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Optimization of Machining Parameters for Electrochemical Discharge Machining for Soda Lime Glass

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***Abstract:** In this study machining of soda lime glass with the help of copper electrode (cathode) and stainless steel (anode) electrode has been done. The electrolyte used was a mixture of sodium hydroxide and potassium oxide of specific concentration. An orthogonal array of L27 has been designed for the different input parameters such as voltage, electrolyte concentration and current. From the experimental study it was found that the applied voltage has the maximum influence on the responses that is material removal rate (MRR) and tool wear rate (TWR). Highest value for MRR was obtained at an applied voltage, electrolyte concentration, current of 70 V, 35 wt% and 6A respectively & TWR was minimum at an applied voltage, electrolyte concentration, current of 60V, 25 wt% and current was 6A respectively.*
***Keywords:** ECDM, soda lime glass, MRR, current, taguchi*

I. INTRODUCTION

For the manufacturing of high-quality products most of the industries are dependent on traditional and non-traditional manufacturing processes, which make changes in size, shape, dimensions and surface quality of the product. Various non-traditional machining methods are applied to process the brittle and hard materials such as glass, ceramics and its composites materials [1]. The glass having the highest hard and brittle material therefore it is a challenging task to process it with both traditional and modern manufacturing processes. From the family of glass sodalime glass is mostly used in industries for different purposes due to its excellent properties such as high chemical resistivity, corrosion resistance, biocompatibility, high specific strength, heat-resisting capacity, excellent mechanical hardness, excellent anodic bonding, high electrical resistivity and good surface quality [2-4]. The glass material can be efficiently machined by using electrochemical discharge machining process (ECDM), Electro chemical discharge machining (ECDM) is micro machining hybrid process where the machining is done with the both thermal sparking and chemical etching phenomena. Generally, ECDM is used for the machining of electrically non- conducting, high strength and brittle materials. ECDM has the potential of machining of electrically non-conducting materials like glass, composites, ceramics and other hard and brittle materials which are electrically non-conducting materials like quartz, glass , composites, ceramics and other hard and brittle materials which having the huge application in the field of aerospace, defense, electronics and automobile [5].

ECDM was the first machining procedure which was, ready to do machining of non-leading, fragile and other hard materials.ECDM was the principal created by Kurafuji and Suda of japan in year 1968[6]. After that they named that machining procedure as electrical release machining this procedure was predominantly blend of ECM and EDM in this procedure they characterized the odds of making miniaturized scale openings in a glass. Their examination was identified with discover the impact of electrolyte fixation and device cathode materials on MRR instrument. After Kurafuji and Suda of japan took a shot at ECDM another analyst in the time of 1973 Cook et.al [7] give the new name of the procedure as electro release machining of electrically non-leading fragile and hard materials, by saying that the procedure which is portrayed by the Kurafuiji and Suda is not quite the same as the ECM and EDM. He connected the diverse procedure to various classes of non-directing materials and furthermore considered the impact of that distinctive electrolyte on various non-leading materials. In the year 1985, T suchiya et al [8] gave another name of that ECDM procedure which was named as the wire electrochemical release machining process. In that procedure he demonstrated that this strategy can be utilized to cut distinctive glass and earthenware production. In the year 1990 at the same time explore had been done on the ECDM procedure. In the year 1997, Another Researcher Basak and Ghosh [9] discover that the MRR in the ECDM is the joined impact of starting and compound response between the instrument terminal tip and work piece. Amid their investigated worked they additionally built up the improved model of ECDM to anticipate the attributes of MRR for changing distinctive info parameters of ECDM, their work likewise asserted that the upgrade of the capacity of the procedure through adjustment of electrolyte circuit. In the year 2004, Sakarbalak et al. [10] built up another model of to discover the current of electrochemical disintegration and electro release machining in the ECDM procedure. In this model they attempted to utilize fluffy rationale controller for ECDM process. In year 2004, Mediliyegedara et al. [11] built up another technique which is new as control procedure for ECDM process in which machining process is completed a primer investigation of heartbeat grouping framework.

In this present study, an attempt is made to find out the optimum parameters values for soda lime glass while machining it on electrochemical discharge machining process with different input variables.

