Project Presentation

Effects of Graphite Powder Mixed Dielectric on Material Removal Rate and Surface Roughness in Electrical Discharge Machining of Cu-Al Alloy

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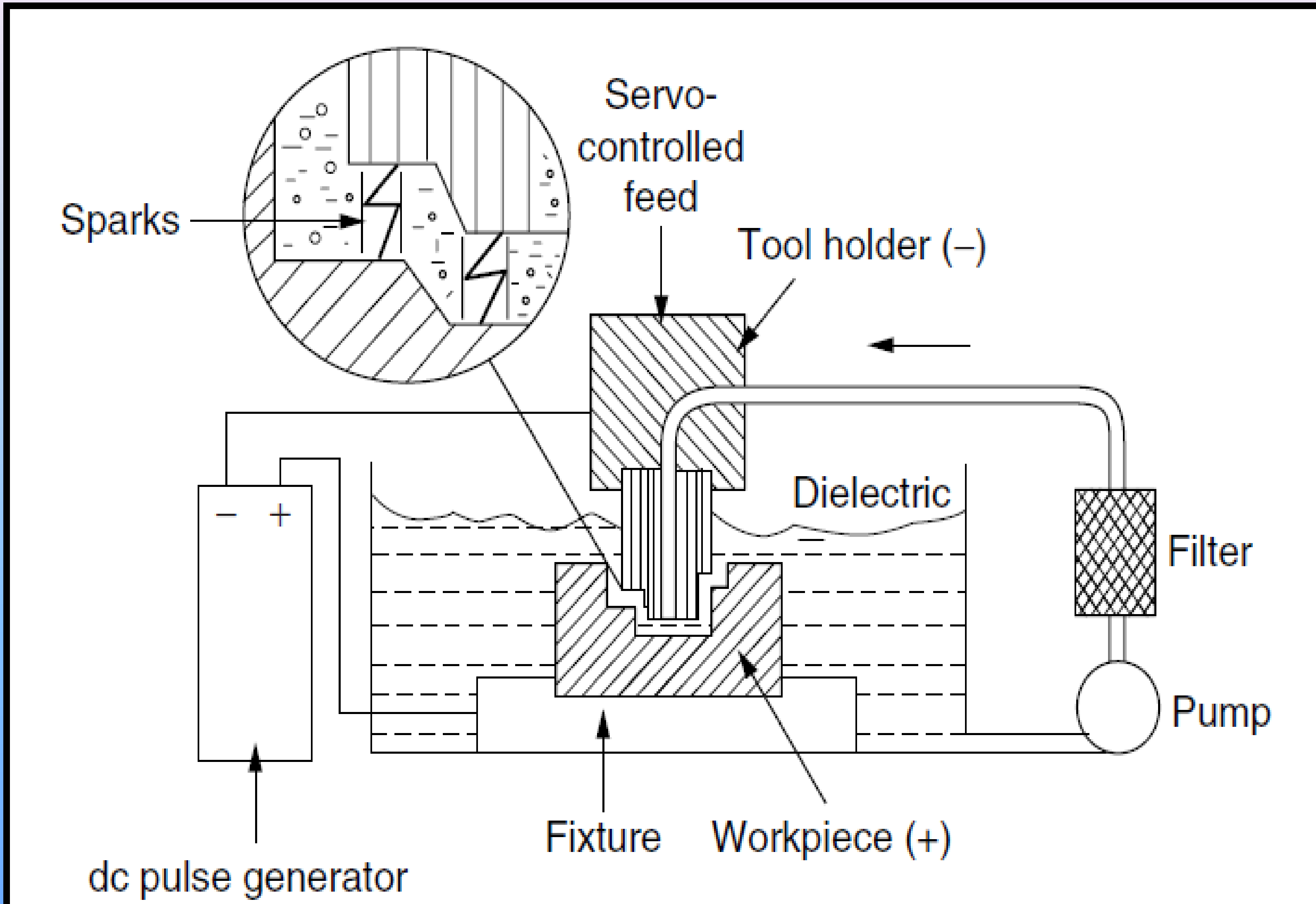
Contents

Introduction

EDM: Electric-Discharge Machining

- EDM is a nonconventional process which involves removal of machining allowance by melting and vaporizing the workpiece material.

