Optimization of Process Parameters of Powder Mixed Dielectric EDM for MRR and Ra

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Abstract - Powder mixed electric discharge machining (PMEDM) is a recent innovation for enhancing the capabilities of electrical discharge machining process. The objective of present study is to realize the potential of graphite powder as additive in enhancing machining capabilities of PMEDM. Taguchi methodology has been adopted to plan and analyze the experimental results. L9 Orthogonal Array has been selected to conduct experiments. Discharge current, duty factor, spark gap and concentration of fine graphite powder added into the dielectric fluid were chosen as input process variables to study performance in terms of material removal rate and surface roughness. The effect of process parameters is analyzed in this paper

KEY WORDS: **EDM, ANOVA, MRR, RA, PROCESS PARAMETERS, TAGUCHI METHODOLOGY,GREY RELATIONAL ANALYSIS**

1.INTRODUCTION

Electric discharge machining is a thermo-electric non-traditional machining process. Material is removed from the work piece through localized melting and vaporization of material. Electric sparks are generated between two electrodes when the electrodes are held at a small distance from each other in a dielectric medium and a high potential difference is applied across them. Localized regions of high temperatures are formed due to the sparks occurring between the two electrode surfaces.

1.1 PRINCIPLE OF POWDER MIXED EDM

In this process, the material in powder form is mixed into the dielectric fluid either in the same tank or in a separate tank. When a voltage of 80-320 V is applied to both the electrodes, an electric field in the range 105 to 107 V/m is created. The spark gap is filled up with additive particles, and the gap distance between tool and the work piece increases from 25 μm to 50 μm to many times larger. The powder particles get energized and behave in a zig-zag fashion. The grains come close to each other under the sparking area and gather in clusters.

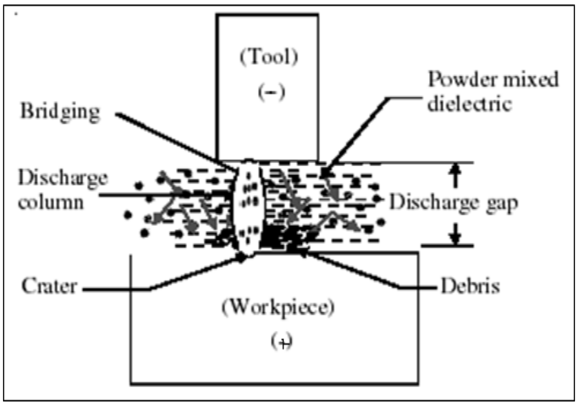


Figure 1.1 Principle of PMEDM Process

1.2 EXPERIMENTAL SET UP

Figure 1.2 Powder mixed Electric discharge machining (PMEDM).

The various input parameters and output parameters (response variables) selected for the experimentation are as follows:

1) Input parameters

1 Discharge current (Ip)
2 Duty factor (τ)

3 Spark gap (SG)
4 Concentration of dielectric (C)

2) Output parameters

1 Material removal rate (MRR)
2 Surface Roughness (Ra)

Graphite powder- The grain size of graphite powder is 15microns.

Tool selection-The selected tool is of pure copper. The length of the tool is 80 mm and diameter of tool is 20 mm. In most of the industries for EDM, the tool used is of copper material. Since copper is cheap as compared to graphite and readily available in the market.

Work piece selection- Material EN-8 is medium carbon steel has good tensile strength and usually used in applications such as shafts, studs, stressed pins, keys etc. The dimensions of work piece are70x25x6 mm.

Dielectric (EDM oil) - The dielectric used in my experimentation work is EDM oil. The concentration of this dielectric is varied by adding graphite powder. This affects the material removal rate and surface finish

2. RESULTS AND DISSCUSSION.

The experimental results are given below.

Expt no.	Discharge current [Ip]	Duty factor [τ]	Spark gap SG	Conc. dielectric [C]	MRR mm3 /min	Ra µm
1	10	5	0.05	0	26.63	5.73
2	10	7	0.1	3	28.09	5.61
3	10	9	0.15	6	29.81	5.5
4	15	5	0.1	6	41.58	6.6
5	15	7	0.15	0	35.40	6.7
6	15	9	0.05	3	40.21	6.82
7	20	5	0.15	3	68.47	7.15
8	20	7	0.05	6	70.88	7.23
9	20	9	0.1	0	69.85	7.45

Table 1: Experimental results

3. REGRESSION ANALYSIS

The regression equation for MRR is,

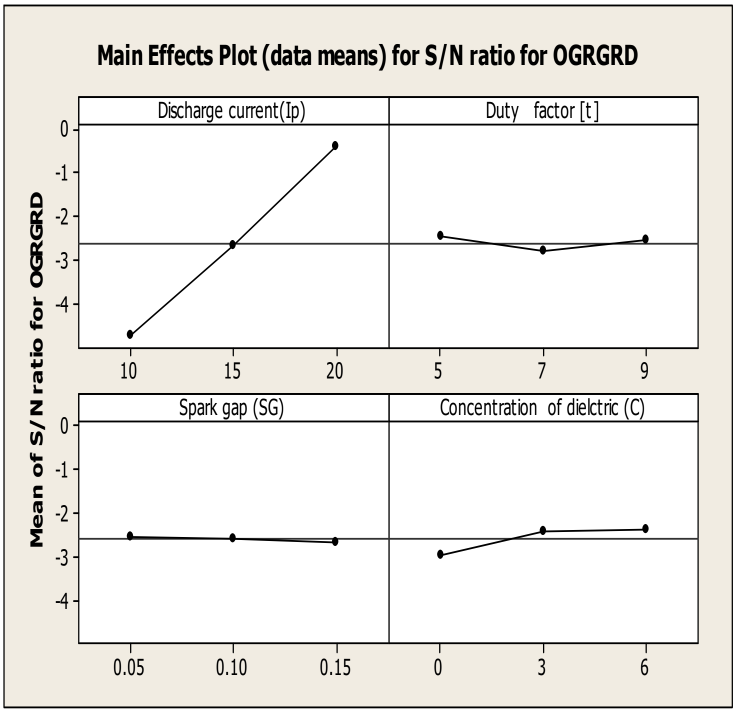
MRR = - 18.9 + 4.16 Discharge current + 0.27 Duty Factor - 13.5 spark gap + 0.577 concentration

The regression equation for Ra is,

Ra = 4.10 + 0.166 Discharge current + 0.0242 Duty Factor - 1.43 spark gap - 0.0306 concentration

4. GREY RELATINAL ANALYSIS

This approach converts a multiple- response- process optimization problem into a single response optimization situation.



Graph 1. S/N Ratio plot of overall grey relational grade

With the help of the graph , optimal parametric combination has been determined. The optimal factor setting becomes as Ip_3, τ_1, SG_1, C_3.

5. CONFIRMATORY EXPERIMENTS

	Optimal settings		%Error
	Prediction	Experimental	
Level of factors	Ip=20A, τ=5, SG=0.05mm, C=6g/l	Ip=20A, τ=5, SG=0.05mm, C=6g/l	
MRR(mm^3 /min)	68.43	69.33	1.29
Ra(µm)	7.28	7.17	1.51

Table 2. Results of confirmatory experiment

5. CONCLUSION

The material removal of the EDM process is rather low, especially in the case of EDM where the total volume of a cavity has to be removed. If the EDM is operated at the optimum setting of electrical parameters then this drawback can be minimized. While machining the material EN8, the industrialist can directly use the optimum values so that the material removal rate will be maximum and Ra value will be minimum. The common optimum values for both MRR and Ra can be easily obtained by the use of grey relational analysis method

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