Suresh Gyan Vihar University, Jaipur
International Journal of Converging Technologies and Management (IJCTM)
Volume 6, Issue 1, 2020
ISSN: 2455 – 7528

Comparative analysis of Micromachining by Electrochemical Discharge Machining

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ABSTRACT

In this paper, the assorted analysis on ECDM by assorted authors are discussed. The abstraction of electrochemical acquittal machining (ECDM), as well accepted as electrochemical atom machining (ECSM), was presented for the aboriginal time in 1968. This analysis commodity presents an absolute analysis of these contempt developments in ECDM process, its variants abnormally the agency MRR which is the prime and alone affair in amalgam machining industry. The approaching analysis possibilities are articular and presented as analysis potentials.

Keywords: ECDM, MRR, ADVANCEMENTS

1. INTRODUCTION

Electrochemical discharge machining is a discharge centered fabric elimination approach which has the knowledge for use as a micro-machining system. This process is above all priceless for machining electrically non-conducting materials. This complicated approach includes multiple parameters including instrument-electrode fabric, electrode measurement and form, wettability characteristic of software-electrode, feed-expense, workpiece fabric, pulsed utilized voltage, current, electrolyte, gap between inter-electrode and workpiece, distance between cathode and anode, anode materials, and so on [1].

It utilizes electrochemical and physical marvels to machine glass. The essential standard is clarified in Fig. 1. The workpiece is dunked in a proper electrolytic arrangement (normally NaOH or KOH). A consistent beat DC voltage is applied between the device cathode and the counter-anode. The device cathode is plunged a couple of millimeters in the electrolytic arrangement and the counter-anode is, when all is said in done, an enormous level plate. The apparatus cathode surface is in every case fundamentally littler than the counter-anode surface (by about a factor of 100). The device anode is by and large enraptured as a cathode; however the contrary polarization is additionally conceivable [2].

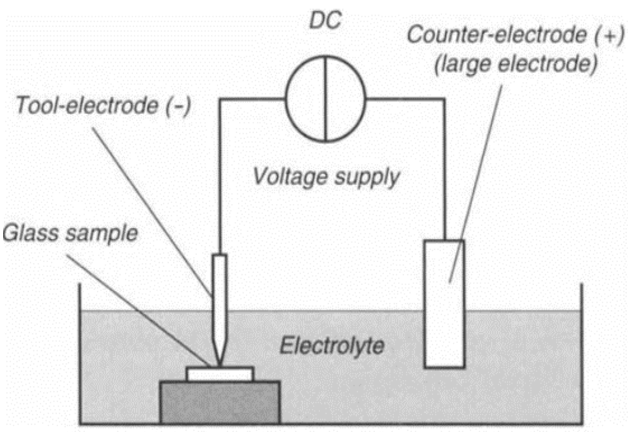

Figure 1 schematic diagram of ECDM set up

2. EXPERIMENTATION

2.1 Process parameters

After series of pilot experiments the best parameters of the operating range were selected. The pilot experiments were conducted for different combination of input parameters. The table of which has given below.

2.2 Experimental details

In the initial stage the readings were conducted without flow from the hollow electrode, whereas in the later stage the experiments were conducted with the flow of electrolyte in cathode. Various electrolytes like NaOH, KOH, $NaNO_3$, NaCl were used to investigate the output parameters.

Table 1 Process parameters and their specifications

Constant process parameter	Specification
Electrolyte	NaOH + KOH,$NaNO_3$ + NaOH and NaCl + NaOH
Tubular electrode (Tool) material / size	SS-304 / 1.27 mm OD and 0.838 mm ID
Anode (Auxiliary electrode)	Graphite block Length 30 * width 25 * thickness 20 mm
Work material / size	Soda lime glass slide / (75*25*1.3) mm^3
t_{off} (milli sec.)	100
Machining time (sec.)	300
Variable process parameter	Range
Applied Voltage (V)	50,57,63,69 and 75
D.F.	65,68,70,73 and 75
Electrolyte concentration (%, wt./Vol.)	40,45,50,55 and 60
Electrolyte flow rate (ml/ min)	1,2, 3, 4 and 5 (PF-ECDM)

