Comparative Study of Dielectric Fluid in Powder Mixed Electro – Discharge Machining

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Abstract— Electro discharge machining (EDM) is nontraditional machining process which is used to remove the material by thermal energy of the spark. All electrically conductive materials can be machined. EDM is a capable of machining hard material components or geometrically complex. As there is no direct contact between tool and work piece, no physical cutting forces are present between tool and workpiece. In recent years to enhance process capabilities, powder mixed electric discharge machining (PMEDM) is used as new technique. In PMEDM dielectric fluid is mixed with additive powder. For Experimentation parameters selected are peak current, pulse on time, duty cycle and different dielectric media. Material removal rate, tool wear rate and surface roughness are taken as the output parameter.
Key words: PMEDM, Material removal rate, Surface roughness, Tool Wear Rate

I. Introduction

In PMEDM process, a suitable material in fine powder form (Aluminum, Chromium, Graphite, Copper, Silicon Carbide, etc.) is mixed into the dielectric fluid of EDM. Additive powder particles fill the spark gap (Fig. 1). The performance of EDM process is significantly affected by addition of powder. The electrically conductive powder particle reduces the insulating strength of the dielectric fluid and increases the spark gap distance between the tool electrode and workpiece. This results as stable process, thereby improving material romoval rate (MRR) and surface Roughness (SR).

II. Experimental Setup

PM-EDM setup is used and experiments are carried on EDM (Fig. 2.). Design of experiments is done by using Taguchi technique. Mild Steel of 2 mm thick is used as a work piece material. Copper electrode with a diameter of 6 mm is used as tool electrode. The machining is performed in standard Kerosene.

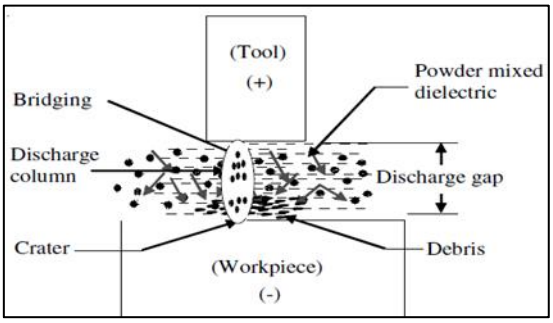

Fig. 1: Principle of PMEDM Process [3]

Silicon Carbide (SiC), Graphite and Aluminium oxide (Al2O3) powder is mixed in Kerosene(Ker) as per the requirements of the experiments. The powder particle size of 15 microns and powder concentration of 50 gm/litre is used. Experiments are performed on Sumedha EDM machine. The experimental layout for the machining parameters using the L12 orthogonal array is used. This array consists of four parameters and three levels

Level	Current (A)	POT (µsec)	Duty cycle (%)	Dielectric fluid
1	5	5	90	Silicon Carbide(SiC)
2	10	10	85	Graphite
3	15	30	80	Aluminum Oxide (Al2O3)

Table 1: Process Parameters and their Levels for Trial Experiments

Exp. No.	Dielectric media	Current (A)	POT (µsec)	Duty cycle (%)	MRR (gm/min)	TWR (gm/min)	SR (µm)
1	Ker	5	5	90	0.0134	0.0005	4.73
2	Ker	10	10	85	0.0698	0.0018	6.70
3	Ker	15	30	80	0.0853	0.0037	8.50
4	Ker+SiC	5	5	90	0.0296	0.0006	2.64
5	Ker+SiC	10	10	85	0.0777	0.0028	5.11
6	Ker + SiC	15	30	80	0.0982	0.0057	6.77
7	Ker+Graphite	5	5	90	0.0402	0.0009	3.83
8	Ker+Graphite	10	10	85	0.0896	0.0069	6.21
9	Ker+Graphite	15	30	80	0.1250	0.0090	7.93
10	Ker + Al_2O_3	5	5	90	0.0337	0.0008	3.2
11	Ker + Al_2O_3	10	10	85	0.0812	0.0049	5.81
12	Ker + Al_2O_3	15	30	80	0.1085	0.0087	7.6

Table 2: Results of Experiments

MRR and TWR are calculated by the following equations:

$$MRR = \frac{Ww1 - Ww2}{T} \qquad (1)$$

$$TWR = \frac{Wt1 - Wt2}{T} \qquad (2)$$

Where

Ww1= weight of work piece before machining (gm)

Ww2= weight of work piece after machining (gm)

Wt1= weight of tool electrode before machining (gm)
Wt2= weight of tool electrode after machining (gm)
T= time for machining (minute).

