International Journal of Modern Engineering Research (IJMER)
www.ijmer.com Vol.3, Issue.3, May-June. 2013 pp-1263-1267 ISSN: 2249-6645

Experimental Study Using Different Tools/Electrodes E.G. Copper, Graphite on M.R.R of E.D.M Process and Selecting The Best One for Maximum M.R.R in Optimum Condition

Santanu Dey, [1] Dr. D.C.Roy[2]

[1]*Masters of Technology, Department of Mechanical Engineering Jalpaiguri Government Engineering College, Jalpaiguri–735102*

[2]*H.O.D & Professor of Mechanical Engineering, Jalpaiguri Government Engineering College, Jalpaiguri–735102, India*

Abstract: *EDM is the thermal erosion process in which metal is removed by a series of recurring electrical discharges between a cutting tool acting as an electrode and a conductive work piece, in the presence of a dielectric fluid. Electrical discharge machining (EDM) is a well-established machining option for manufacturing geometrically complex or hard material parts that are extremely difficult-to-machine by conventional machining processes. Its unique feature of using thermal energy to machine electrically conductive parts regardless of hardness has been its distinctive advantage in the manufacture of mould, die, automotive, aerospace and surgical components.*

Keywords: *M.R.R, Current, Impulse Duration, Spark Gap, Regression Analysis.*

I. Introduction

Electrical Discharge Machine (EDM) is now become the most important accepted technologies in manufacturing industries since many complex 3D shapes can be machined using a simple shaped tool electrode. Electrical discharge machine(EDM) is an important 'non-traditional manufacturing method', developed in the late1940s and has been accepted worldwide as a standard processing manufacture of forming tools to produce plastics moldings, die castings, forging dies and etc. New developments in the field of material science have led to new engineering metallic materials, composite materials, and high tech ceramics, having good mechanical properties and thermal characteristics as well as sufficient electrical conductivity so that they can readily be machined by spark erosion. At the present time, Electrical discharge machine (EDM) is a widespread technique used in industry for high precision machining of all types of conductive materials such as: metals, metallic alloys, graphite, or even some ceramic materials, of whatsoever hardness. Electrical discharge machine (EDM) technology is increasingly being used in tool, die and mould making industries, for machining of heat treated tool steels and advanced materials (super alloys, ceramics, and metal matrix composites) requiring high precision, complex shapes and high surface finish. Traditional machining technique is often based on the material removal using tool material harder than the work material and is unable to machine them economically. An electrical discharge machining (EDM) is based on the eroding effect of an electric spark on both the electrodes used. Electrical discharge machining (EDM) actually is a process of utilizing the removal phenomenon of electrical-discharge in dielectric. Therefore, the electrode plays an important role, which affects the material removal rate and the tool wear rate.

There are two main types of EDM-
- The ram type.
- The wire-cut type.

This project is based on the ram type EDM.
Ram type E.D.M
- The electrode/tool is attached to the ram that connected to the positive pole.
- The work piece is connected to the negative pole.
- The work is then positioned so that there is a gap between it and the electrode.
- The gap is then flooded with the dielectric fluid.
- The spark Temperatures generated can range from 7,760° to 11,650° Celsius.

II. Objective Of The Project

In this research work the main objective is to compare two electrodes e.g. (Copper & Graphite) using in EDM machining and selecting the best electrode on basis of highest Metal Removal Rate (MRR) and surface finish. Equipments used for EDM process:
- One mild steel metal piece (98.7*87.2*12).
- Copper & Graphite Electrode.
- Rustolic E.D.M. 20 Dielectric Fluid.
- EDM machine.