2.2.1 NaOH+ KOH WITHOUT FLOW

Table 2 Response parameters of NaOH+ KOH without flow

Sr. No	Voltage (volts)	Conc. (%wt./vol.)	D.F. (T_{ON}/ T_{ON+} T_{OFF})	MRR (mg/min)	DOC (mm)
1	57	45	68	0.800	1.2632
2	69	45	68	1.260	1.4970
3	57	55	68	1.040	1.2796
4	69	55	68	1.280	1.4822
5	57	45	73	1.040	1.2459
6	69	45	73	1.280	1.5991
7	57	55	73	1.160	1.2285
8	69	55	73	1.280	1.5408
9	63	50	70	1.240	1.3439
10	63	50	70	1.220	1.4411
11	63	50	70	1.280	1.4469
12	50	50	70	0.480	1.2925
13	75	50	70	1.360	1.6033
14	63	40	70	1.280	1.4285
15	63	60	70	1.300	1.4108
16	63	50	65	1.280	1.3430
17	63	50	75	1.220	1.4394
18	63	50	70	1.420	1.3670
19	63	50	70	1.460	1.4102
20	63	50	70	1.440	1.3404

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2.2.2 NaOH+ KOH WITHOUT FLOW

Table 3 Response parameters of NaOH+ KOH with flow

Sr. No	Voltage (volt)	Conc (% wt./ vol.)	EFR (ml/min)	D.F. (T_{ON}/ T_{ON+} T_{OFF})	MRR (mg/min)	DOC (mm)
1	57	45	2	68	1.280	1.2555
2	69	45	2	68	1.160	1.4798
3	57	55	2	68	1.060	1.3785
4	69	55	2	68	1.200	1.4663
5	57	45	4	68	1.380	1.2117
6	69	45	4	68	1.460	1.6011
7	57	55	4	68	1.040	1.2223
8	69	55	4	68	1.300	1.5412
9	57	45	2	73	1.340	1.2080
10	69	45	2	73	1.320	1.6255
11	57	55	2	73	1.680	1.3928
12	69	55	2	73	1.960	1.5363
13	57	45	4	73	1.080	1.3394
14	69	45	4	73	1.240	1.5549
15	57	55	4	73	1.160	1.2900
16	69	55	4	73	1.800	1.5578
17	50	50	3	70	1.120	1.2105
18	75	50	3	70	1.620	1.6066
19	63	40	3	70	1.480	1.5520
20	63	60	3	70	1.860	1.6121
21	63	50	1	70	1.360	1.5526
22	63	50	5	70	1.380	1.5127
23	63	50	3	65	1.540	1.3166
24	63	50	3	75	1.960	1.4833
25	63	50	3	70	2.460	1.4325
26	63	50	3	70	2.280	1.4760
27	63	50	3	70	2.480	1.4558
28	63	50	3	70	2.400	1.4089
29	63	50	3	70	2.560	1.4798
30	63	50	3	70	2.380	1.4060

