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EXPERIMENTAL INVISTIGATION OF EDM PROCESS PARAMETERS ON WPS (D2 STEEL) MATERIAL USING COPPER, BRASS AND GRAPHITE ELECTRODE

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Abstract - *Electrical spark machining is an advance machining process primarily used for hard metals which are not possible by conventional machine. In die Sinking EDM process, two metal parts are submerged in an insulating liquid and are connected to a source of current which is switched on and off automatically. The analysis of process parameters on responses has been done by conducting a set of experiments on WPS steel with graphite, copper and brass as tool electrodes. Central composite design was used for conducting the experiment and developing empirical models for MRR with the help of taguchi method. Pulse on time is most significant factor over other machining parameters for electrode wear rate with all electrode tools.*

Key Words: WPS, EDM, ANOVA, TAGUCHI .

1. INTRODUCTION

Electrical Discharge Machining (EDM) is a controlled metal-expulsion process that is utilized to evacuate metal by methods for electric start disintegration. In this procedure an electric start is utilized as the slicing apparatus to cut (disintegrate) the work piece to deliver the completed part to the coveted shape. The metal-evacuation process is performed by applying a throbbing (ON/OFF) electrical charge of high-recurrence current through the cathode to the work piece. This evacuates (disintegrates) extremely little bits of metal from the work piece at a controlled rate.

EDM start disintegration is the same as having an electrical short that consumes a little gap in a bit of metal it contacts. With the EDM procedure both the workpiece material and the anode material must be conveyors of power. The EDM procedure can be utilized in two distinctive ways:

1. A pre-moulded or framed cathode (instrument), generally produced using graphite or copper, is moulded to the type of the depression it is to duplicate. The framed anode is nourished vertically down and the invert state of the cathode is dissolved (consumed) into the strong work piece.
2. A continuous-travelling vertical-wire electrode, the diameter of a small needle or less, is controlled by the computer to follow a programmed path to erode or cut a narrow slot through the work piece to produce the required shape.

In this experiment a pre-moulded or framed cathode, produced from copper, graphite and brass are used.

1.1 OBJECTIVE OF THE PRESENT WORK

1. To find feasibility of machining WPS tool steel using copper electrode, brass electrode and graphite electrode internal flushing.
2. To analyse the material removal rate over cut by using the machining parameter selected for current, pulse on time, pulse off time using Taguchi design approach.
3. To find the influence of MRR With current, pulse duration time.

2. LITERATURE REVIEW

S.H.Tomadiet. al. Examined the impact of process parameters like Pulse on time, Pulse off time, Supply Voltage, top current on material evacuated rate (MRR) and cathode wear (EW). The Tungsten Carbide was utilized as the work piece material and Copper Tungsten as terminal. The full factorial plan of trial was utilized to investigation the ideal state of machining parameters. Creator reasoned that for surface harshness the most powerful factor were voltage trailed by beat off time, top current and if there should arise an occurrence of material expulsion rate, it was seen that the beat on time factor was the most compelling, trailed by voltage, top current and heartbeat off time. K.D.[1]

Shailesh Dewanganet. al. researched the impact of process parameters like Pulse on time, Discharge ebb and flow and Diameter of anode on material expulsion rate (MRR), Tool wear rate (TWR) and over cut. The trial utilized AISI P20 apparatus steel as workpiece and U-formed copper device as anode with inside flushing framework. The S/N proportions utilized for limiting the TWR and amplifying the MRR and Taguchi technique utilized for advancement the procedure parameters. It was presumed that heartbeat on time was the most affecting variable for MRR and afterward release current and the last one is the breadth of the apparatus. MRR expanded with the release current and if there should arise

an occurrence of the device wear rate, the most impacting factor is beat on time at that point release present and after that width of hardware. [2]