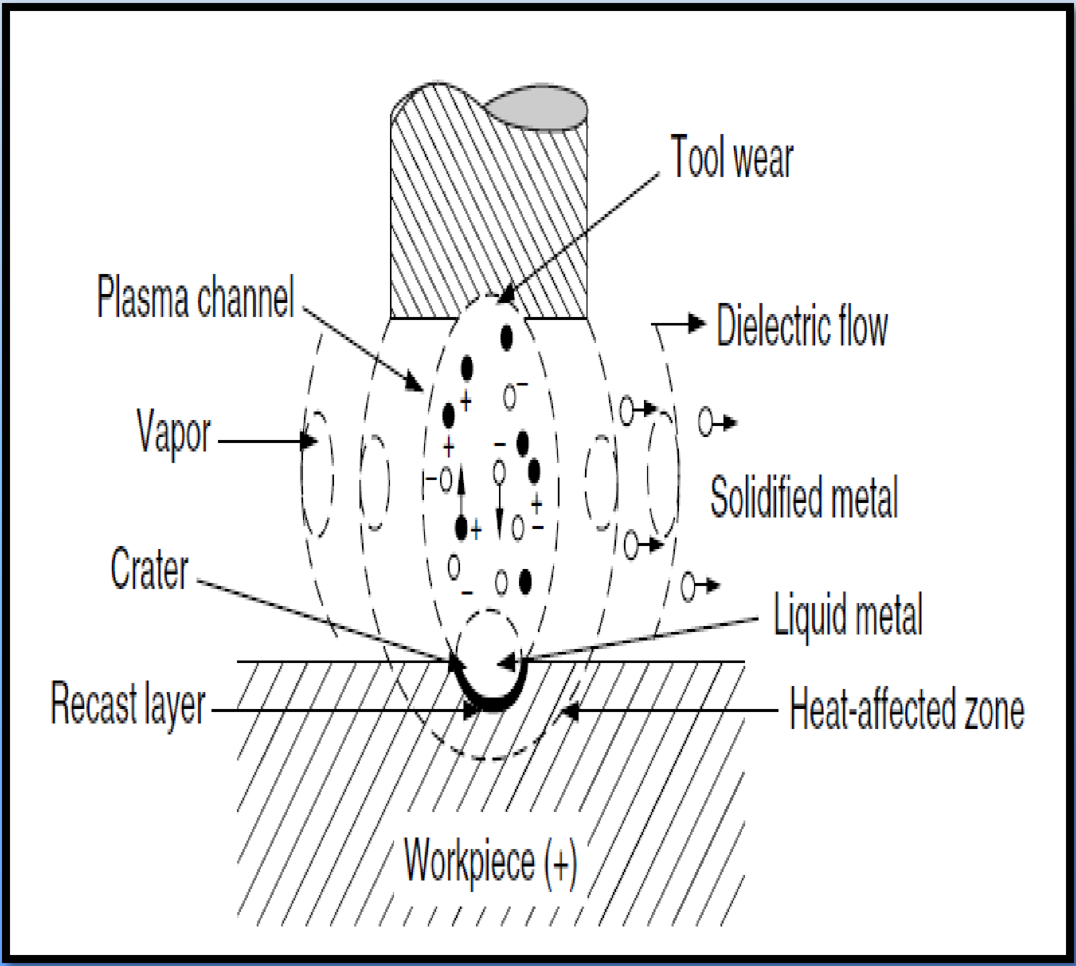
- The source of heat required for material removal is the plasma created between the electrode and workpiece.



