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EFECT OF BORON CARBIDE (B4C) ABRASIVE ON THE PERFORMANC OF EDM

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ABSTRACT

In this paper the B4C particles are used with dielectric fluid to optimize the process parameters of die sinking EDM. It gives the combined effect of Abrasion and thermal interactions to improve the EDM performance. The dielectric fluid mixed with abrasive, facilitate the bridging effect and minimize the insulating strength of the dielectric fluid. It improves the SR and MRR. The experiments are designed by Taguchi technique and the grey relation Taguchi technique is applied to optimize the multiple response characteristics. An experimental set up is developed to conduct the experiments. The multiple response characteristics is converted into a single response optimization by grey relation analysis technique. Larger value of Grey Relational Grade Taguchi Technique is considered as better multiple performance characteristics by GRG value. The significant parameters are pulse current, abrasive size and abrasive concentration.

KEYWORDS: Grey Relation Grade. Boron Carbide Abrasive, Material Removal Rate, Surface Roughness, Dielectric Fluid

1. INTRODUCTION:

EDM has been recognized as an excellent machining to obtain more accurate and complex shapes on hard and brittle materials. However the machining process has limited application when there is high metal removal and high surface quality is required. Advanced materials like super alloys, Die steel are having wide spread industrial applications. In this machining the B4C particles are used with the dielectric. This type of the EDM the spark occurs between the two electrodes in a dielectric. This type of machining has the advantage of spark erosion in the form of positive and negative charges at the top and bottom of abrasive. The electric charges then leads to the discharge between the phenomenon increases the sparking intensity leading to faster erosion from the work surface other abrasive particles resulting in series discharge and discharge between the electrode and work piece take place. Thus it has absolved that the mixing of B4C particles MRR increases and improves the surface finish.

Grey relational technique is used to solve multiple responses. Grey analysis theory used to solve the complicated interrelation ship on the multi performance characteristics. The GRG is calculated to find the multi performance characteristics can be converted into a single grey relational grade. To verify the optional machining parameter combinations the experiments are conducted. The Result shows that this system is efficient and effective in determining the optional parameters for Tool wear, MRR and surface roughness.

2. LITERATURE REVIEW

The brief summary of the review of Literature is given as follows.

H. Narumiya, investigated effects of powder in dielectric on MRR and surface roughness. It was reported that aluminum and powders of graphite in the dielectric gives better surface than the silicon powder. For the aluminum and graphite

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powder particles the improved results are found.

M.L.Jeswani, Carried out the work by mixing the powder of graphite into kerosene oil dielectric in EDM. He observed that addition of powder of graphite inter space increases and found improvement in process stability.

Paulo Pecas. E. Henriques (2003), investigated the effect of powder in EDM dielectric. It was found that the improvement in polishing of EDM. The evaluation was done by surface morphologic analysis.

P. Pecas, E. Henriques (2008), Carried out the work on EDM using simple & -mixing the powder in dielectric. The powder mixed promotes the reducing the surface roughness and it is confirmed that the area of electrode influence the surface quality.

3: EXPERIMENTATION

3.1 EXPERIMENTAL SET UP:

The new experimental setup is developed for abrasive mixed EDM. In this modified system the dielectric circulation system is designed for 5 liters of dielectric fluid. For the better circulation of the abrasive mixed dielectric fluid micro pump is used. PNC-480 Die-sinking EDM was used to conduct the experiments. To separate the abrasive from the debris the magnets are used. Stirrer is introduced to mix the abrasive thoroughly with to avoid the settling at the bottom of the tank.

Current, pulse on time, Abrasive concentration, Abrasive size, duty cycle and Gain are considered as parameters. The Boron Carbide abrasive is mixed into the dielectric, work material is D3-Diesteel and brass is used as electrode. Die sinking EDM is used to perform the experiments. An electric field is created by applying the voltage between the work and electrode. The particles get charged and the grains will inter locking between the other abrasive particles. By the bridging effect the voltage and insulating strength of the dielectric decreases and fast short circuit takes place therefore early explosion in the gap. The discharge takes place in series between the electrode and work, due to increase in frequency of discharge fast sparking takes place, erosion of metal take place faster and MRR increases.

