 75) µs, Pulse off time(2, 5, 8, 11) µs, Gap voltage(40, 60, 80 ,100) V, Concentration(0, 2, 4, 6) g/l of fine silicon powder added into the dielectric fluid, was chosen as input process variables, to study performance with respect to MRR & SR.

Nimo Singh Khundrakpam, (2014) [13] have studied The effects of various tool electrode diameter and flushing pressure of (PMEDM) have been investigated to reveal their impact on (MRR) of EN-8 steel by mixing Zinc (Zn) powder to kerosene dielectric.

Why PM-EDM: Following are the limitations of Conventional EDM Machining which are not usually seen with PMEDM:

- Not conventional for non-conductive materials (unless specific setup is available).
- More expensive process than conventional milling or turning.
- Slow rate of material removal.
- Additional time and cost for creating electrodes (for sinker EDM).
- Reproducing sharp corners on work piece is difficult due to electrode wear.
- Power consumption is high.
- Overcut is formed sometimes.
- Excessive tool wear occurs during machining.
- Surface cracking may occur in some materials owing to their affinity to become brittle at room temperature.
- Distortion of surface microstructure by EDM.
- Fire hazards due to combustible dielectrics.

Gap Analysis:

1. Less work has been reported using powders of important alloying elements such as Manganese, Chromium, Molybdenum and **Vanadium** in the dielectric medium.
2. Some **die steel materials** such as OHNS die steel, Molybdenum high speed tool steels and Water-hardening die steels (W-series) have not been tried as work materials.
3. There is negligible published work available on comparative analysis of various EDM techniques of MRR improvement with same/different work materials in EDM.
4. The effect of discharge current and pulse duration has been taken into consideration in research works but variation in pulse interval has not been investigated.

Why Vanadium: Vanadium has the following key properties which makes it suitable for use: Soft, Ductile, Bright white in appearance, Has good structural strength, Possesses good corrosion resistance to alkalis, sulphuric acid, hydrochloric acid etc. And it oxidizes at temperatures greater than 660°C.

Objective: The prime objective here is to:

1. To make use of powdered **Vanadium** in the dielectric medium.
2. To work on **Hard Materials** such as OHNS die steel, molybdenum high speed tool steels and water-hardening die steels (W-series).
3. Hence, by using Taguchi Methodology, the objective is to **study the impact of this method on Parameters like**:
   a) Surface roughness
   b) Material Removal Rate (MRR)
   c) Tool Wear Rate (TWR).
   d) Variation in Pulse interval
   e) Powder Concentration
4. And finally to **compare the results** obtained by this methodology with that of conventional EDM and PMEDM of additives other than Titanium.

Material: Three types of material will be tested: AISI-D3, H-13 & AISI-D6, the chemical composition of these materials is as listed below:

No	Elements	AISI-D3 steel	H13	AISI-D6 steel
1	C	2.10	0.465	2.48
2	Si	0.145	1.05	0.264
3	M n	0.292	0.312	0.328
4	P	0.020	0.038	0.035
5	S	0.007	0.015	0.049
6	Cr	12.1	4.50	12.4
7	Mo	0.001	1.16	0.118
8	Ni	0.119	0.258	0.243
9	Cu	0.021	0.185	0.123
10	V	_____	0.862	0.012
11	W	_____	0.005	0.764
12	Fe	Balance	Balance	balance

Table 1: Chemical composition of Die Steels

Methodology: The aim of this research work is to study the effect of Vanadium powder mixed - dielectric combination upon MRR, by changing the various input machining process parameters, For conducting the experiment, it has been decided to follow the Taguchi design of experiments and a suitable orthogonal array L27 is to be selected after taken into concern the below design variable. The orthogonal array needs to be selected for five variables namely work piece, powder type and concentration, peak current and pulse of time.

Software Use: The effect of process parameters on material removal rate is analyzed by using statistical software MINITAB 16.

Testing Parameters: Following are parameters to be tested:

a) Surface roughness
b) Material Removal Rate (MRR) & corresponding Peak Current
c) Tool Wear Rate (TWR).
d) Variation in Pulse interval
e) Powder Concentration

Expected Outcomes:

1. The addition of Titanium powder mixed dielectric result in high MRR when compared with other mixed powder such as aluminum and manganese.
2. The significant factors for MRR are peak current, powder concentration and powder types.
3. The parameter pulse on time has no significance on material removal rate.
4. Maximum MRR have obtained at a high peak current for the considered concentration of Titanium powder.
5. Current has the highest rank; signifying highest contribution to MRR and work piece has the lowest rank.

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