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Experimental Investigation Of Performance Of Different Electrode Materials In Electro Discharge Machining For Material Removal Rate And Surface Roughness

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Abstract: Electrical Discharge Machining (EDM) is now a well-established machining option in many industries. EN-9 is an important tool mainly because of its high hardness, strength, wear resistance and high melting point. Normally, EDM is capable of machining geometrically complex or hard material component, that are precise and difficult to machine. The objective of this research is to study the performance of different electrode Materials on EN-9 workpiece with EDM process. **Approach:** The electrode materials were graphite, copper and Brass. The important parameters were peak current, pulse on time, pulse off. A workpiece material was EN-9. **Results:** The results show that the Graphite electrode gives higher MRR than other two Electrodes. Brass electrode gives better surface finishing among three electrodes. Powder electrode gives the better MRR and high SR more than solid electrode.

Key words: EDM, electrode, pulse on time, pulse off time, MRR, SR

1. INTRODUCTION

Electrical Discharge Machining (EDM) is a machine that is used as non-traditional manufacturing and this machine is continually developing further technology that would be impossible to produce with faster and conventional. This machine produces tools with complex-shapes and being used extensively in industries. Furthermore EDM can operate as surface finish in last stage of tool production.

EN-9 is an important tool mainly because of its high hardness, strength and wear resistance. In an EDM operation, it is need to select right parameters for sparking performance. However, the right and desired parameters that base on the experience, instruction manual or a large number of test of experiment that require a lot of time and materials. This study present experimental analysis based on full factorial design. The objective of this research is to study the performance of different electrode materials on EN-9 workpiece with EDM process.

2. EXPERIMENTAL MATERIALS

Workpiece material: The workpiece material was a EN-9 The electrode materials were graphite, copper and brass. The chemical composition of electrode materials which is show in Table 1.

Table: 1:- Chemical composition of Electrode materials

Composition in %	Copper	Brass
Copper	99.750	56.700
Aluminium	0.040	0.025
Tin	0.030	0.020
Phosphorous	0.030	0.020
Lead	0.009	3.000
Iron	0.015	0.100
Zinc	0.060	39.850
Nickel	0.010	0.0770

Testing of the electrode materials was done at DIVINE Lab at Ahmadabad.

Fig:1:- Different Electrodes (Graphite, Brass, copper)

3. EXPERIMENTAL SETUP

EDM Components
- Electric power supply
- Dielectric system (DEF-92 Fluid is used.)
- Work piece
- Electrode (Tool)
- Servo control

SPECIFICATION

- Make: JOEMARS
- Made: Z 50 JM-322

TECHNICAL SPECIFICATION

-Table size : - 600 X 300 mm
-X, Y, Z Travel :- 300/200/200mm
-Max. Electrode weight : 60 Kg
-Max. Workpiece Weight: - 550 Kg
-Tank size : - 830X500X300 mm
-Weight of machine : - 1050 Kg

The EDM machine is mfg by JOEMARS series Z 50 JM-322. To start at determine try-out of suitable parameter relative in EDM process, such as polarity, duty factor, on time, off time, open circuit voltage, discharge current and electrode materials type. The detailed machining conditions used in this investigation were given in Table 2. Finally, the experiment result comparative the optimal parameters of material removal rate, surface roughness.

Fig:2:- Electro Discharge Machine used for performing experiments

Table 2: Experimental conditions

Workpiece	EN-9
Electrodes	Copper, Graphite, Brass
Polarity	Positive (+)
Pulse On-time	45, 55,65µs
Pulse Off-time	30, 45,60µs

Surface Roughness

Surface topography or surface roughness ,also known as surface texture are terms used to express the general quality of a machined surface, which is concerned with the geometric irregularities and the quality of a surface Roughness measure as the arithmetic average, Ra (µm). The Ra will be measured using a surface roughness tester from Mitutoyo, Model: SJ 201P.

Fig. 3 Surface roughness tester.

The Ra values of the WEDMed surface were obtained by averaging the surface roughness values of 5 mm measurement length.

Material Removal Rate

It is well-known and elucidated by man EDM researchers by Roethel that Material Removal Mechanism (MRM) is the process of transformation of material elements between the work-piece and electrode. The transformation are transported in solid, liquid or gaseous state, and then alloyed with the contacting surface by undergoing a solid, liquid or gaseous phase reaction.MRR is expressed as the ratio of the difference of weight of the workpiece before and after machining to the machining time and density of the material.

$$MRR = \frac{\text{volume of material removed from part}}{\text{time of machining}}$$

