

EXPERIMENTAL INVESTIGATION OF PROCESS PARAMETERS FOR MACHINING OF ALUMINIUM ALLOY 6082 WITH GRAPHITE TOOL ON EDM

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ABSTRACT: Now a days, the production of complicated shapes of different components with high accuracy is very difficult and take much time by conventional machining process. To get-rid of the one non conventional machining process which is used very widely in EDM, it is necessary to optimize the process parameters like pulse on-time (T_{ON}), pulse off-time (T_{OFF}), discharge current (I), voltage (V) for maximization of material removal rate (MRR), minimum tool wear rate (TWR), minimum surface area (R_a) for various materials like aluminium alloy 6082. The aluminium alloy 6082 is machined using graphite electrode on spark erosion machine. Basically EDM is well-established non-conventional machining process used for manufacturing geometrically complex or hard and electrically conductive material parts that are extremely difficult to cut by other conventional machining processes. Erosion pulse discharge occurs in small gap between work piece and the electrode, this removes the unwanted material from the parent metal through melting and vaporizing in the presence of dielectric fluid. The presence of metal particles in dielectric fluid diverts its properties, which reduces the insulating strength of the dielectric fluid and increases the spark gap between work piece and electrode. As a result, the process becomes more stable and surface finish increases. The EDM process is mainly used for making dies, moulds, parts of aerospace, automotive industry and surgical components etc.. The process parameters are optimized for maximum material removal rate (MRR), tool wear rate (TWR) and surface roughness (R_a) based on experimental results by using DOE and optimization for best machining can be done by response surface methodology.

Key words: electrical discharge machining, current, voltage, aluminium alloy 6082, Graphite tool, RSM.

I. INTRODUCTION:

Presently now a days, the generation of confused states of various segments with high precision is troublesome and take much time by traditional machining procedure like machine tools, to overcome this imperfection utilizing the non-regular machining procedure like EDM. The right determination of machining condition is one of the most significant viewpoints to mull over in most of assembling forms and especially, in procedures identified with Electrical Discharge Machining (EDM). EDM has risen as an exceptional methodology for machining conductive metals that are generally troublesome or difficult to machine with customary techniques. It is a fit for machining geometrically mind boggling and hard material parts, that are exact and hard to-machine, for example, heat treated device steels, composites, super alloys, pottery, carbides, and so on being broadly utilized in bite the dust and form making enterprises, aviation, flight and atomic ventures. Inside EDM process, the working hole between the instrument and work piece is exceptionally little (in the scope of 10-100 μm). In this outrageous little hole, the machined garbage on the off chance that present, at that point causes superfluous interference in the machining. Likewise the expulsion of this flotsam and jetsam from the machining hole is troublesome. Likewise in the wake of machining, the geology of the machined surface by customary EDM brings about cavity development and surface breaks, because of numerous reasons like arcing, short and open circuiting an imprudent power caused during dielectric blast. Flushing the garbage completely and totally from the machining hole is one of the real difficulties in EDM process. Aggregation of trash in machining hole space causes idle heartbeats, for example,