II. EXPERIMENTAL DETAILS

Miniaturized scale machining of soft drink lime glass is finished with the copper cathode pole of 2mm width as an apparatus, with the remain of separation between instrument i.e. copper pole and workspace surface i.e. soft drink lime glass is 0.2mm. Machining is finished with the by moving the device descending way with the assistance of gravity encouraging system with the consistent feed.

Test are planned by utilizing the taguchi strategy in which L27 symmetrical exhibit are taken for the structure of no try different things with the procedure parameter connected voltage(V), electrolyte focus (EC) and current(C). Each procedure parameter are having the tree distinctive dimension i.e. Connected voltage has the dimensions of 50V, 60V and 70V.similarly electrolyte likewise has three distinctive dimension which are 25%, 30% and 35% and current additionally has three diverse dimension which are given by 4A, 5A and 6A.

Table 1- Different process parameter with their different level

Name	Level
Applied voltage (V)	50, 60, 7 0
Electrolyte concentration (Noah+ KOH) (Wt %)	25%, 30%, 35%
Current (A)	4, 5, 6

III. RESULT AND DISCUSSION

Table 2 represent the run order and the values for tool wear rate and material removal rate as per desired input variables and corresponding to that the SN ratio are also listed.

Table 2- Data for MRR and TWR

Exp no	Applied voltage (V)	Electrolyte concentration (%wt)	Current (A)	MRR (mg/min)	TWR (mg/min)	SNRA1	SNRA2
1	50	25	4	0.161	0.017	-15.8635	35.391
2	50	25	5	0.175	0.015	-15.1392	36.4782
3	50	25	6	0.181	0.01	-14.8464	40
4	50	30	4	0.21	0.019	-13.5556	34.4249
5	50	30	5	0.221	0.0425	-13.1122	27.4322
6	50	30	6	0.25	0.01	-12.0412	40
7	50	35	4	0.275	0.0125	-11.2133	38.0618
8	50	35	5	0.28	0.015	-11.0568	36.4782
9	50	35	6	0.301	0.0155	-10.4287	36.1934
10	60	25	4	0.312	0.0125	-10.1169	38.0618
11	60	25	5	0.33	0.0125	-9.6297	38.0618
12	60	25	6	0.35	0.0134	-9.1186	37.4579
13	60	30	4	0.345	0.0145	-9.2436	36.7726
14	60	30	5	0.354	0.0175	-9.0199	35.1392
15	60	30	6	0.365	0.0167	-8.7541	35.5457
16	60	35	4	0.398	0.0175	-8.0023	35.1392
17	60	35	5	0.407	0.0189	-7.8081	34.4708
18	60	35	6	0.409	0.018	-7.7655	34.8945
19	70	25	4	0.406	0.0212	-7.8295	33.4733
20	70	25	5	0.422	0.0245	-7.4938	32.2167
21	70	25	6	0.431	0.0267	-7.3105	31.4698
22	70	30	4	0.454	0.0298	-6.8589	30.5157
23	70	30	5	0.466	0.032	-6.6323	29.897
24	70	30	6	0.487	0.0324	-6.2494	29.7891
25	70	35	4	0.503	0.0356	-5.9686	28.971
26	70	35	5	0.516	0.0365	-5.747	28.7541
27	70	35	6	0.535	0.0378	-5.4329	28.4502

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The primary objective was to optimize the process parameters if ECDM for soda lime glass machining. Fig 1 shows the main effect plot of tool wear rate and from the plot it can be found that TWR first increases upto 60 V which is also maximum and then suddenly decreases and in case of electrolyte concentration it is maximum at 25% then decreases and almost become stable between 30% to 35% and TWR is maximum at 6 A current whereas least at 5 A. The response table for TWR is shown in table 3 and from that it can be concluded that applied voltage is the significant factor and current is the least important variable.