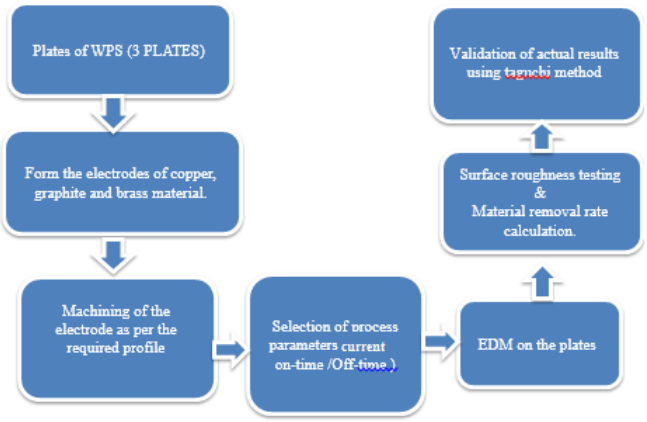
T. A. El-Taweel researched the relationship of process parameters in EDM of CK-45 steel with novel apparatus anode material, for example, Al-Cu-Si-TiC composite item utilizing powder metallurgy strategy. In this investigation, crest current, dielectric flushing weight and heartbeat on time are considered as info process parameters and the procedure exhibitions, for example, MRR and TWR were assessed. The examination was completed with the assistance of reaction surface system. It was inferred that the pinnacle current was observed to be the most essential factor affecting both the MRR and TWR while dielectric flushing weight has little impact on the two reactions. Al-Cu-Si-Tic anodes were observed to be more touchy to crest current and heartbeat on time than regular cathodes. [3]

Herpreet Singh et. al.examined the impact of working parameters like heartbeat on-time and heartbeat off-time for reactions, for example, Metal evacuation rate (MRR) and Tool Wear Ratio (TWR) on the EDM utilizing steel as workpice and cryogenic and non-cryogenic anode of copper material. The cryogenic treatment is utilized for expanding the material expulsion rate and bringing down the instrument wear rate. It was discovered that with increment in heartbeat on time apparatus wear rate is diminished in both terminal cryogenic treated and non - cryogenic copper anode. Apparatus wear rate is expanded with increment in pulse off time. [4]

Anish et. al. created quadratic models for the machining rate, surface unpleasantness and dimensional deviation to connect the prevailing machining parameters: beat on time, beat off time, top current, start hole voltage, wire feed and strain in wire EDM process for unadulterated titanium. A trial plan of the Box-Behnken in view of RSM has been connected to play out the experimentation work and discovered that the most critical parameters regarding the reaction factors are observed to be beat on time, beat off time, top current and start hole voltage and furthermore infer that the machining rate, surface harshness and dimensional deviations were genuinely very much fitted with the test results with 95% certainty level. [5]

EDM process done on die steel and the WPS is the most general used material for making moulding dies and copper, brass and graphite are most common electrodes used for the EDM process so, to get to know the effects of these electrodes on WPS materials this experimental investigation has been done.