short and open circuit and bend. These kinds of releases don't expel any material from the work piece and also it harms the surface respectability of machined work piece. By thinking about these reasons, the majority of the scientists concentrated on the strategies which improve the flushing in EDM, endeavors like presenting of empty cylinders, vibration to work piece, dielectric changes, and so on. Strategies, for example, EDM with pivoting instrument cathode low recurrence vibration helped EDM and joined of vibration and revolution of anode was acquainted with build up the flushing of dissolved molecule in hole space and improve the machining execution. The utilization of attractive field in non-customary machining procedure was effectively presented by numerous analysts in various ways. Advancement of Magnetic grating completing (MAF) and attractive. The Grating stream completing (MAFF) techniques to clean metal, earthenware and composite materials up to the mirror surface. Utilization of attractive field in electrolytic completing procedure. Was effectively endeavored in improving the nature of EDM machined surface by presenting attractive abrasives. Albeit a few inquiries about coordinated the attractive field with the assembling procedure, just a couple of work researched the impacts of attractive power on EDM execution. Lin and Lee (2008) connected the attractive field over EDM process and inferred that flotsam and jetsam expulsion from the machining hole improves the EDM procedure strength and furthermore the proficiency, nature of machined surface particularly during high release vitality system. The utilization of attractive fields for hole cleaning in EDM was first connected by De Bruijn et al. (1978) in the examination and inferred that for attractive work piece materials, the use of attractive field disposes of the flotsam and jetsam from the machining hole all the more effectively. Another pattern setting exploratory research field was helped by Joshi et al., presenting a throbbing attractive field over dry EDM process, the crossover procedure relatively demonstrated increasingly proficient than ordinary way. In this examination, an endeavor of connecting electric field arrangement to the EDM machine was finished. The consolidated arrangement was then used to get ready for a progression of tests of this work. The EDM framework parameters like current (I), beat on schedule (TON), beat off time (TOFF) were shifted at various levels and afterward the impacts on machining reactions like material expulsion rate (MRR) and surface unpleasantness (Ra) were investigated. The exploratory outcomes recommend that the joined arrangement has beneficial outcome over EDM process and furthermore the surface incorporates given by magnifying instrument pictures on smaller scale structures were at benefit on the equivalent and sifted by a siphon from the capacity tank. All through the investigations work piece was aluminum amalgam 6082 t6 and cathode device material was graphite. The work piece surface and anode end surface was ground cleaned with the sand paper to guarantee evenness and soil free conditions.

II. LITERATURE REVIEW:

Electrical release machining is a machining strategy primarily utilized for hard metals or those that would be hard to machine with customary techniques. EDM normally works with materials that are electrically conductive, in spite of the fact that methods for machining protecting pottery with EDM have likewise been proposed.

Some survey on research papers require to ponder in this part associated towards electrical release machining. From the readings out in these papers and postulation is for the most part worried through the EDM settings, for example, the release current, applied voltage, plus on time, plus off time, duty cycle, etc. and how these parameters will influence the machining yields like MRR, Ra, TRR and so on.

K.S.BANKER, A.D.OZA, R.B.DAVE [2013] learn about the exhibition capacities of EDM machining utilizing aluminum, brass and copper for AISI304L material. In EDM process the material is expulsion is happened electro thermally by arrangement of progressive discrete releases among terminal and the work piece. The execution abilities of the EDM procedure by utilizing distinctive anode materials has been completed. In this postulation utilizing the different kinds of cathode materials for improving the machining proficiency. The target of the trial is to recognize the best material regarding higher MRR, lower TWR, and magnificent surface unpleasantness.

ANUP B.PATEL, Mr.KRUNAL SHAH, Mr.DIVYANG PANDYA [2014] learn about the trial examination and improvement of procedure parameters in WEDM for aluminum - 6082. This research completed for the compound 6082 of aluminum material. The research did here incorporate material evacuation rate and surface unpleasantness of the equivalent material. Input process parameters that are contemplated are wire speed & wire strain. The impact of info parameter on execution parameter, for example, material expulsion

rate and surface harshness was tentatively noted and advancement of parameters is finished with assistance of RNS.

NALIESETTY VIMALA[2018] learn about the advancement of procedure parameters utilizing taguchi technique while machining H13Hot kick the bucket steel material on bite the dust sink EDM.Here investigation did on the H13 hot steel material by utilizing the copper tool. The goal of the proposition is getting most extreme material expulsion rate, least apparatus wear rate and surface unpleasantness of work piece by DOE esteems at that point plot the diagrams identified with MRR,TRR and Ra.

G. D'Urso, G. Maccarini and C. Ravasio dissected the impact of anode material in smaller scale electro-release machining (EDM) penetrating of tempered steel and tungsten carbide metal plates.

Metal and tungsten carbide cathodes were chosen dependent on their diverse electrical and warm properties. The trial battle depended on the execution of an enormous number of miniaturized scale gaps did by differing some procedure parameters, specifically the pinnacle current, voltage, and recurrence.