EDM schematic

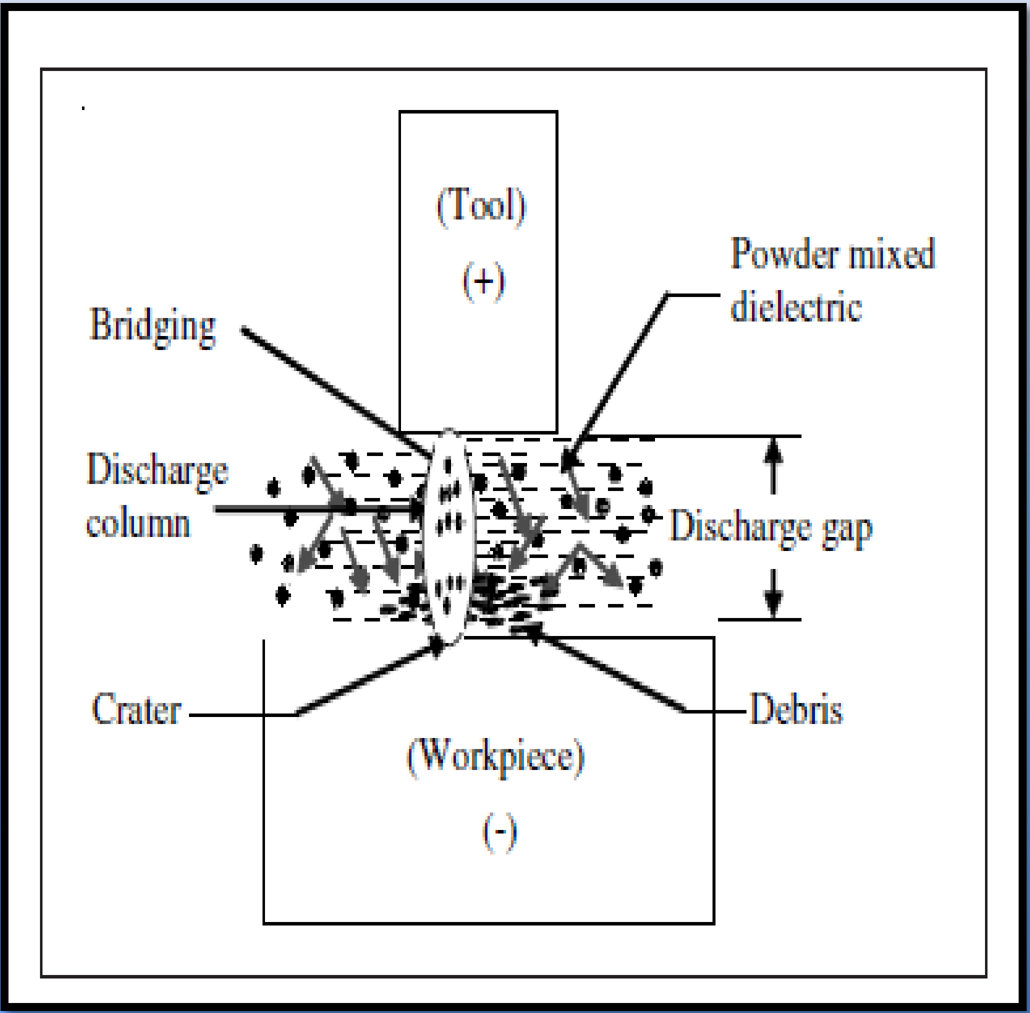
Mechanism of material removal

- The removal of material is based upon the electro-discharge erosion (EDE) effect of electric sparks occurring between two electrodes that are separated by a dielectric liquid.