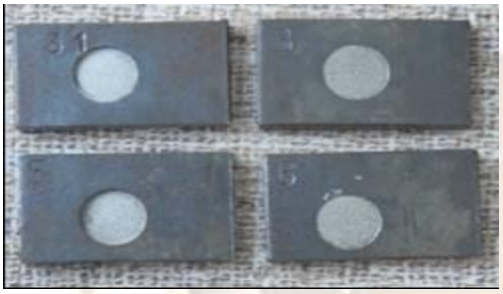


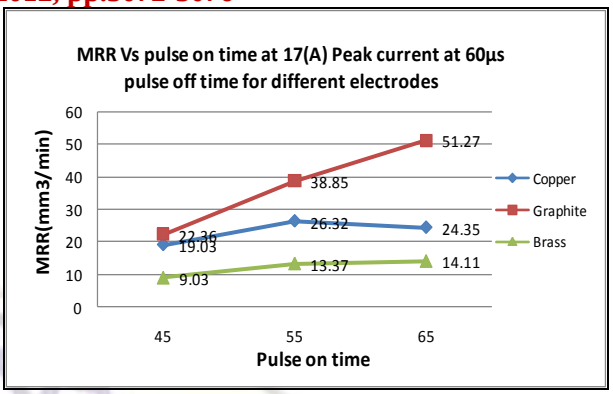
Fig.4:- Machined Workpiece

4. RESULTS AND DISCUSSION

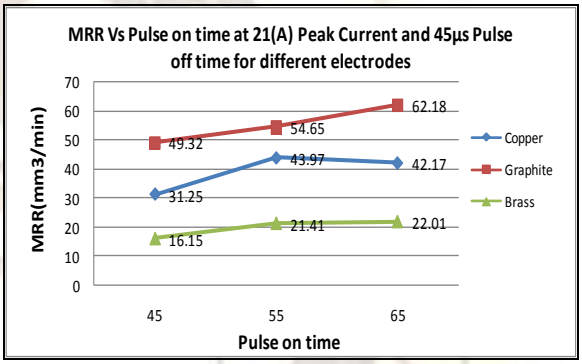
Here levels are selected based on full factorial methods

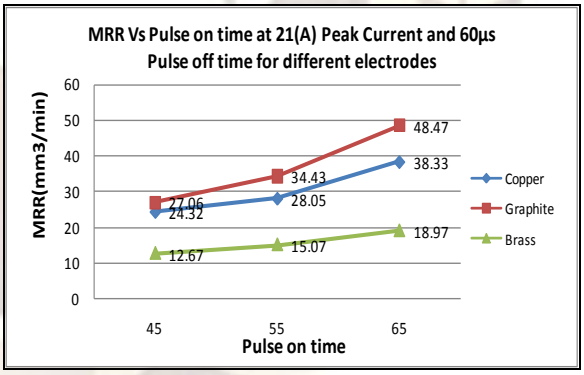
Table 3:- Factors with level values for different Electrode

Factors	Level 1	Level 2	Level 3
Peak current (A)	17	21	28
Pulse on-time (µs)	45	55	65
Pulse off-time (µs)	30	45	60

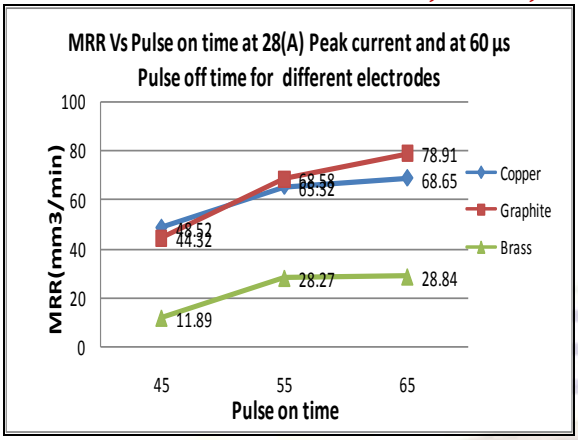


The maximum & minimum MRR is 51.27 mm^3/min & 9.03 mm^3/min which is for graphite & brass electrode is at 60µs pulse off time and 65µs & 45 pulse on time at 17 A peak current respcetively.

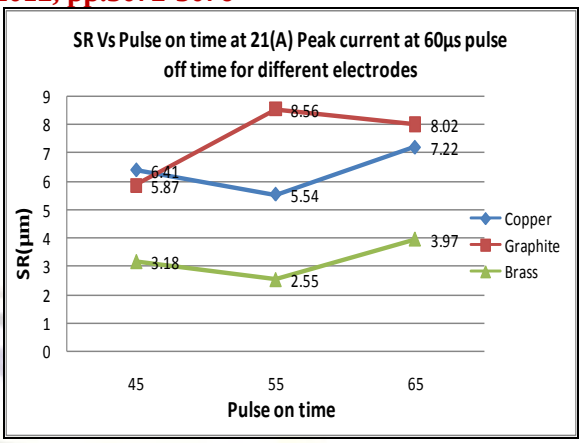




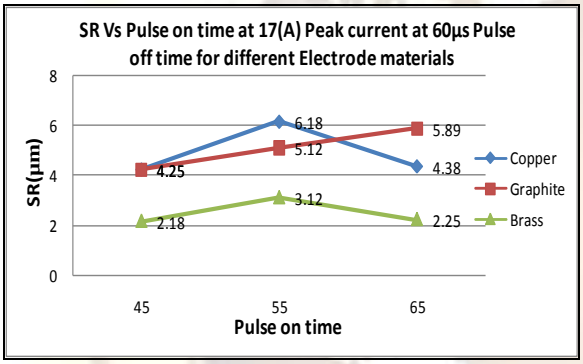
The maximum & minimum MRR is 62.18 mm^3/min &12.57 mm^3/min which is for graphite & brass electrode is at 45µs & 60µs pulse off time and 65µs & 45 pulse on time at 21 A peak current respcetively.