Fig. 1: Abrasive mixed EDM- setup

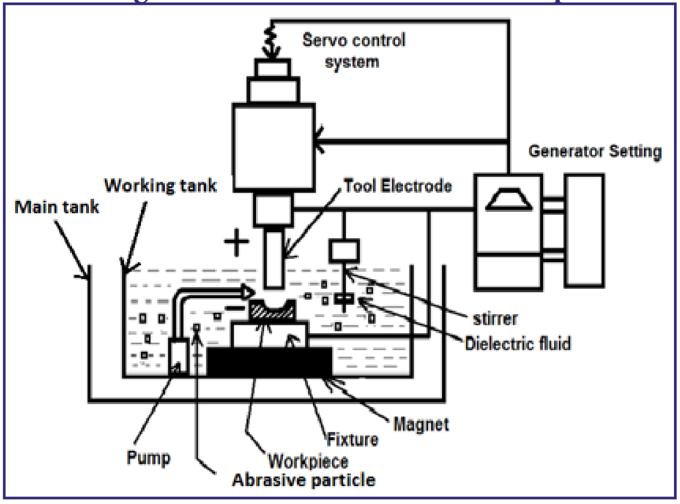
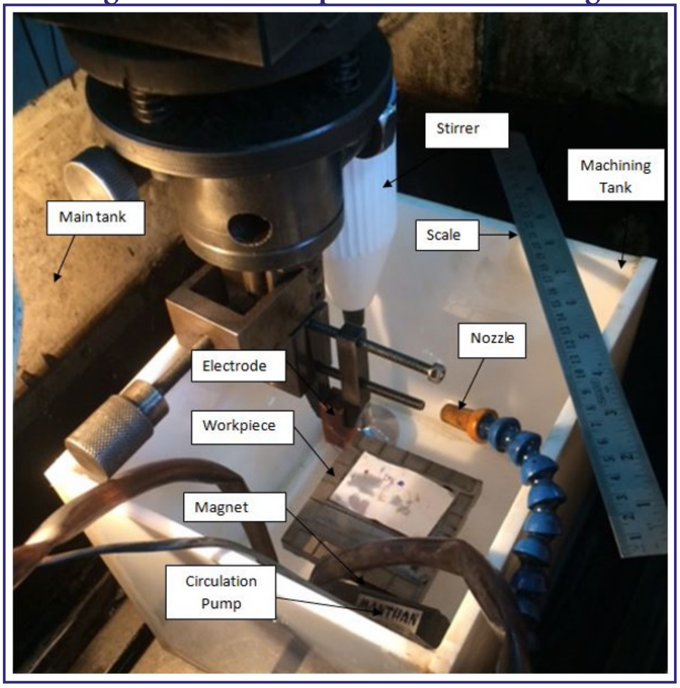


Fig. 2: EDM Set-Up for abrasive mixing



3.2 Work and Abrasive material

D3 Die steel was selected as work material. D3 die steel is an air hardening high carbon high chromium tool steel. It displays excellent wear resistance, heat treatable and will offer a hardness in the rage 58-64 HRC. It is used in blanking, thread rolling, drawing dies and pressing tools. A typical composition of D3 die steel is C (2.10%), Si (0.30%), Cr (11.50%), Mn (0.40%), Ni (0.311%).

B4C is hardest abrasive material among other abrasives and it is with a chemical formula of B4C. The density of B4C is 3.21g/cm3 and melting point is 27000c and there is no affect on acids and alkalis at 8000c. The high strength gives this material better thermal shock.

Fig. 3: Surface Roughness Measurement

3.3 Experimental Design

Minimum No. of experiments considered are = 18

The orthogonal array selected is L18 (21 x36)

Table 1: Process parameters and Levels

Code	Parameters	Levels		
		1	2	3
A	Nozzle flushing	Yes	No	-
B	Discharge current (Amp)	6	9	12
C	Duty Cycle (%)	0.6	0.7	0.8
D	Pulse on time (sec)	50	100	150
E	Abrasive concentration (g/lit)	2	4	6
F	Abrasive size	180	300	400
G	Gain (mm/sec)	0.8	0.9	1.00

Table 2: Parameters Assignment and experimental results

Expt. No.	Parameters							MRR (mm3/min)	SR (µm)	TWR (mm3/min)
	A	B	C	D	E	F	G			
1	Y	6	0.6	50	2	320	0.8	20.248	-4.082	35.917
2	Y	6	0.7	100	4	400	0.9	21.304	-2.007	38.416
3	Y	6	0.8	150	6	600	1.0	22.000	1.938	40.915
4	Y	9	0.6	50	4	400	1.0	23.756	-5.153	17.654
5	Y	9	0.7	100	6	600	0.8	24.302	-2.922	19.331
6	Y	9	0.8	150	2	320	0.9	23.322	-7.272	13.936
7	Y	12	0.6	100	2	600	0.9	26.701	-9.966	10.342
8	Y	12	0.7	150	4	320	1.0	26.188	-8.464	10.722
9	Y	12	0.8	50	6	400	0.8	27.454	-7.272	13.555
10	N	6	0.6	150	6	400	0.9	21.868	0.819	38.416
11	N	6	0.7	50	2	600	1.0	20.298	-4.349	40.000
12	N	6	0.8	100	4	320	0.8	21.007	-2.278	33.979
13	N	9	0.6	100	6	320	1.0	24.217	-7.604	13.722
14	N	9	0.7	150	2	400	0.8	23.191	-4.910	15.239
15	N	9	0.8	50	4	600	0.9	23.761	-3.227	19.331
16	N	12	0.6	150	4	600	0.8	26.547	-9.277	10.428
17	N	12	0.7	50	6	320	0.9	26.903	-8.130	10.903
18	N	12	0.8	100	2	400	1.0	26.128	-10.291	9.168