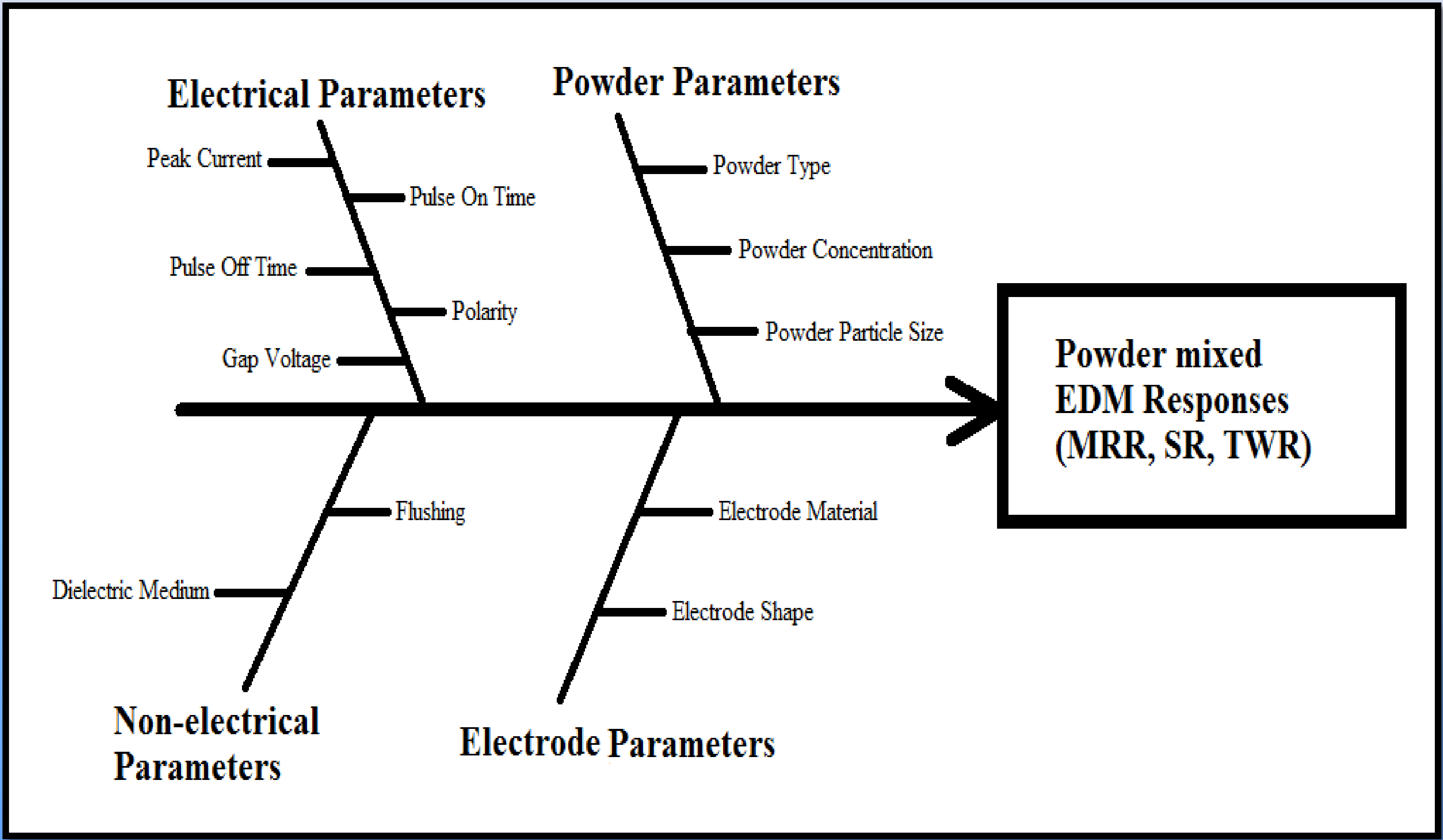


PMEDM: Powder Mixed EDM

- Powder particles gets energized and arrange themselves in the form of chains at different places under the sparking area under the influence of electric forces.
- Due to bridging effect, the gap voltage and insulating strength of the dielectric fluid decreases.



Process parameters



Literature survey

- Wu et al. studied the effects of addition of Al powder in dielectric. Surface roughness was improved up to 60% compared to pure dielectric.
- Kansal et al. studied the effect of addition of the silicon powder on machining rate of AISI D2 Die Steel. It was found that the peak current, powder concentration, Ton and Toff significantly affect the MRR
- Chaw et al. concluded that the addition of Sic in water as dielectric increases the inter-electrode gap, removes debris easily, and increases MRR.

Objectives of Project work

- To analyze the effects of dielectric fluid mixed with micro-sized graphite powder on the MRR and SR during electric discharge machining of Cu-Al alloy using copper electrode.
- To make a comparison between the effects of dielectric fluid mixed with graphite powder and that of dielectric fluid without mixing the powder.