The device wear proportion and material expulsion rate were accepted as procedure execution files, while the diametric overcut and decrease rate were considered as geometric files. The investigation of fluctuation (ANOVA) was connected on the outcomes turning out from the examinations. Additionally, a general Process Index dependent on both procedure parameters and cathode material properties was proposed. This file fits, with a decent connection level, all the procedure execution and geometric markers for both the thought about work piece materials. An examination between the presentations estimated utilizing treated steel and tungsten carbide work pieces was likewise done. The consequences of this test research demonstrated that electrical resistivity, warm conductivity, and liquefying purpose of both anode and work piece materials significantly affect the procedure and geometric execution.

III.EXPERIMENTATION:

There has been a long-standing, uncertain discussion about whether graphite or copper is a superior EDM terminal material. The inclination is most consistently the equivalent in any one geological locale. In North America, the favored anode material has moved from copper to graphite. In Europe and Asia, many contend that copper is the best material. Maybe it's a great opportunity to investigate the two materials to distinguish the distinctions and help you select the one that is most fitting for your EDM applications.



Fig:1.Sample work material(aluminium alloy 6082)

Aluminum combination 6082 is a medium quality compound with amazing consumption obstruction .it has the most astounding quality of the 6000 arrangement alloys. Alloy 6082is known as an auxiliary alloy. IN plate form, 6082 is the amalgam most ordinarily utilized for machining.

TABLE:1.chemical composition

Element	Si	Fe	Cu	Mn	Mg	Zn	Ti	Cr	Al
%Present	0.7-1.3	0.0-0.5	00-0.1	0.4-1.0	0.6-1.2	0.0-0.2	0.0-0.1	0.0-0.25	Balance

General properties:

Density	2.7g/cm ³
Young's modulus	71Gpa or 10Msi.
Ultimate tensile strength	140to330Mpa
Yield strength	280Mpa
Melting point	575°c

Electrode material:

In this analysis we are utilizing electrolytic graphite material. It can be expelled or attracted and after that machined to required shape and size. It has low wear rate during roughening and finishing activities. Attributes of graphite device

- High electrical and warm conductivity

Chemical composition electrolytic graphite:

Chemical composition –carbon

General properties:

Density 2.09-2.23g/cm³

Melting point 4300k

IV. EXPERIMENTAL SETUP:

To begin with, the work piece is to be mounted on the table of EDM. The work piece is situated at wanted spot on the 'T' space table by opening the entryway of the tank, at that point clasp the work piece. In the wake of clipping the work piece and setting it appropriately, hold the anode immovably in the V square. By X-Y organize and servo slide developments, the anode ought to be situated over the ideal cavity. At that point alter the buoy switch with the goal that the dielectric level is at least 5mm over the highest starting point. At that point close the entryway solidly with the clasps. The activity is currently set for working the machine.



Fig2.experimental setup without magnetic field

IV. EXPERIMENTAL PROCESS:

In EDM, for the most part the device is associated with the negative terminal of the generator and the work piece is associated with positive terminal. Presently, the DRO is arrangement for the anode position as for work piece. DRO sets the estimations of reference point as inception for cathode, to change units, to flip between either gradual or supreme beginning or profundity of cut. After the info parameters flow (I), voltage (V), Pulse ON Time (TON) and Pulse OFF Time (TOFF) are set in the control board, the Electrical release machining begins and relying on the connected potential distinction and the hole between the instrument and work piece, an electric field would be set up. As the electric field is set up between the instrument and the activity, the free electrons on the device are exposed to electrostatic powers

The rapid electrons at that point encroach at work and particles on the instrument consequently machining the work piece. Likewise, the flushing is exchanged ON and is set at a weight of 0.75 kg/cm². The time taken for the procedure for the ideal profundity of cut, the device and work piece loads when each machining trial and the surface harshness esteems are noted. The Material Removal Rate and Tool Wear Rate are determined as,

$MRR = \frac{\text{weight before machining} - \text{weight in the wake of machining}}{\text{Time} \times \text{thickness of material}}$
Where weight in grams, time in minutes, and thickness in kg/mm³.

TWR= (Tool weight before machining-Tool weight in the wake of machining)/time Where weight in grams and time in minutes.