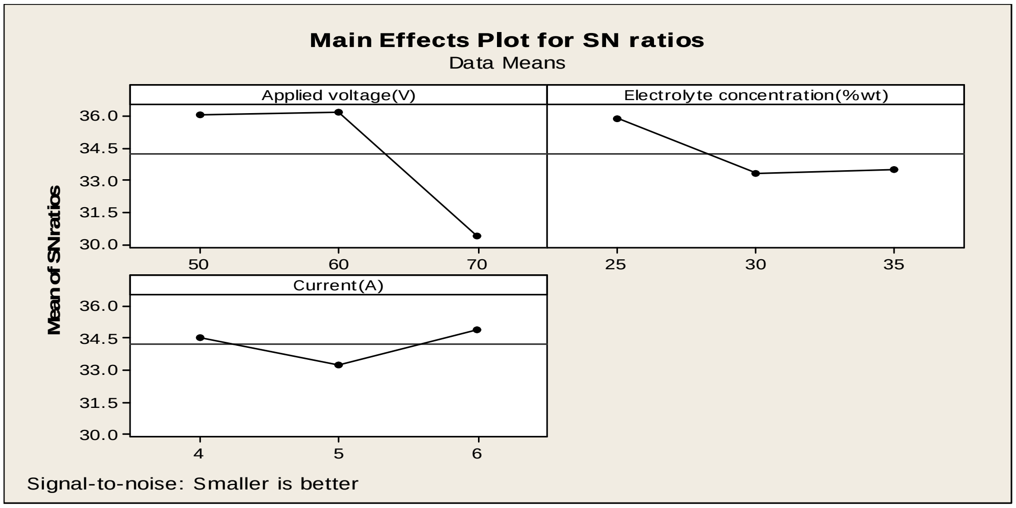

Fig.1 – Main effect plot for Tool Wear Rate

Table 3- Response table for TWR

Level	Applied voltage	Electrolyte conc.	Current
1	36.05	35.85	34.53
2	36.17	33.28	33.21
3	30.39	33.49	34.87
Delta	5.78	2.57	1.65
Rank	1	2	3

Figure 2 shows the main effect plot of material removal rate and from the plot it is found that MRR will be maximum when the applied voltage, electrolyte concentration and current are 70 V, 35% and 6 A respectively. Table 4 present the response variable for MRR and it was found that voltage is the significant and current is the least important variable in material removal rate.

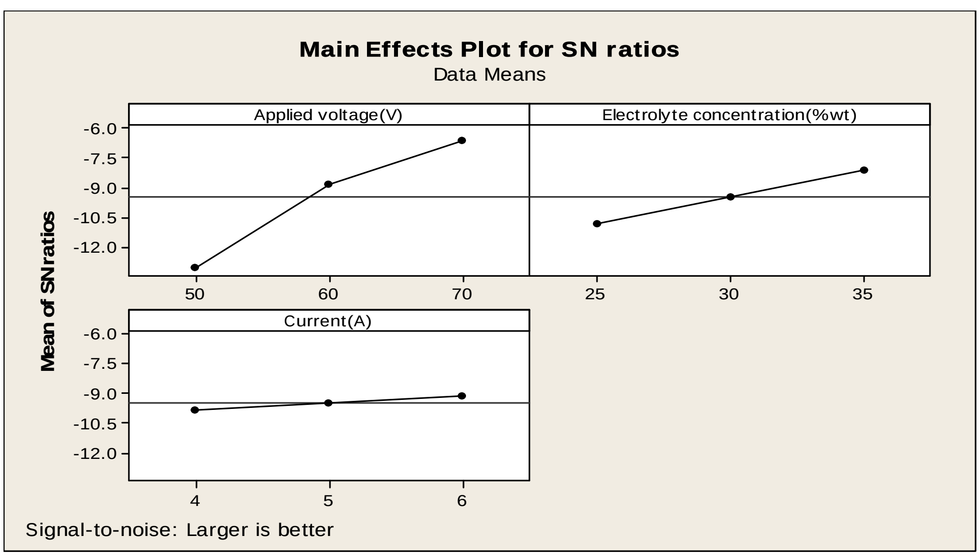

Fig.2 – Main effect plot for Material Removal Rate

Table 4 – Response table for Material Removal Rate

Level	Applied voltage	Electrolyte conc.	Current
1	-13.029	-10.816	-9.850
2	-8.829	-9.496	-9.515
3	-6.614	-8.158	-9.105
Delta	6.415	2.658	0.745
Rank	1	2	3

IV. CONCLUSION

From this study the following conclusion has drawn:

A. For material removal rate, the most important parameter is applied voltage and least effective parameter is current.
B. The most advantageous combination for the input variable in case of MRR is applied voltage 70 V, electrolyte concentration 35 % and current of 6 ampere.
C. For tool wear rate, the most important parameter is applied voltage and least effective parameter is current.
D. The most advantageous combination for the input variable in case of TWR is applied voltage 60 V, electrolyte concentration 25 % and current of 6 ampere.