3. METHODOLOGY

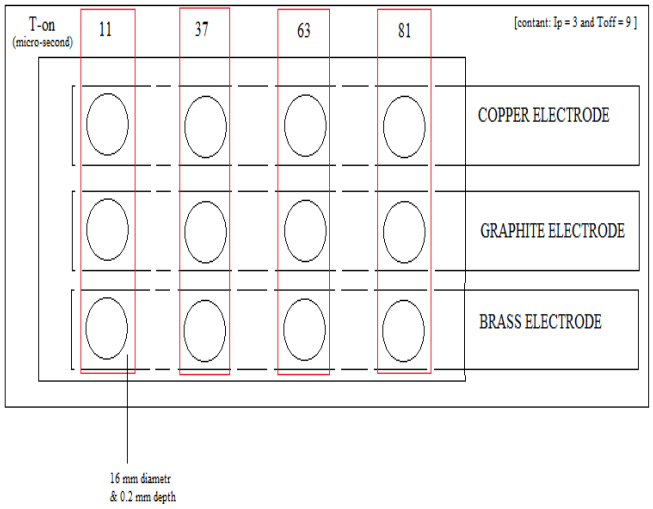


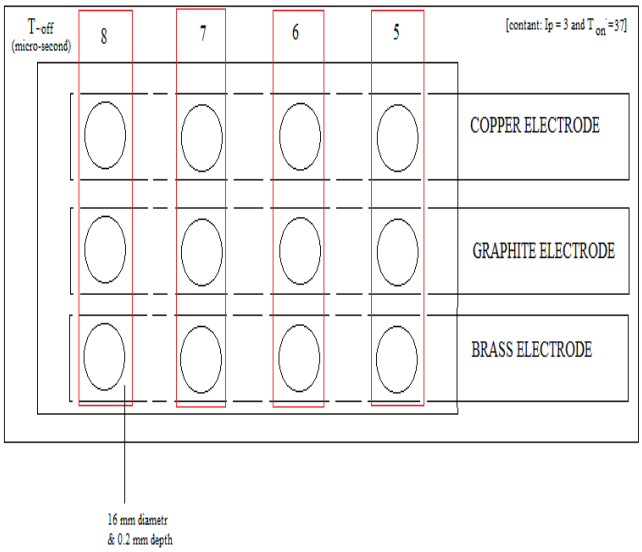
3.1 Experimental procedure

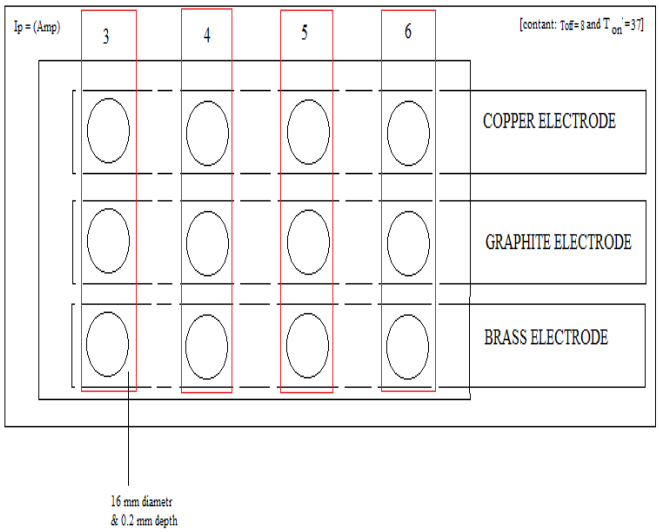
1. The work piece material selected for this study was WPS material tool steel. The chemical composition of wps steel is shown in above Table. The specimen is of rectangular in shape with 105 mm length, 85 mm breadth, and 6 mm thickness. 3 kinds of tool electrode materials using as a electrode such as brass, copper and graphite.
2. Spark gap which was maintained by a distance of 0.02 mm, depth of cut of 0.20 mm and dielectric fluid of standard EDM oil are the constant parameters in this study. Cu electrode made through powder metallurgy is of diameter 16.00 mm and a length of 120 mm respectively. Here in this project the effect of input machining parameter (viz. electrode type, peak current, and on / off time) on tool wear rate is studied here. The values were noted as per the design of experiment trial conditions using taguchi method.
3. There are 3 plates taken and 3 parameters has been selected such as t-on, t-off, and current (v_g) to perform the EDM process on the 3 plates of WPS materials by the three types of electrode material such as copper, brass and graphite.
4. The results are in the form of material removal rate.

D2 steel composition	
Elements	**Weight in %**
Carbon	1.55
Chromium	12.0
Molybdenum	0.80
Vanadium	0.90
Iron	Balance
Silicon	0.25
Manganese	0.35