Experimental details

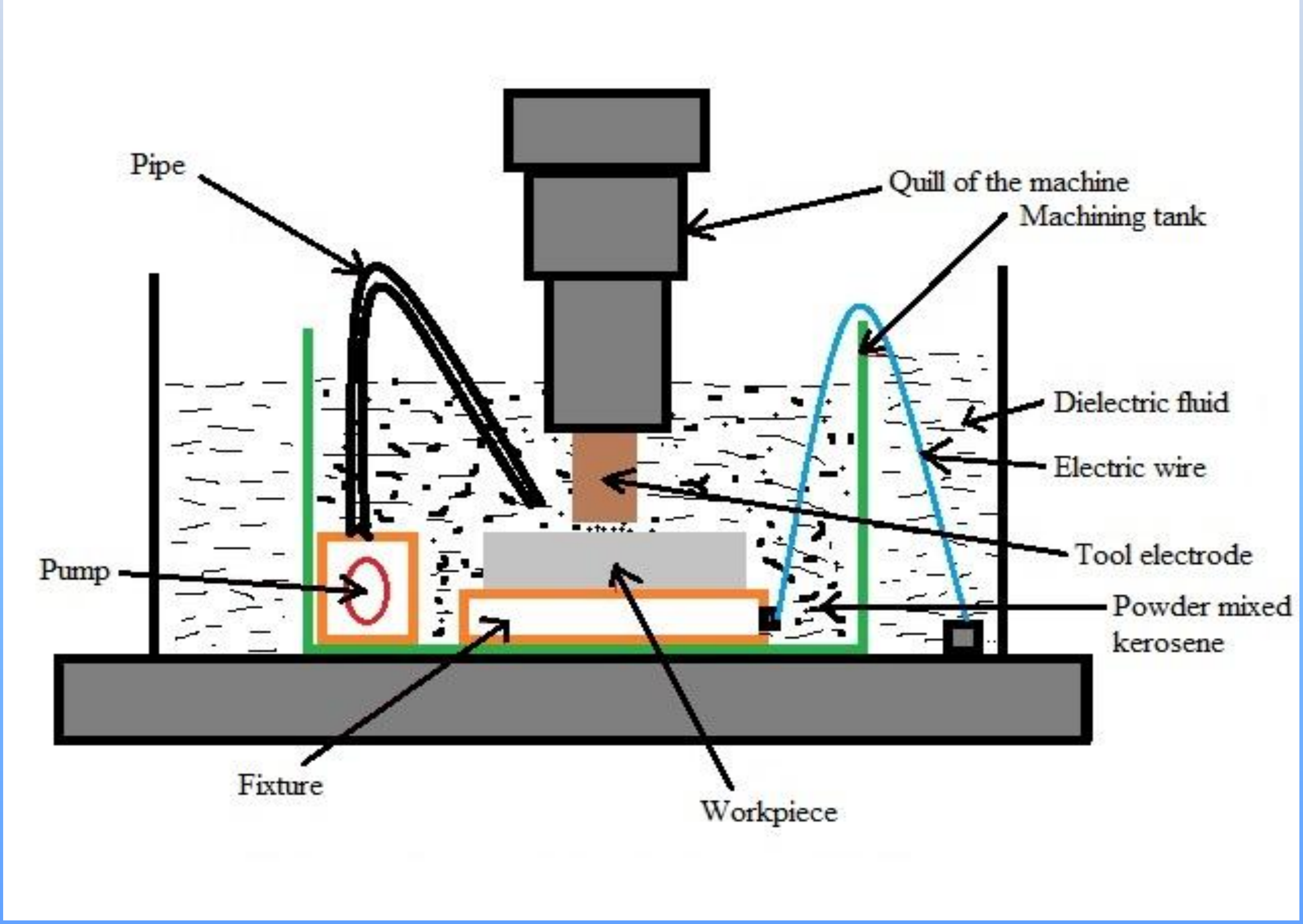
Parameters to be controlled

Parameters	Level 1	Level 2	Level 3
Powder Concentration, g/l (A)	0	3	6
Peak Current, Amp. (B)	3	6	9
Pulse On Time, µs, (C)	50	100	200

Output responses

- Material Removal Rate
- Surface Roughness (SR)

Experimental Set-up



Details contd..

