Experimental Investigation on Influence of Process Parameters for Machining AISI 310 on EDM

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Abstract- 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. The non-contact machining technique has been continuously evolving from a mere tool and dies making process to a micro-scale application. machining alternative attracting a significant amount of research interests. In the present work, Experimental investigations were carried out to find out Material Removal Rate (MRR), Surface Roughness (SR) and Tool Wear Rate (TWR) for different machining parameters. Different electrode materials viz. copper, bronze, aluminum are selected for the Investigation. The objective of the experiments is to identify the best material in terms of higher MRR, excellent surface finish and low tool wear rate. Various machining parameters were used to conduct the experiments and surface finish, MRR and Tool wear rate were measured. From the experimental results it was found that when current is increased surface finish value will be increased and MRR was decreased. Copper electrode has better Material removal rate as compared with Aluminum and Bronze under the same conditions.

Keywords – Material Removal Rate (MRR), Surface Roughness (SR), Tool Wear Rate (TWR)

I. INTRODUCTION

In non-conventional machining, considerable amount of material is removed from the raw material to get the desired profile. This fact leads metal removal, a more expensive process when compared to other manufacturing processes. So cost consciousness is very much expected in producing a component. There are no scientific and economics approaches to reduce the non-productive times but there are considerable possibilities in reducing the machining time without detracting the quality of the machined component. Presently greater attention is given to Material Removal Rate (MRR), surface roughness and Tool wear rate in the industry. There is a need to select the machining parameters for economic machining. Due to high investment and machining cost of nonconventional machines, there is a need to efficiently operate the machines. The cost of machining is sensitive to the selection of machining variables. The machining variables are selected properly by using optimization techniques. With the advancement and developments in new technologies, low weight- high strength, high hardness and temperature resistant materials have been developed for special applications such as aerospace, automobile, medical etc. In the machining of hard and metal matrix composite materials, traditional manufacturing processes are being increasingly replaced by more non-traditional machining processes such as Electrical Discharge Machining (EDM). Since the introduction of the Wire Electric Discharge Machining (WEDM) process, it has evolved from a simple means of making tools and dies to the best alternative of producing micro-scale parts with the highest degree of dimensional accuracy and surface finish. Selection of correct machining conditions is the most important aspect to be taken into consideration while machining a component. WEDM is a complex machining process controlled by a large number of process parameters such as the voltage, discharge frequency, discharge current intensity, wire electrode speed, dielectric flow rate, type of electrode etc. Any slight variations in the process parameters can affect the machining performance. Therefore, detailed information of the WEDM parameters and their influence on output machining characteristics should be available before machining in EDM. This literature reviews the research work with an attempt to understand and interpret the previous work on different aspects related to EDM/WEDM.

II. Experimental setup and Process

2.1 EXPERIMENTAL PROCESS –

The machining is carried out on ElectronicaC-425 EDM setup. Stainless steel 310 is used as work material with Copper, aluminum and bronze as electrodes and SPO oil as dielectric oil. Experiments were performed using ElectronicaC-425 EDM Machine. The experiments are conducted using different process parameters like peak current, pulse on time, pulse off time, gap, sensitivity, resistance, duty cycle, impulse current, pulse current, spark time, lift time. The work piece material used for experimentation is ANSI 310. The experiments are conducted using different electrode material like Copper, Aluminum and Bronze.

Figure 1. ElectronicaC-425 EDM machine used for experimentation

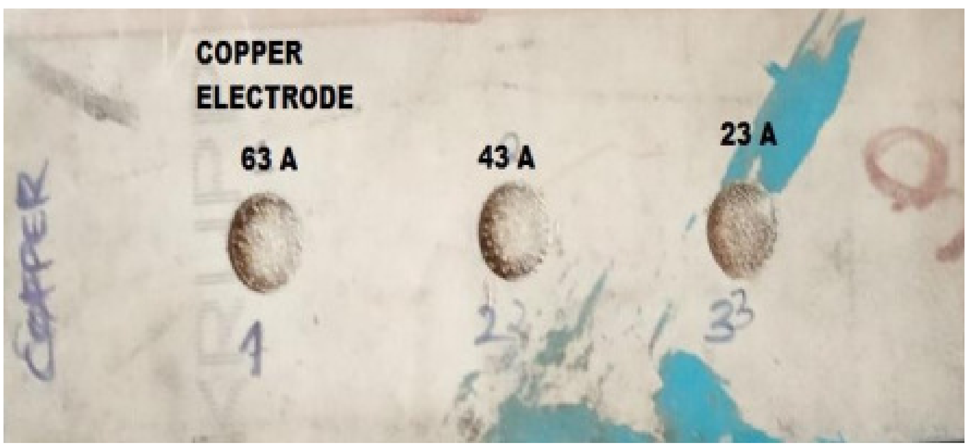
After the machining process, the MRR is evaluated for each cutting condition by measuring the amount of material removed and the time taken for the material removal. Machining experiments for determining the metal removal rate will be carried out by setting voltage in the range of 120-200v, the discharge current in the range of 6.0 to 18.0A, the pulse duration in the range of 30-90µs, and the gap between the electrode and work piece in the range of 10-200 microns. After calculating MRR, the surface roughness and tool wear rate is also calculated for each electrode used. The results are then compared to find the effect of the current on the output parameters.