3.2 Experimental design



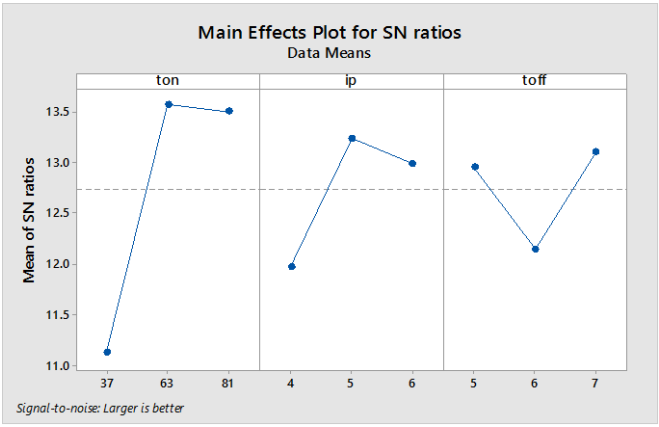




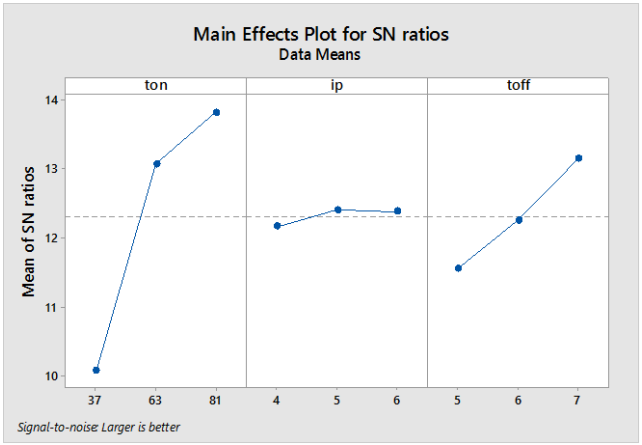
4. PERFORMANCE ANALYSIS

Table 1-: Responses MRR and input factors

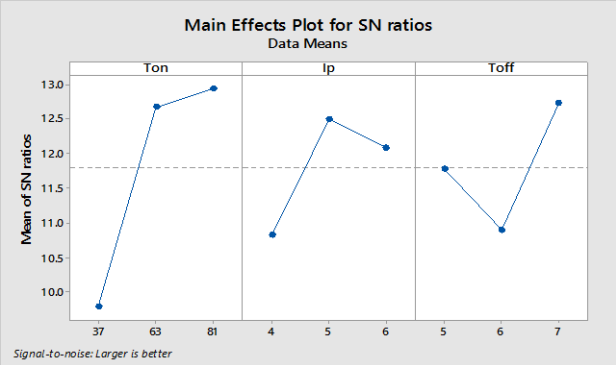
EXPERIMENTS	INPUT FACTORS			OUTPUT RESPONSES		
Trial no.	Ton µs	Ip amp	Toff µs	MRR-Cu	MRR-Gr	MRR-brass
1.	37	4	7	3.215	3.1565	3.1025
2.	37	5	6	3.658	3.254	3.0258
3.	37	6	5	3.958	3.152	3.125
4.	63	4	5	4.257	4.126	3.852
5.	63	5	7	4.856	5.354	5.10
6.	63	6	6	5.265	4.125	4.052
7.	81	4	6	4.565	5.126	3.512
8.	81	5	5	5.456	4.158	4.856
9.	81	6	7	4.264	5.532	5.123



Graph 1-: Main Effect plot for Mean of Cu



Graph 2-:mains effect plot for SN ratios for Graphite



Graph 3-: Main Effect plot for Mean of Br

5. OPTIMUM CONDITION

Parameters	Work material		
	COPPER	GRAPHITE	BRASS
Optimum MRR condition	A8B7C7	A7B6C6	A7B3C2
Peak current contribution	15.74	0.4568	18.95
Pulse ON time contribution	63.56	71.52	59.95
Pulse OFF time contribution	12.53	16.23	20.92

Factors Above Shows the Toff, Ton, And Ip, Values As under,
A5 = 63 µs, A8 = 81 µs, A7 = 81 µs,
B5 = 5A, B9 = 6 A, B7 = 4 A, B6 = 6 A, B3 = 6 A,
C5 = 7 µs, C9 = 7 µs, C7 = 6 µs, C6 = 6 µs, C2= 6 µs

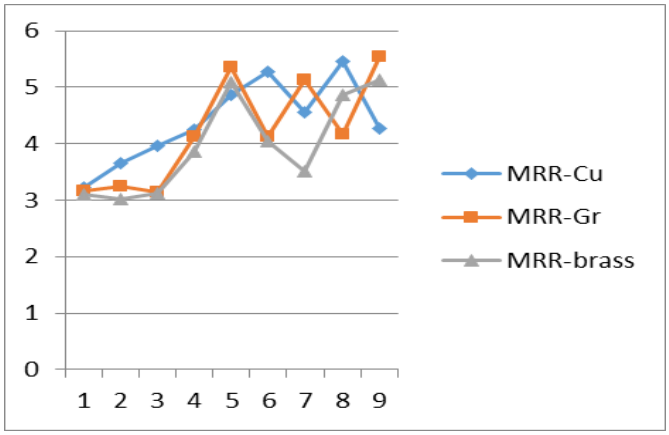
6. CONDUCT THE CONFIRMATION TEST

In this study, the influence of the process parameters and optimization of copper, graphite and brass materials in the die sinking EDM was studied by using taguchi method, from the results; it was found that Toff, Ip, and Ton found to play more significant role in EDM operation. Also it was found that, the optimum level of the factors for SR and MRR are different for each other. From the ANOVA, pulse ON time is more significant than other factors.