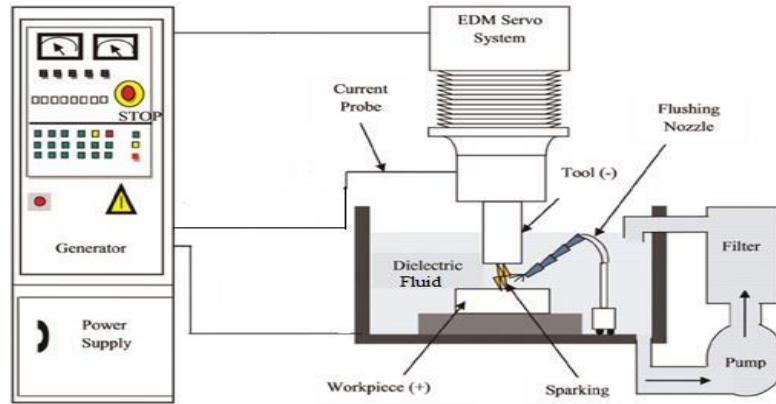


Fig 3. Block diagram of EDM



Fig:4.al alloy6082 before machining material

fig 5.al alloy 6082 afetr machinig material

TABLE 2.Observation table:

S.NO	Current (I)	T _{ON}	T _{OFF}	Voltage (v)	M.R.R (mm ³ /min)	T.R.R (g/min)	Time (sec)	R _a	R _z
1	15	7	7	40	142.2729	-150.87048	1.3667	13.76	38.91
2	15	8	8	50	75.84512	16.4227	4.6342	13.76	38.91
3	15	8	8	60	84.8978	31.7164	4.0179	11.045	31.215
4	15	9	9	70	86.45678	22.9263	3.6670	13.96	39.47
5	20	7	8	70	47.46653	13.5116	6.4841	14.79	41.695
6	20	8	7	80	63.90426	24.8623	5.5349	15.2	42.98
7	20	9	10	40	98.92596	37.22039	2.9839	13.395	37.89
8	20	10	9	60	66.37188	18.74519	5.3347	14.915	42.185
9	25	7	7	80	80.7457	35.89950	4.0181	12.915	36.53
10	25	8	9	70	76.56542	-3.12805	4.6680	16.515	46.715
11	25	10	8	80	66.15209	18.08861	5.2348	12.16	34.38
12	25	9	7	60	103.8070	47.61285	2.7508	17.395	49.195
13	15	7	7	60	98.8877	11.23384	3.5843	16.075	45.465
14	15	8	8	50	64.59604	33.20582	4.3174	13	36.755
15	15	8	8	60	62.804122	27.12488	5.3016	11.799	33.365
16	15	9	9	70	35.7757	33.33207	6.0666	10.399	29.405
17	20	7	8	70	32.05387	17.77680	5.6502	15.915	45.015

18	20	8	7	80	45.23505	28.4435	4.6669	21.75	61.53
19	20	9	10	80	31.94344	25.6352	5.3335	14.275	40.38
20	20	10	9	60	30.80257	28.1949	4.8336	12.64	35.68
21	25	7	7	80	37.616521	29.8657	4.6669	14.945	43.04
22	25	8	9	70	43.22469	26.37671	5.1668	16.27	46.025
23	25	9	7	60	38.77134	36.4909	3.9166	13.56	38.34
24	25	10	8	80	37.0991	35.21014	3.9334	11.73	32.67

VI. ANALYSIS OF VARIANCE (ANOVA):

Investigation of difference is a theory testing procedure used to test the correspondence of at least two populace (or treatment) implies by looking at the changes of tests that are taken. ANOVA permits one decide if the contrasts between the examples are just because of irregular error (sampling blunders) or whether there are precise treatment impacts that causes the mean in one gathering two vary from the mean in another. More often than not ANOVA is utilized to look at the correspondence of at least three methods, anyway when the methods from two examples are contrasted utilizing ANOVA it is proportionate with utilizing a t-test to analyze the methods for free examples.