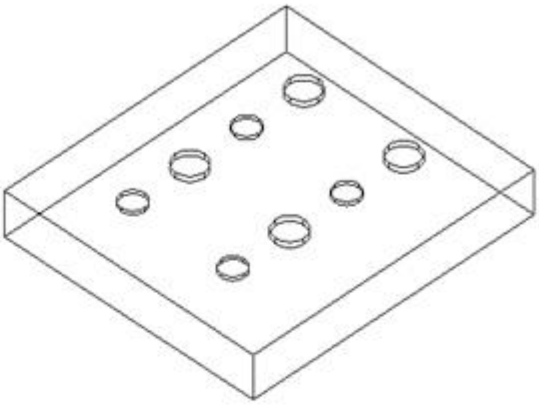

Figure: Top – view of work piece

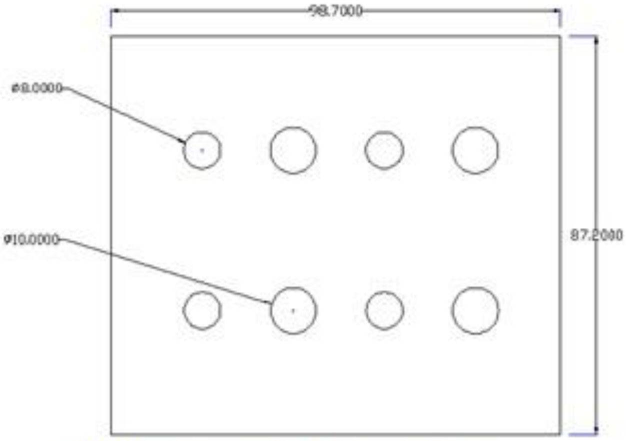

Figure: Isometric view of work piece

III. Observation Table

Copper electrode

Impulse	Spark Gap	I	U	T	Time		
					Idle	M/C	Total
1040	0.08	7	6	12	1.25	25.45	27.10
1050	0.14	8	6	15	1.14	6	7.14
1060	0.20	9	6	17	0.30	8.25	8.55
1070	0.26	10	6	18	0.36	6.40	7.26

Graphite electrode

Impulse	Spark Gap	I	U	T	Time		
					Idle	M/C	Total
1040	0.08	7	6	12	1.40	18.24	20.04
1050	0.14	8	6	15	0.23	6	6.23
1060	0.20	9	6	17	0.48	14.10	14.58
1070	0.26	10	6	18	0.58	11.58	12.16

Sample Calculation:-

M.R.R $=\frac{Volume}{Time}$

depth of hole (h) = 1mm

dia of the hole (d) = 8mm

Volume of the hole = $\frac{\pi}{4} * d^2 * h$

$= \frac{\pi}{4} * 8^2 * 1$

$= 50.26\ mm^3$

M.R.R = $\frac{50.26}{25.45}\ mm^3/_{min}$ M/C Time=25.45min

$= 1.975\ mm^3/_{min}$

IV. Regression Analysis

Based on the experimental data gathered, statistical regression analysis enabled to study the correlation of process parameters with the MRR.

In this study, for three variables under consideration, a polynomial regression issued for modeling. The coefficients of regression model can be estimated from the experimental results. The effects of these variables and the interaction between them were included in this analyses and the developed model is expressed as interaction equation:

$Y=a+bX_1+cX_2+\ldots\ldots+nX_m$ (1)

Where a, b, c. Etc are co-efficient of their corresponding parameter.

The unknown coefficients are determined from the experimental data. Since, EDM process is non-linear in nature, a linear polynomial will be not able to predict the response accurately, and therefore the second-order model (quadratic model) is found to be adequately model the process.

Level of Observation:-

Control parameters	Level		Observed value
	Min. level	Max. level	
Current (Amp.)	7	10	M.R.R.(mm3/min)
Impulse Duration (µs.)	12	18	M.R.R. (mm3/min)
Spark Gap (mm.)	0.08	0.26	M.R.R.(mm^3/min)

Table -1: Result of experimental value

SL. NO.	Current (Amp.)	Impulse Duration (µs.)	Spark Gap (mm.)	A	B	C	Material Removal Rate {M.R.R.} (mm^3/min)
1	7	12	0.08	-1	-1	-1	1.975
2	7	12	0.26	-1	-1	1	2.76
3	7	18	0.08	-1	1	-1	8.38
4	7	18	0.26	-1	1	1	8.38
5	10	12	0.08	1	-1	-1	14.28
6	10	12	0.26	1	-1	1	8.36
7	10	18	0.08	1	1	-1	18.41
8	10	18	0.26	1	1	1	10.17

Here current, Impulse Duration and Spark Gap denoted as A, B and C. Equation (1) can be rewritten as in (2)

$$Y = C_o + C_a*A + C_b*B + C_c*C + C_d*A*B + C_e*A*C + C_f*B*C \quad (2)$$

Normal equations are:

$$\sum Y = nC_o + C_a\sum A + C_b\sum B + C_c\sum C + C_d\sum A*B + C_e*\sum A*C + C_f\sum B*C \quad (3)$$
$$\sum Y*A = C_o \sum A + C_a\sum A^2 + C_b\sum A*B + C_c\sum A*C + C_d\sum A^2*B + C_e*\sum A^2*C + C_f\sum A*B*C \quad (4)$$
$$\sum Y*B = C_o \sum B + C_a\sum A*B + C_b\sum B^2 + C_c\sum B*C + Cd\sum A.B^2 + C_e*\sum A*B*C + C_f\sum B^2*C \quad (5)$$
$$\sum Y*C = C_o \sum C + C_a\sum A*C + C_b\sum B*C + C_c\sum C^2 + Cd\sum A.B.C + C_e*\sum A*C^2 + C_f\sum B*C^2 \quad (6)$$
$$\sum Y.A.B = C_o\sum A.B + C_a\sum A^2 B + C_b \sum AB^2 + C_c\sum A.B.C + Cd\sum A^{2.}B^2 + C_e*\sum A^2*B*C + C_f \sum A.B^2.C \quad (7)$$
$$Y\sum A*C = C_o\sum A*C + C_a\sum A^2*C + C_b\sum A*B*C + C_c\sum A*C^2 + C_d\sum A^2.B*C + C_e*\sum A^2*C^2 + C_f\sum A*B*C^2 \quad (8)$$
$$\sum Y*B*C = C_o\sum B*C + C_a\sum A*B*C + C_b\sum B^2*C + C_c\sum B*C^2 + C_d\sum A.B^2*C + C_e*\sum A*B^2*C + C_f\sum B^2*C^2 \quad (9)$$

Equation of the fitted model for MRR from solving above equations:

MRR = – 64.7089 + [(7.323 * current) + (2.402 * Impulse duration) + (119.229 * Spark gap) – {0.167 *(current * Impulse duration)} – {13.759 *(Current * Spark gap)} – {1.398 * (Impulse duration *Spark gap)}]

Table -2: Results showing the experimental and predicted value and error

SL. NO.	Current (amp.)	Impulse Duration (µs.)	Spark Gap (mm.)	Exp. MRR	Pred. MRR	Error	%Error
1	7	12	0.08	1.975	1.8393	0.1357	6.87
2	7	12	0.26	2.76	2.9945	0.1845	6.27
3	7	18	0.08	8.38	8.56626	0.18626	2.17
4	7	18	0.26	8.38	8.16162	0.21838	2.61
5	10	12	0.08	14.28	14.49414	0.21414	1.48
6	10	12	0.26	8.36	8.16948	0.195052	2.78
7	10	18	0.08	18.41	18.2151	0.1949	1.06
8	10	18	0.26	10.17	10.3806	0.2106	2.03

V. Graph & Table

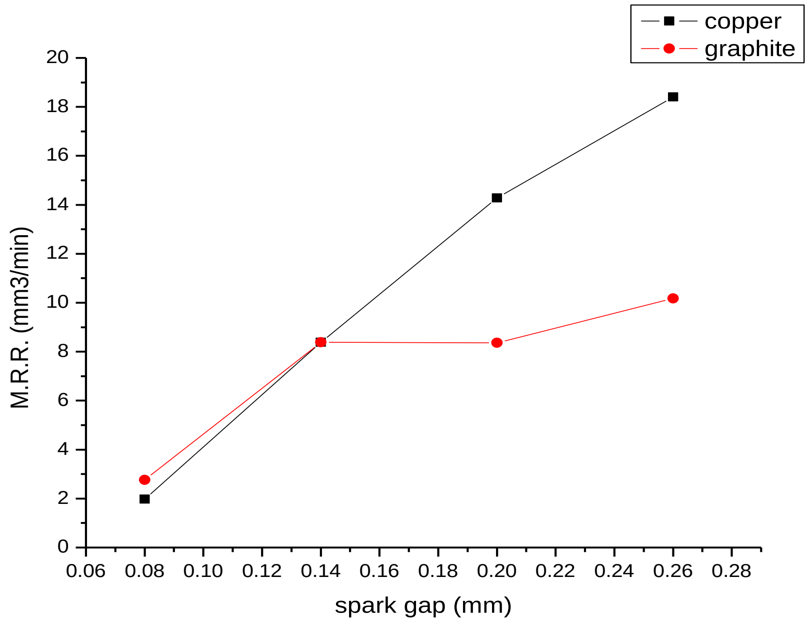

Table- 3: Spark gap v/s MRR

Spark gap (mm)	MRR (copper)	MRR (graphite)
0.08	1.9745	2.76
0.14	8.38	8.38
0.2	14.28	8.36
0.26	18.41	10.17