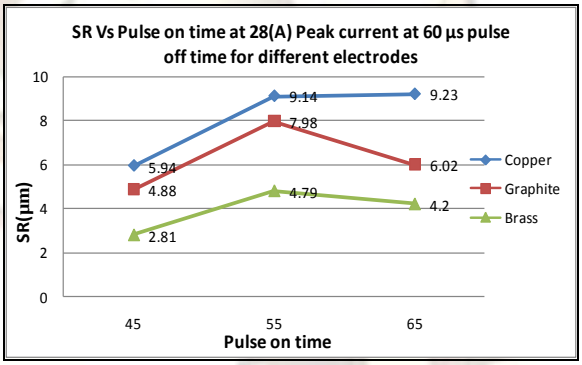


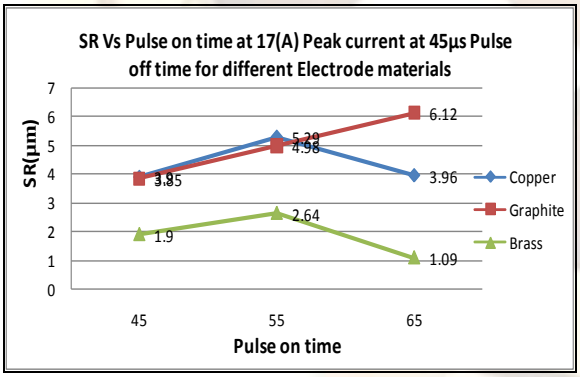
The maximum & minimum MRR is 78.91 mm^3/min &11.89mm^3/min which is for graphite & brass electrode is at 60µs pulse off time and 65µs & 45 µs pulse on time at 28 A peak current respcetively.



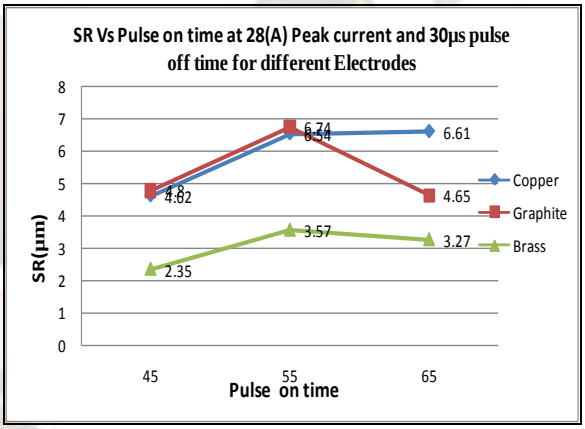
The maximum & minimum SR is 8.56 µm & 2.55 µm which is for graphite & brass electrode is at 60µs pulse off time and 55 µs pulse on time at 21A peak current respcetively.







The maximum & minimum SR is 6.18 µm & 1.09 µm which is for copper & brass electrode is at 60µs & 45 µs pulse off time and 55µs & 65 pulse on time at 17 A peak current respcetively.



The maximum & minimum SR is 9.14 µm &2.35 which is for copper & brass electrode is at 60µs & 30µs pulse off time and 65µs & 45 pulse on time at 28 A peak current respcetively.

CONCLUSION

From this research it can be concluded that following below:

- Peak current, pulse off time and pulse on time significantly affects the MRR and SR in EDM.
- Analysis of variance shows that peak current and Pulse on time are having more influence to material removal rate.
- Surface roughness was mainly affected by the current and pulse on time. At higher value of current causes the more surface roughness. Higher surface finish can be achieved value can be achieved at lower current.
- Peak current and pulse on time are the most influential parameters for reducing surface quality.
- The Brass electrode gives the poor material removal rate and gives the better than surface finish than other two electrodes.
- The graphite electrode gives the most material removal rate and gives the better than surface roughness but it gives high electrode wear ratio.
- The material powder electrode gives the better MRR than solid electrode.

- The optimum levels of various process parameters obtained in this experimental work are:

1. Graphite electrodes gives highest MRR among three electrodes when Peak current = 28 A, 65 µs pulse on time, 60 µs pulse on time.
2. Similarly Brass electrodes gives lowest MRR among three electrodes when Peak current = 17 A, 45 µs pulse on time, 60 µs pulse on time.
3. Brass electrodes gives better surface finishing among three electrodes when Peak current = 17 A, 65 µs pulse on time, 45 µs pulse on time.
4. Similarly copper electrodes gives poor surface finishing among three electrodes when Peak current = 28 A, 65 µs pulse on time, 60 µs pulse on time.

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