Table 2-: Verification of optimum results

Performance measure	Optimum condition	Experimental optimum values	Predicted value.
MRR for Copper (mm^3/min)	A8B7C7	4.87	4.23
MRR for graphite (mm^3/min)	A7B6C6	5.89	5.562
MRR for brass (mm^3/min)	A7B3C2	5.123	4.9122

7. COMPARISON OF EXPERIMENTAL MATERIAL REMOVAL RATE BETWEEN COPPER, BRASS AND GRAPHITE



Graph 1-: comparison of MRR

Table 3-: validation of optimum results.

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8. CONCLUSION

This study covers the observations about the Surface roughness, material removal rate over the WPS material by the process of EDM machine for the different input parameters to thoroughly study over the effect of EDM machining process on the WPS material. Throughout the experimentation I got some results as under.

1. The electrodes used are brass, copper and graphite, out of which the graphite electrode having the best surface finish as compared to the copper and brass as its hardness is lower than the other two electrodes.
2. The copper electrode having the poor surface finish as compared to the graphite and brass.
3. The optimum conditions found by the experimentation process and followed by the taguchi analysis, from the analysis I got the optimum conditions for the surface roughness and material removal rate as given in above result table.
4. Optimum condition shows that pulse on time having maximum effect on surface roughness and current having minimum.

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REFERENCES

[1]. S. H. Tomadi, M. A. Hassan, Z. Hamedon, Member, IAENG R.Daud, A. G. Khalid, ―Analysis of the Influence of EDM Parameters on Surface Quality, Material Removal Rate and Electrode Wear of Tungsten Carbide‖, Proceeding of the International Multi Conference of Engineers and Computer Scientists, vol. II, 2009, pp 01-06.

[2]. shailesh ku. dewangan, 2chitrakant tiger, 3nitin nayak. "optimization of edm process parameters by using pca based grey relation analysis", international journal of mechanical and production engineering, issn(p): 2320-2092, issn(e): 2321-2071 volume- 6, issue-2, feb.-2018.

[3]. T. A. El-Taweel," Multi-response optimization of EDM with Al– Cu–Si–TiC P/M composite electrode, The International Journal of Advanced Manufacturing Technology". September 2009, Volume 44, Issue 1, pp 100-113.

[4]. Singh, Herpreet, Singh, Amandeep, 2013—Effect of Pulse on / Pulse off on Machining of Steel Using Cryogenic Treated Copper Electrode‖, International Journal of Engineering Research and Development 5(12):29-34.

[5]. Anish Kumar , Vinod Kumar, Jatinder Kumar , "Prediction of Surface Roughness in Wire Electric Discharge Machining (WEDM) Process based on Response Surface Methodology". International Journal of Engineering and Technology Volume 2 No. 4, April, 2012.

[6]. T. A. El-Taweel," Multi-response optimization of EDM with Al– Cu–Si–TiC P/M composite electrode, The International Journal of Advanced Manufacturing Technology". September 2009, Volume 44, Issue 1, pp 100-113.

[7].Sohani, M.S., Gaitonde, V.N., Siddeswarappa, B., Deshpande, A.S., 2009. "Investigations into the effect of tool shape with size factor consideration in sink electrical discharge machining (EDM) process", International Journal of manufacturing technology 45, p.1131- 1145.

[8].Mohd Amri Lajis., H.C.D. Mohd Radzi., "The Implementation of Taguchi Method on EDM Process of Tungsten Carbide". European Journal of Scientific Research ISSN 1450-216X Vol.26 No.4 (2009), pp.609-617 © EuroJournalsPublishingInc.2009http://www.eurojournals.com/ejsr.htm.

[9]. M. S. Azad and A. B. Puri, "Simultaneous optimisation of multiple performance characteristics in micro-EDM drilling of titanium alloy," International Journal of Advanced Manufacturing Technology", vol. 61, no. 9-12, pp. 1231–1239, 2012. View at Publisher · View at Google Scholar ·View at Scopus.