ANOVA depends on contrasting the difference (or variety) between the information tests to variety inside every specific example. In the event that the between variety is a lot bigger than the inside variety, the methods for various examples of won't be equivalent. On the off chance that the between and inside varieties are roughly a similar size, at that point there will be no huge distinction between test implies.

TABLE 3. ANOVA results for MRR:

Source	DF	Adj SS	Adj MS	F-value	P-value
I	2	1511.5	755.77	1.27	0.019
T _{ON}	3	350.9	116.97	0.20	0.897
T _{OFF}	3	718.8	239.59	0.40	0.754
V	4	4810.8	1202.69	2.02	0.016
Error	11	6544.0	594.91		
Lack-of-fit	1	4.0	4.03	0.01	0.939
Pure Error	10	6540.0	654.00		
Total	23	18729.1			

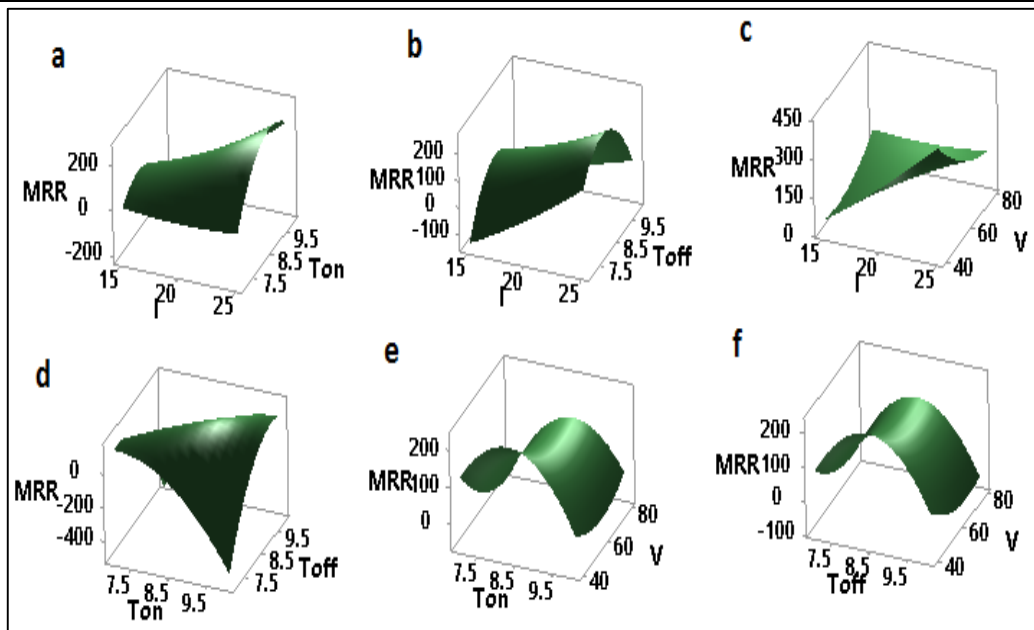


Fig 6. Graphs for two factors interaction on MRR(aluminum alloy 6082)

TABLE 4.ANOVA result for TWR:

Source	DF	Adjss	Adj MS	F-value	P-value
I	2	2029.7	1014.85	1.13	0.038
T _{on}	3	2334.4	778.15	0.87	0.488
T _{OFF}	3	2098.1	699.37	0.78	0.531
V	4	10657.7	2664.43	2.96	0.029
Error	11	9891.2	899.20		
Lack-of-fit	1	8963.7	8963.65	96.64	0.000
Pure error	10	927.6	92.76		
Total	23	32520.8			