2.2.3 NaOH+ NaNO3 WITH FLOW

Table 4 Response parameters of NaOH+ $NaNO_3$ with flow

SR. NO	Voltage (volt)	Conc. (% wt./vol)	EFR (ml/min)	D.F. (T_{ON}/ T_{ON+} T_{OFF})	MRR (mg/min)	DOC (mm)
1	57	45	2	68	1.460	1.460
2	69	45	2	68	1.120	1.220
3	57	55	2	68	1.440	1.440
4	69	55	2	68	1.460	1.460
5	57	45	4	68	1.360	1.360
6	69	45	4	68	1.380	1.380
7	57	55	4	68	1.480	1.480
8	69	55	4	68	1.380	1.380
9	57	45	2	73	1.400	1.400
10	69	45	2	73	1.420	1.420
11	57	55	2	73	1.360	1.360
12	69	55	2	73	1.420	1.420
13	57	45	4	73	1.080	1.280
14	69	45	4	73	1.420	1.420
15	57	55	4	73	1.480	1.480
16	69	55	4	73	1.320	1.320
17	50	50	3	70	1.220	1.228
18	75	50	3	70	1.200	1.220
19	63	40	3	70	1.260	1.260
20	63	60	3	70	1.240	1.240
21	63	50	1	70	1.440	1.440
22	63	50	5	70	1.540	1.540
23	63	50	3	65	1.220	1.224
24	63	50	3	75	1.880	1.880
25	63	50	3	70	1.960	1.960
26	63	50	3	70	2.000	2.010
27	63	50	3	70	2.120	2.120
28	63	50	3	70	1.900	2.540
29	63	50	3	70	2.040	2.340
30	63	50	3	70	2.060	2.260

2.2.3 NaOH+ NaCl WITH FLOW

Table 5. Response parameters of NaOH+ NaCl with flow

Sr. No	Voltage (volt)	Conc. (%wt. /vol.)	EFR (ml/min)	D.F. (T_{ON}/ T_{ON+} T_{OFF})	MRR (mg/min)	DOC (mm)
1	57	45	2	68	1.460	1.6015
2	69	45	2	68	1.760	1.5246
3	57	55	2	68	1.400	1.5715
4	69	55	2	68	1.300	1.3829
5	57	45	4	68	1.460	1.371
6	69	45	4	68	1.440	1.2747
7	57	55	4	68	1.600	1.3337
8	69	55	4	68	1.240	1.3302
9	57	45	2	73	1.880	1.5563
10	69	45	2	73	1.600	1.3654
11	57	55	2	73	1.060	1.3455
12	69	55	2	73	1.100	1.3326
13	57	45	4	73	1.160	1.5941
14	69	45	4	73	1.100	1.533
15	57	55	4	73	1.180	1.6164
16	69	55	4	73	1.000	1.5606
17	50	50	3	70	1.380	1.9436
18	75	50	3	70	1.120	1.7948
19	63	40	3	70	1.160	1.4219
20	63	60	3	70	1.180	1.4596
21	63	50	1	70	1.300	1.4849
22	63	50	5	70	1.500	1.4108
23	63	50	3	65	1.920	1.385
24	63	50	3	75	1.940	1.4544
25	63	50	3	70	2.080	1.467
26	63	50	3	70	2.160	1.4691
27	63	50	3	70	2.100	1.4618
28	63	50	3	70	2.040	1.4343
29	63	50	3	70	2.060	1.4043
30	63	50	3	70	2.040	1.4102

2.3 Comparison of investigations of mixed electrolyte

Table 6. Comparison of investigations of mixed electrolyte

Sr. No.	Electrolyte name/type	MRR (Max.)	DOC (Min.)
1	NaOH+ NaOH without flow	1.460	1.2285
2	NaOH+ NaOH with flow	2.560	1.2080
3	NaOH+ $NaNO_3$ with flow	2.120	1.2200
4	NaOH+ NaCl with flow	2.160	1.2747

3. CONCLUSIONS

In this paper various electrolytes have been compared with various factors keeping into consideration. When we look into comparison of the outcome results the material removal rate and diameter of overcut of the process of NaOH and KOH with flow gives optimized results . Thus, can be concluded with the fact that NaOH + KOH remains the main source of electrolyte which can be used for machining. While the fact that environmentally friendly electrolyte can be used in future to avoid harmful gases emitting during reaction and efforts can be made to reduce the operating temperature while during machining which can leads to change in chemical particles of the machining surface.

Table 7 Parameters influencing machining process

Machining Parameter	Ranking	Percentage
Duty Factor	II	26
Electrolyte Flow rate	IV	18
Applied voltage	I	34
Electrolyte Concentration	III	22

4. REFERENCES

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