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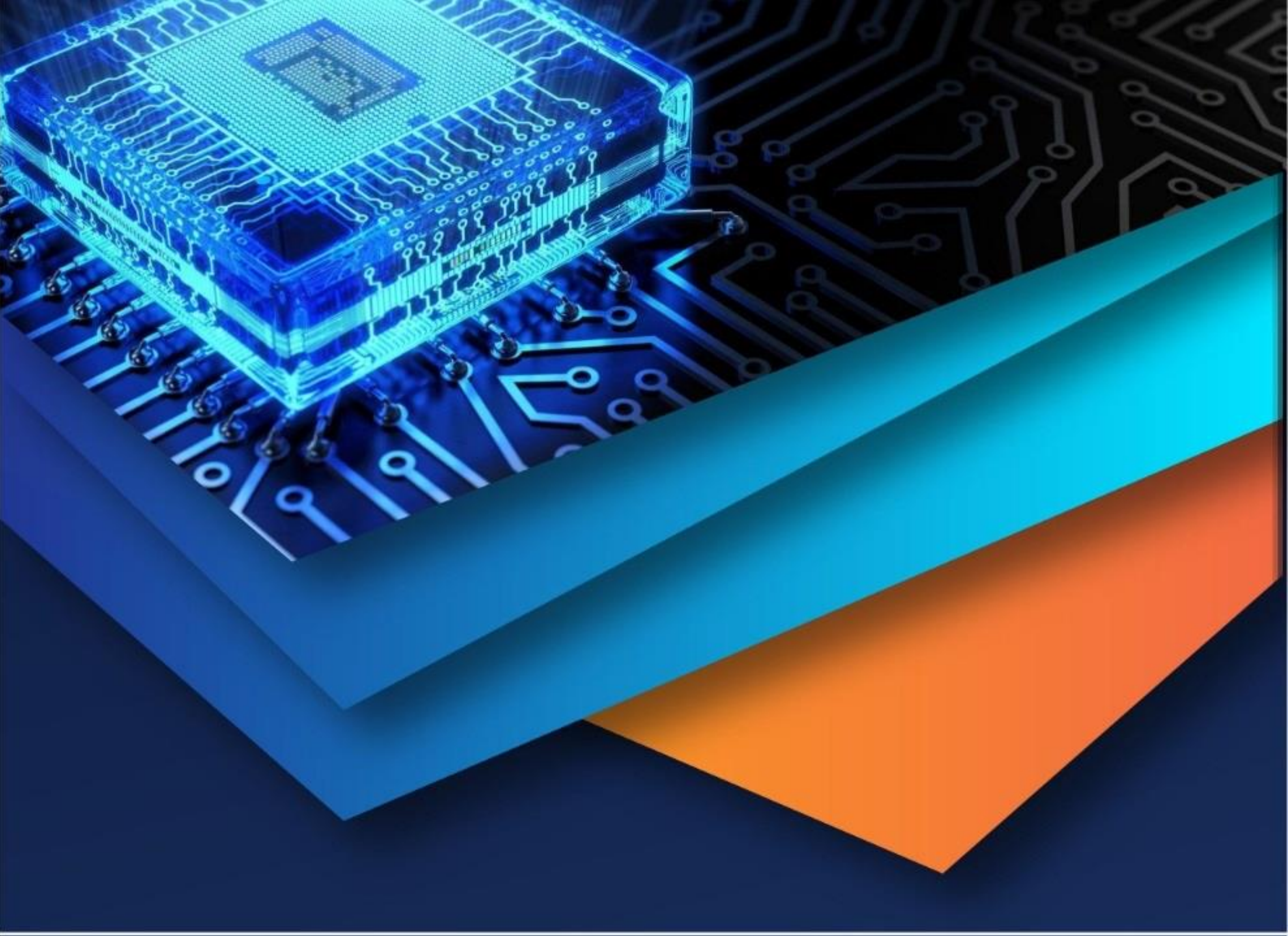

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