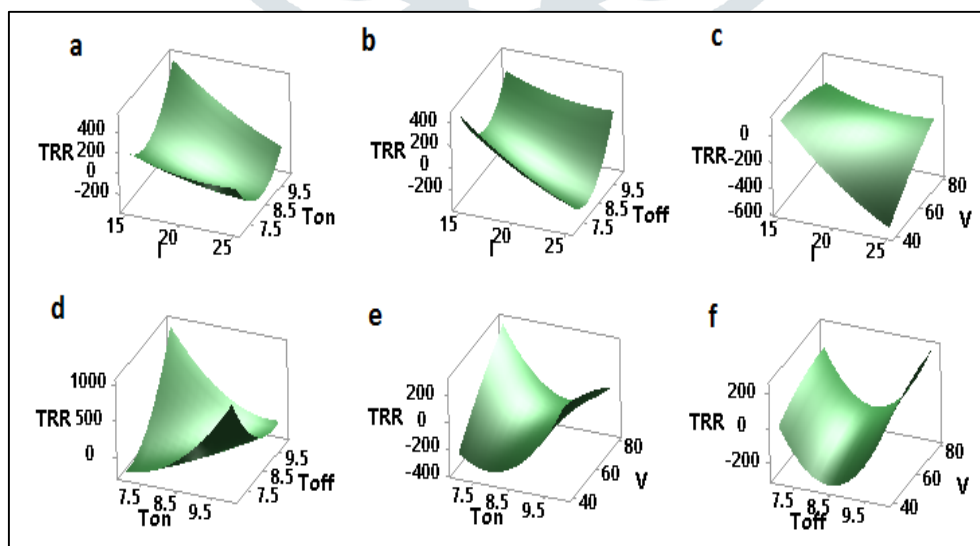


FIG:7.Graphs for two factor intraction on TRR

TABLE 5.ANOVA results for Ra:

Source	DF	Adj SS	Adj MS	F-VALUE	P-VALUE
I	2	3.100	1.5502	0.41	0.671
T _{on}	3	21.202	7.0674	1.88	0.191
T _{OFF}	3	37.003	12.3344	3.29	0.024
V	4	17.491	4.3727	1.17	0.037
Error	11	41.278	3.7525		
Lack of fit	1	0.156	0.1557	0.04	0.850
Pure error	10	41.122	4.1122		
Total	23	133.110			

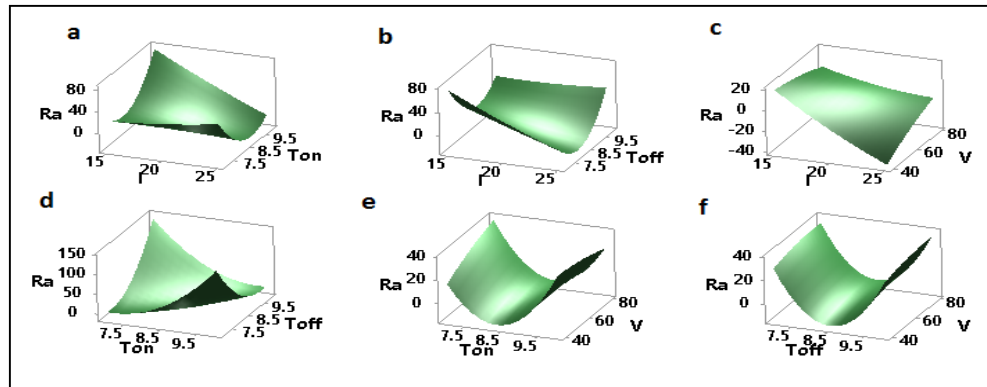


Fig 8. Graphs for two factor interaction of Ra

TABLE 6.ANOVA results for Rz:

Source	DF	Adj SS	Adj MS	F-value	P-value
I	2	24.98	12.492	0.41	0.675
T _{ON}	3	163.81	54.605	1.78	0.208
T _{OFF}	3	292.51	97.504	3.18	0.036
V	4	132.38	33.096	1.08	0.412
Error	11	336.84	30.621		
Lack of fit	1	1.02	1.024	0.03	0.865
Pure error	10	335.81	33.581		
Total	23	1077.78			