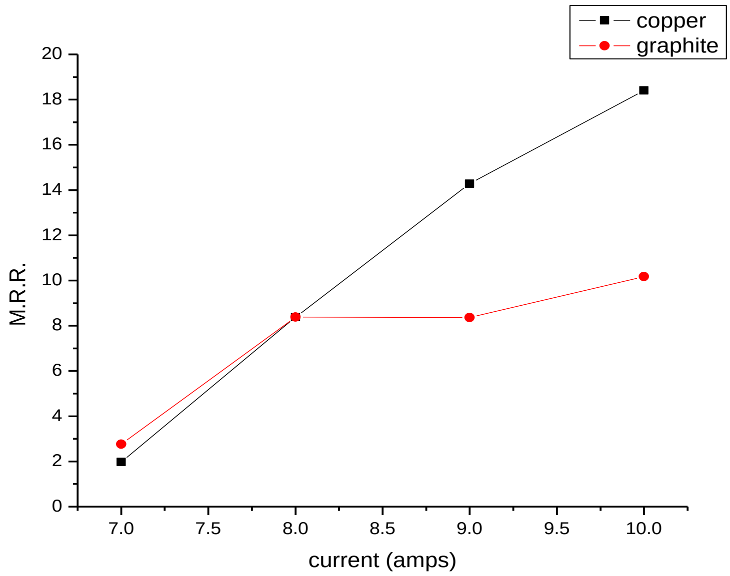

Table – 4: Current v/s MRR

Current (amps)	MRR (copper)	MRR (graphite)
7	1.9745	2.76
8	8.38	8.38
9	14.28	8.36
10	18.41	10.17

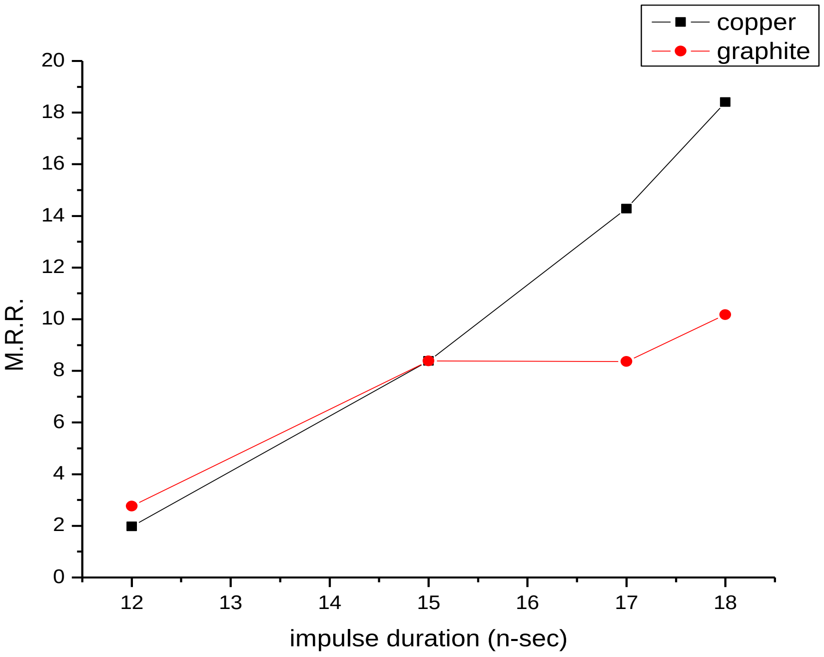

Table-5: Impulse duration v/s MRR

Impulse duration (n-sec)	MRR (copper)	MRR (graphite)
12	1.9745	2.76
15	8.38	8.38
17	14.28	8.36
18	18.41	10.17

VI. Conclusion

1. From the analysis of graph- it can be identified that at the initial stage MRR using graphite electrode is more as compare to copper electrode .Which implies that at low current, impulse duration and spark gap using graphite electrode is more economical. But as the value of the parameters increases, MRR with copper electrode increases more rapidly in respect of graphite electrode.
2. Finally, it can be concluded that graphite electrodes are best suitable for lower values of parameters and mainly for finishing work as graphite electrode produces better surface finish due to lower MRR and copper electrodes are suitable for high metal removal process where finish requirements are not significant.

References

Journal Paper:

[1]. Anand Pandey, Shankar Singh, Current research trends in variants of Electrical Discharge Machining: A review, International Journal of Engineering Science and Technology, Vol. 2(6), 2010, 2172-2191.

[2]. Mr. V. D. Patel, Prof. C. P. Patel, Mr. U.J. Patel, Analysis of Different Tool Material On MRR and Surface Roughness of Mild Steel In EDM, International Journal of Engineering Research and Applications (IJERA),Vol. 1, Issue 3, pp. 394-397.

[3]. J. Valentincic, D. Brissaud, M. Junkar, EDM process adaptation system in tool making industry ,Journal of Materials Processing Technology, Journal of Materials Processing Technology ,172 (2006) 291–298.

[4]. Qing GAO, Qin-he ZHANG, Shu-peng SU, Jian-hua ZHANG, Parameter optimization model in electrical discharge machining process,J Zhejiang Univ Sci A 2008 9(1):104-108.

Book:

[5]. P.K. Mishra, Nonconventional Machining, (Narosa Publishing House, 1997)