Table 3: Signal to Noise ratio and GRG values

Experi-ment No.	Normalized Signal to Noise ratios			GRG	Rank
	MRR (mm3/min)	SR (µm)	TWR (mm3/min)		
1	0.0000	0.5885	0.1574	0.4180	14
2	0.1465	0.3226	0.6787	0.4675	13
3	0.2431	0.0000	0.0000	0.3548	18
4	0.8467	0.5799	0.7326	0.5627	10
5	0.5625	0.3459	0.6797	0.5253	11
6	0.4266	0.7531	0.8813	0.6477	8
7	0.8954	0.7934	0.9630	0.8218	4
8	0.8242	0.8506	0.9510	0.8086	6
9	1.0000	0.7531	0.8618	0.8176	5
10	0.2248	0.0915	0.0787	0.3662	17
11	0.0070	0.5141	0.0288	0.3939	15
12	0.1053	0.3448	0.2184	0.3938	16
13	0.5507	0.7802	0.8565	0.6661	7
14	0.4083	0.5600	0.8087	0.5710	9

15	0.4875	0.4224	0.6798	0.5224	12
16	0.8796	0.9170	0.9587	0.8624	2
17	0.9235	0.8233	0.9453	0.8358	3
18	0.8159	1.0000	1.0000	0.9102	1

The Expt. No.18 has highest GRG value, it has the best performance characteristics. The combination for optimum sequence of experiments is 16,17,7and 9 etc

4. RESULTS AND DISCUSSION:

Table 5: Table of Response

Level	Flushing (A)	Current (B)	Duty Cycle (C)	Pulse on time (D)	Abrasive conc. (E)	Abrasive Size (F)	Gain (G)
1.	0.6023	0.3990	0.6160	0.5917	0.6271	0.6282	0.5981
2.	0.6134	0.5825	0.6001	0.6308	0.6028	0.6158	0.6101
3.	-	0.8427	0.6073	0.6015	0.5942	0.5802	0.6162
Delta	0.01098	0.4437	0.0158	0.0390	0.0327	0.0481	0.0181
Rank	**7**	**1**	**6**	**3**	**4**	**2**	**5**

The above table gives the different parameter levels. The optimum factors for levels are flushing-2, discharge current-3, duty cycle-1, pulse on time-2, abrasive concentration-1, abrasive size-1, and gain-3. The effective parameters are current with 0.8427, pulse on time-0.6308, abrasive particle size-0.6282, abrasive concentration-0.627), gain-0.6162, duty cycle-0.6160, flushing-0.6134. The optimal combination is A2B3C1D2E1F1G3; it gives reduced TWR, low SR and high MRR.

4.1 CONFIRMATION TEST:

With optimal parameters the confirmation experiments were carried out to predict and evaluate the SR, MRR and TWR for optimum sequence A1B3C1D2E1F1G3.

Table 7: Confirmation results

	Initial machining	Optimal machining		
		Values Predicted	Experimental value	Error (%)
Optimum Levels of combination	A1B2C1 D2 E3F1 G3	A1B3C1 D2E1F1 G3	A1B3C1 D2E1F1 G3	
MRR (mm3/min)	16.25	20.25	20.411	0.783
Ra(µm)	2.401	3.270	3.301	0.93
TWR (mm3/min)	0.206	0.348	0.346	0.57
GRG	0.6661	0.8629	0.8732	

Table.7 gives results for predicted and optimal parameters of B4C abrasive EDM. MRR is 20.411mm^3/min, Tool wear is 0.3460mm^3/min and SR is 3.3011µm. Experimental values are better than predicted and initial values.

5. CONCLUSIONS

The Analysis is carried out for B4C abrasive with D3 Die steel. The GRG is used to optimize the process parameters with the use of Minitab software. The fallowing Conclusions are made.

1. The MRR is increased16.25mm3/min, to 20.41mm3/min.
2. The Abrasive particles enlarges the gap, with this break down discharge is easier in EDM
3. As per the results the optimal sequence obtained is A1B3C1D2E1F1G3.
4. It is observed that the most influencing parameter is discharge current and it is followed by abrasive concentration and other factors are not having significant effect on the response.
5. GRG is developed by using Minitab software to predict the Surface roughness and TWR.
6. As per the confirmation test the surface roughness of 1.0370µm is in accordance with the Predicted value hence it validates the GRG Technique.

6. REFERENCES

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