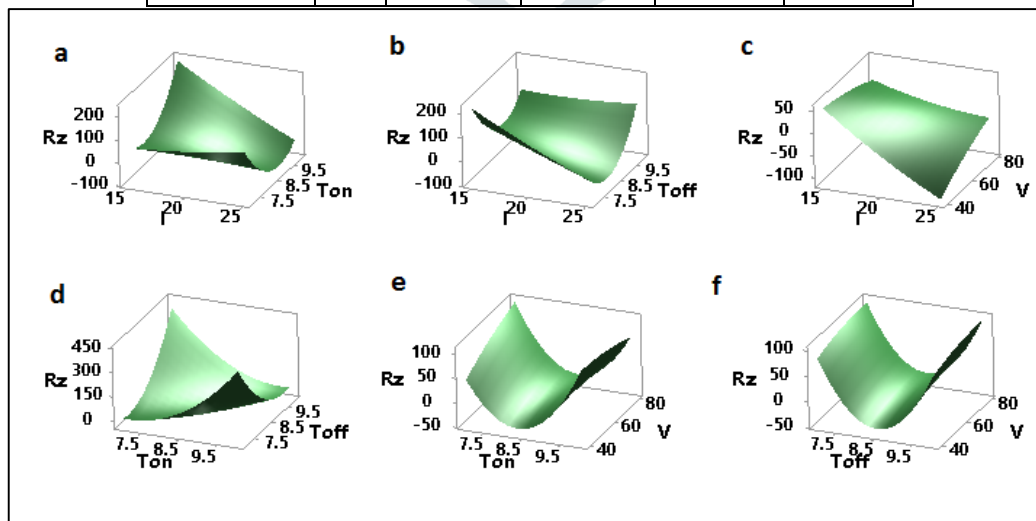


Fig 9.graphs for two factor interaction of Rz

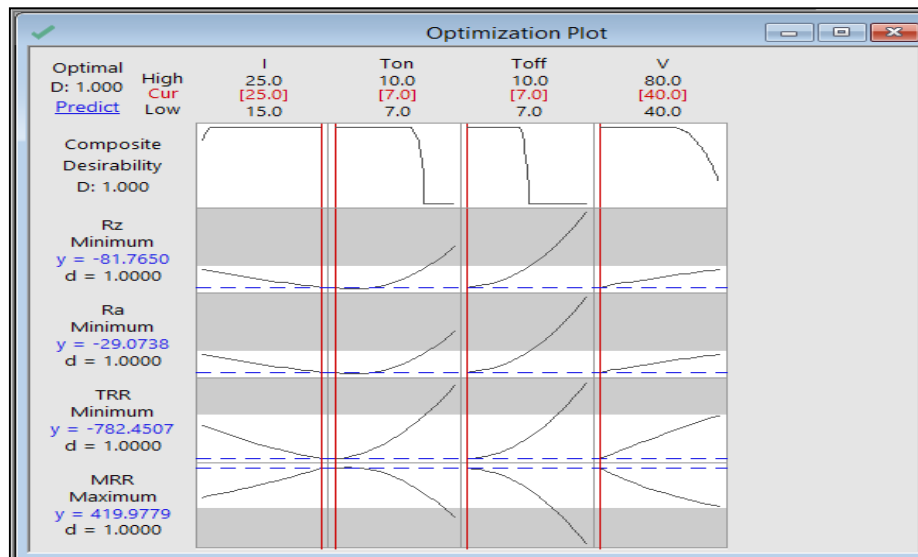
TABLE 7. OPTIMIZATION OF PROCESS PARAMETERS WITH OUT MAGNETIC FIELD

Fig 10. multi objective function of MRR, TRR, Ra and Rz

VII. CONCLUSION:

The optimization of process parameters namely discharge current, pulse on time, pulse off time and voltage can be done by using RSM for eroding aluminum alloy 6082 without application of magnetic field. The conclusion drawn from this work is as follows.

- The ANOVA analysis was applied on to the obtained from testing to determine the most influential process parameters.
- By using the DOE getting the minimum tool wear rate ,maximum material removal rate and minimum surface roughness values
- The RSM was used for multi response optimization process parameters. Current of 25 amps, plus on time 7 milliseconds, plus off time 7 milliseconds and voltage of 40 volts are optimized process parameters for aluminum alloy 6082.
- An empirical relation was developed between the MRR, TWR and Ra and Rz.
- There is lot of scope for future work.
- Graphite electrode can sustain high current density when compared to copper electrode. material removal rate is also high compared to copper electrode. In copper tool having limited material removal rate .

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