Table -1 machining parameters used for experimentation

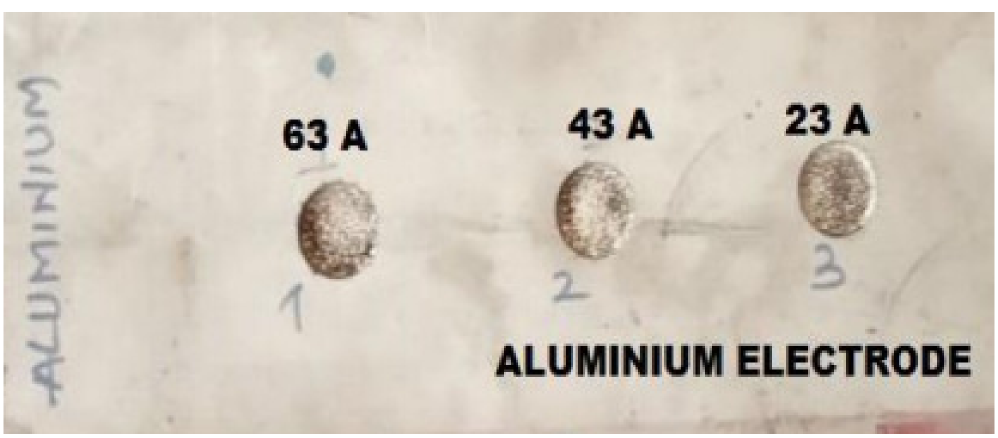
Experimental Condition Description	
Electrode	Copper, Bronze & Aluminium
Workpiece Size	Rectangular Piece Of 100x50x5mm
Input Current	2-20A
Pulse On Time	1-100µs
Gap	10-200µ
Dielectric Fluid	SPO Oil
Work Piece material	AISI 310

2.2. Experimental Procedure

when the required parameters are chosen and set, the machining starts. Either the machining time or the depth of cut is made as a fixed parameter and accordingly the readings are noted down. if the depth of cut is made fixed, then the time taken is noted and if the time is made fixed, the depth of cut is fixed. SPO oil is a combination of hydrated water, kerosene and glycerin. As the electrode moves up and down, due to the contact of the work piece and electrode, the current flows and material is removed which is called pulse on time. When the electrode moves away from metal, the current doesn't flow and the removed material is washed away with the help of dielectric fluid, this stage is called pulse off time. In this way the metal removal takes places. The weight of the tool and the work piece is noted down before and after the experimentation in order to calculate MRR and the TWR. The surface roughness is measured using Mitutoyo Surf test SJ-210 (178-561-02A) for the workpiece machined under different conditions. The samples of the work piece after the experimentation are shown in the figure 2.



(a)



(b)

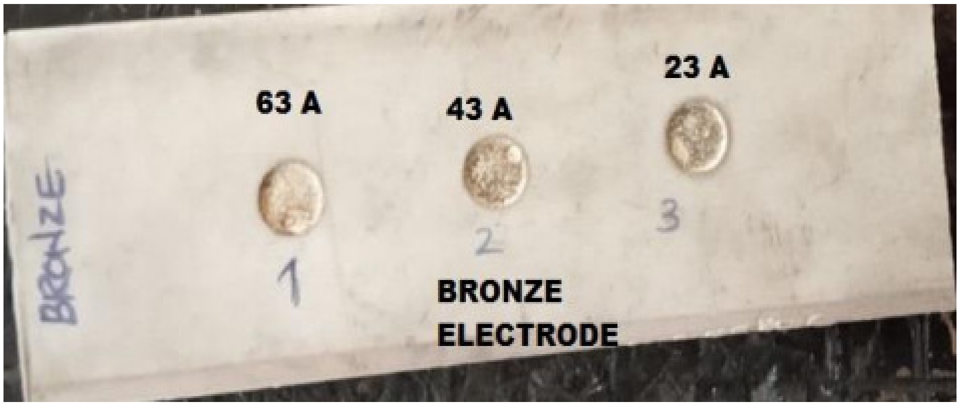
(c) 