Other Details

- Dielectric - Kerosene
- Powder type - Graphite powder (micro-size particle)
- Tool electrode material - Copper electrode of diameter 10 mm
- Work Material - Cu-Al alloy (Al alloy2014)
- Machining Time – 15 min
- Pulse Off Time – 50 μs (constant)
- Polarity – electrode positive

Methodology

- Taguchi’s experimental design approach is applied in designing the experiment. For 3 parameters each with 3 levels in the project work, L9 Taguchi orthogonal array is used.

- In project work, one way ANOVA technique is used for the analysis purpose. The analysis of variance (ANOVA) is a common statistical technique to determine the percent contribution of each factor in the results of the experiment.

L9 Array setting for experiments

Exp. No.	Powder Concentration, g/l (A)	Peak Current, Amp. (B)	Pulse On Time, μs (C)
1	0	3	50
2	0	6	100
3	0	9	200
4	3	3	100
5	3	6	200
6	3	9	50
7	6	3	200
8	6	6	50
9	6	9	100

Results and Discussions

Experimental data

Table 5.1 Experimental data

Exp. No.	Powder Concentration, g/l (A)	Peak Current, Amp (B)	Pulse On Time, µs (C)	MRR_1 (mm^3/min)	MRR_2 (mm^3/min)	SR_1 (µm)	SR_2 (µm)
1	0	3	50	3.57	2.38	4.76	4.87
2	0	6	100	5.23	4.76	4.1	4.9
3	0	9	200	6.66	5.95	6.7	6.2
4	3	3	100	4.04	3.95	4.25	4.41
5	3	6	200	9.76	9.04	4.1	4.05
6	3	9	50	6.66	7.14	6.3	6.5
7	6	3	200	5.23	4.76	4.05	3.9
8	6	6	50	10.95	10.71	3.96	3.8
9	6	9	100	8.09	8.57	5.3	5.1

Contd..

Response Table for MRR

Table 5.3 Response Table for Means (mean of Means at different levels)

Level	Powder Concentration, g/l (A)	Peak current, Amp (B)	Pulse On Time, µs (C)
1	4.758	3.988	*6.900*
2	6.765	*8.408*	5.773
3	*8.052*	7.178	6.903
Delta	3.293	4.420	1.123
Rank	2	1	3

Response Table for SR

Table 5.5 Response Table for Means (mean of Means at different levels)

Level	Powder Concentration, g/l (A)	Peak current, Amp (B)	Pulse On Time, µs (C)
1	5.255	4.373	5.032
2	4.935	*4.152*	*4.677*
3	*4.352*	6.017	4.833
Delta	0.903	1.865	0.355
Rank	2	1	3

contd..

ANOVA for Material Removal Rate

Table 5.6 ANOVA for Material Removal Rate

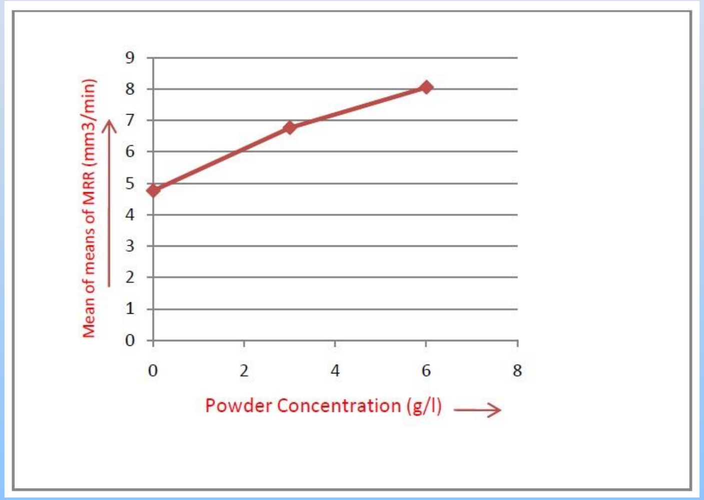
Parameters	DOF	SS	MS	F-Ratio	P (%)
Powder concentration (A)	2	16.53	8.26	4.55	30.65
Peak current (B)	2	31.23	15.61	8.603	57.91
Pulse on time (C)	2	2.54	1.27	0.699	4.71
Error	2	3.63	1.815		6.73
Total	8	53.93			100