Surface roughness values (Ra values) were measured offline by Surtronic- Taylor Hobson surface roughness tester with-

- Cut-off length : 0.25 mm
- Traverse length : 1 mm
- Parameter : Ra
- Range : 100 µm

Fig. 2: PM- EDM Setup used for Experimental Work

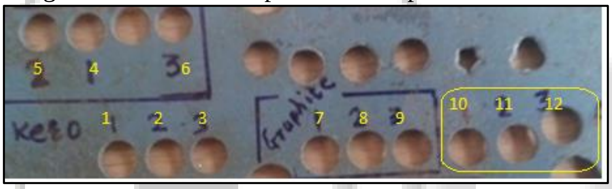

Fig. 3: Workpiece after Machining on PM-EDM

III. RESULTS

Keeping rest of parameter constant, graphs are plotted in such way that performance of kerosene as dielectric fluid with powder mixed kerosene as dielectric fluid will be compared. Then it is found that Material Removal Rate and Tool Wear Rate are more in case of kerosene + graphite as compared to other powder mixed dielectric fluid (Fig. 4 & 5). This is because graphite is having highest electric conductivity than rest of dielectric fluid. Similarly Surface Roughness of kerosene with no powder added is more (Fig. 6). This is because addition of powder modifies Plasma channel resulting in decrease in electric density. Thus uniform distribution of the discharge takes place, which causes uniform material removal on the work piece.

IV. CONCLUSION

Result shows the current play an important role in the PMEDM whereas graphite powder gives better material removal rate (MRR); with powder added in kerosene gives Improvement in surface roughness (SR) and use of graphite powder increases tool wear rate(TWR).

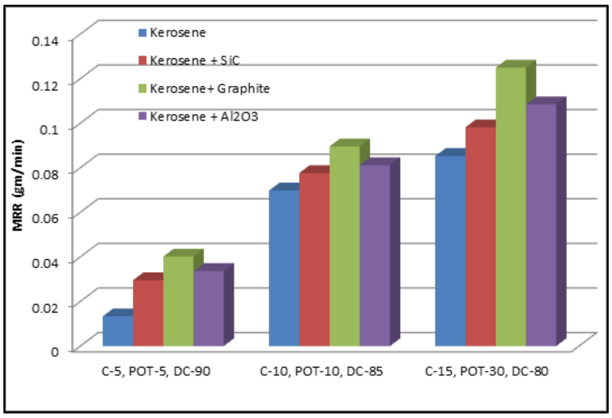

Fig. 4: Effects of Various Dielectric Fluids on MRR

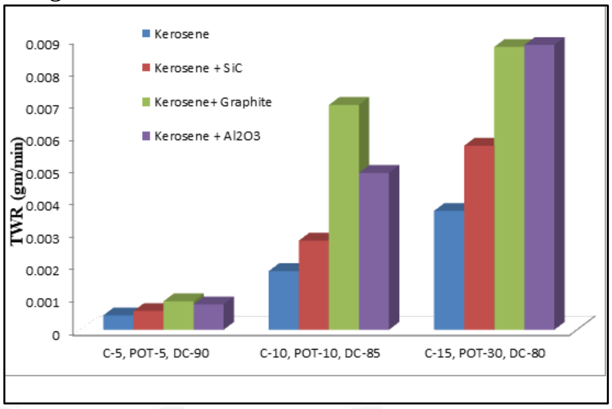

Fig. 5: Effects of Various Dielectric Fluids on TWR

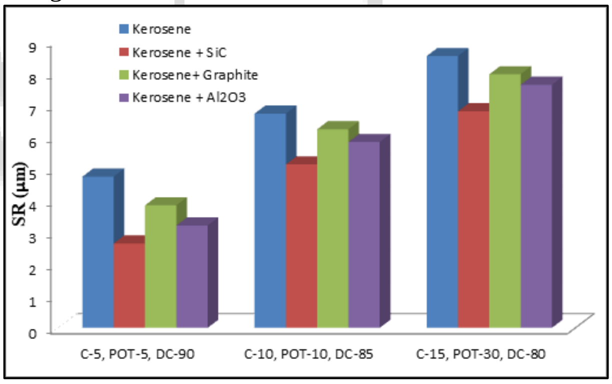

Fig. 6: Effects of Various Dielectric Fluids on SR

V. FUTURE SCOPES

PMEDM can be used to machining of hard to cut material such as INCONEL, etc. Further optimization of input parameters can be done using Grey relation analysis, Response surface Methodology. PMEDM can be combined with ultrasonic or abrasive and powder mixed near dry EDM.

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