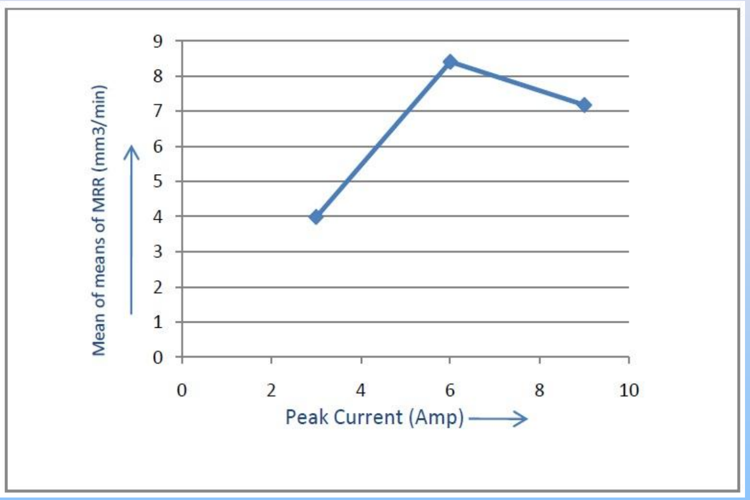
ANOVA for Surface Roughness

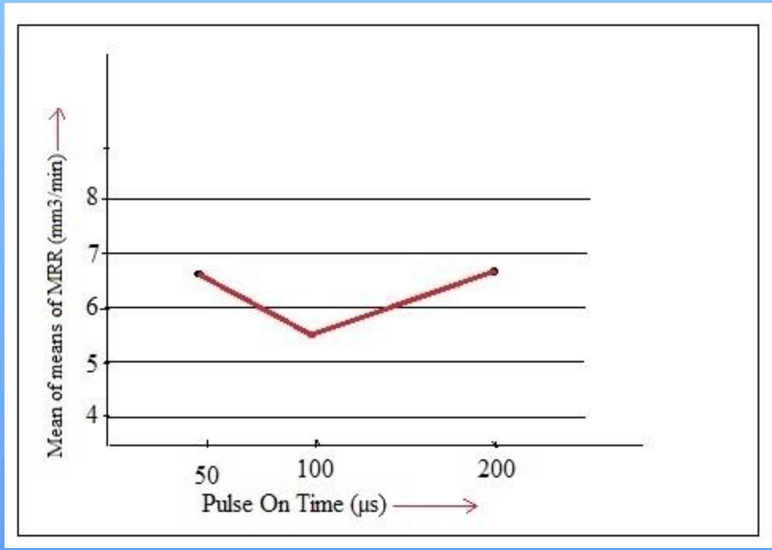
Table 5.7 ANOVA for Surface Roughness

Parameters	DOF	SS	MS	F-Ratio	P (%)
Powder concentration (A)	2	1.26	0.63	11.25	16.17
Peak current (B)	2	6.228	3.114	55.61	79.95
Pulse on time (C)	2	0.19	0.09	1.69	2.4
Error	2	0.112	0.056		1.48
Total	8	7.79			100

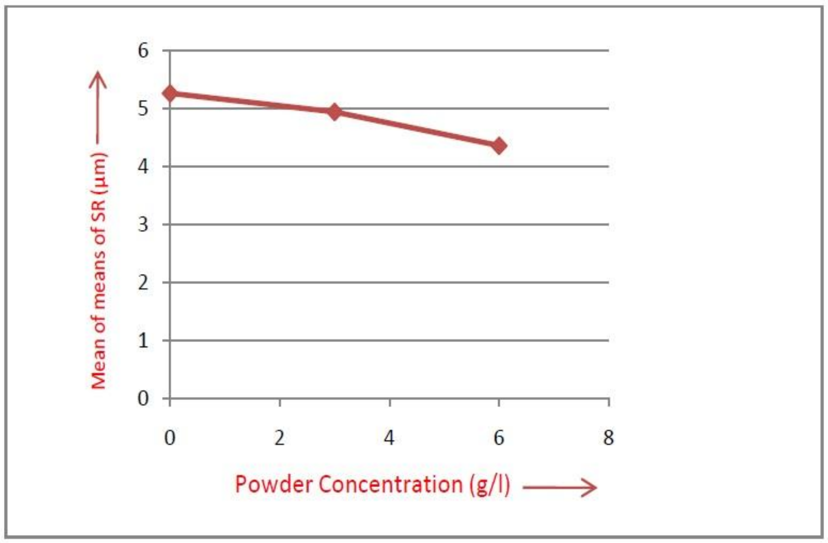
Graphs for Material Removal Rate

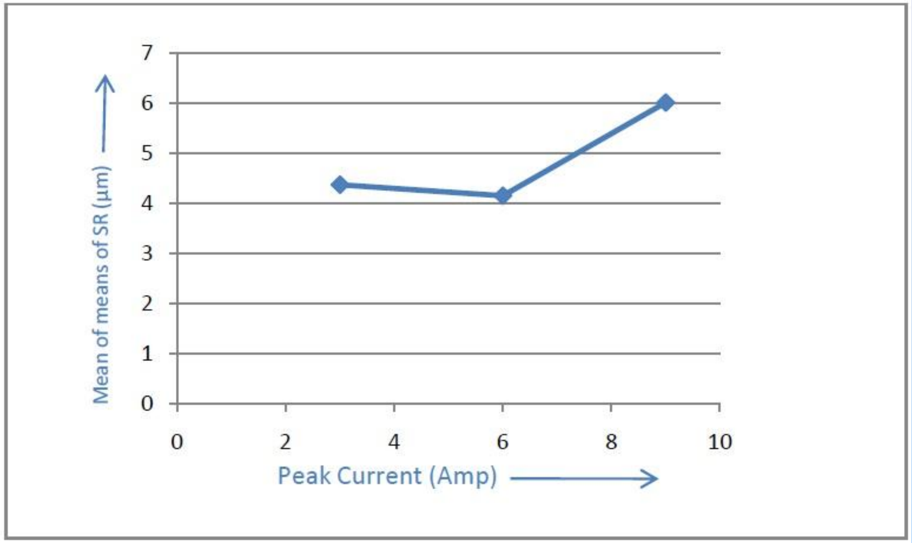


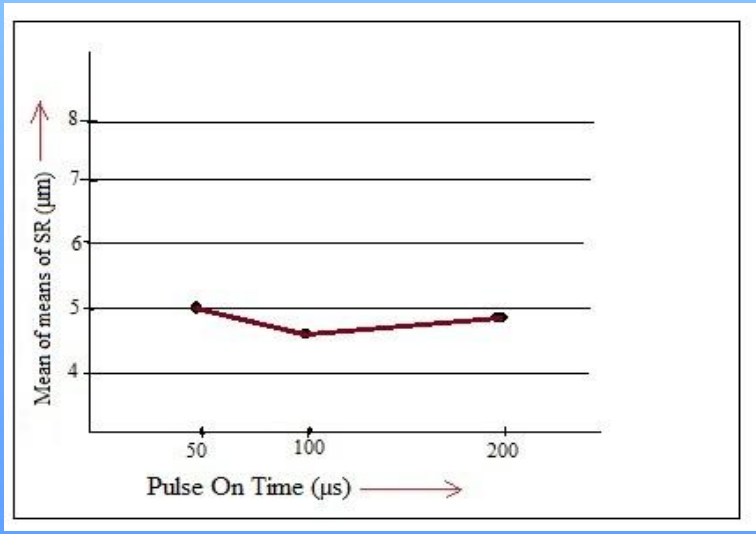




Graphs for Surface Roughness







Conclusions

- The MRR and SR are mainly affected by the peak current, powder concentration and pulse on time. But peak current and powder concentration affects the EDM process most significantly.
- As the powder concentration in dielectric increases, the value of the material removal rate increases and the value of the surface roughness decreases.
- the surface roughness is reduced with powder mixed dielectric as compared to that of pure dielectric fluid.

THANK YOU