Figure 2. Samples of the work piece with electrode material of (a) Copper(b) Aluminium (c) Bronze

III. Results and discussions

The Experimental results are shown in the below tables. The ssamples of the work piece after the experiments were checked for Surface roughness and Material removal rate and the electrode is used for calculating the tool wear rate. The results are shown in the table below.

Table -2 Experiment Results for Roughness value

Electrode material	Current	Roughness value(µm)
Copper-C106/CW024A	63	4.881
	43	3.820
	23	3.495
Aluminum-Alloy 2024	63	4.052
	43	3.812
	23	4.950
Bronze-C63000	63	3.434
	43	2.014
	23	1.807

Table -3 Experiment Results for Material Removal Rate

Electrode material	Current	MRR (cm^3/min)
Copper-C106/CW024A	63	9.677×10^{-3}
	43	10.193×10^{-3}
	23	12.534×10^{-3}
Aluminum-Alloy 2024	63	4.313×10^{-3}
	43	5.298×10^{-3}
	23	7.373×10^{-3}
Bronze-C63000	63	3.12×10^{-3}
	43	1.801×10^{-3}
	23	1.487×10^{-3}

Table -4 Experiment Results for Tool wear rate

Electrode material	Current	TWR (cm^3/min)
Copper-C106/CW024A	63	4.650×10^{-5}
	43	5.580×10^{-5}
	23	2.39×10^{-5}
Aluminum-Alloy 2024	63	5.138×10^{-5}
	43	9.324×10^{-5}
	23	3.597×10^{-5}
Bronze-C63000	63	1.29×10^{-5}
	43	1.58×10^{-5}
	23	2.77×10^{-5}

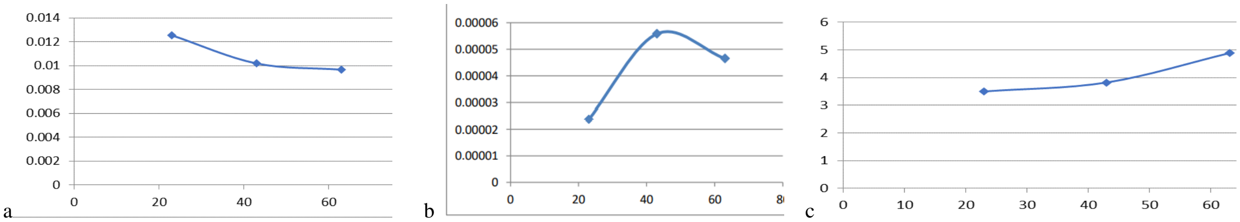


Figure 3. The electrode used is copper and a graph is drawn by taking input current on x axis with (a) MRR (b) TWR (c) Surface roughness

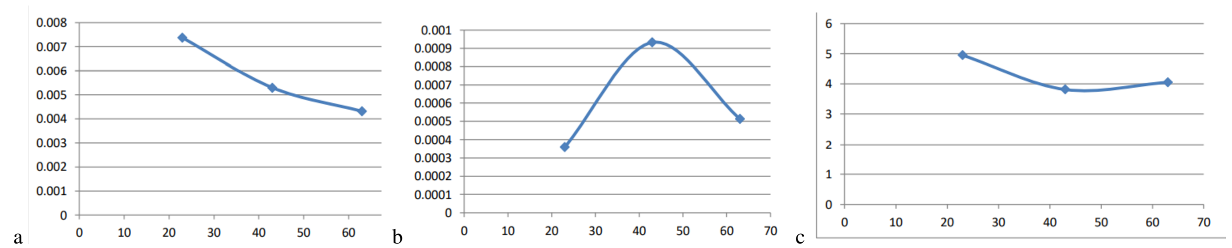


Figure 4. The electrode used is Aluminium and a graph is drawn by taking input current on x axis with (a) MRR (b) TWR (c) Surface roughness

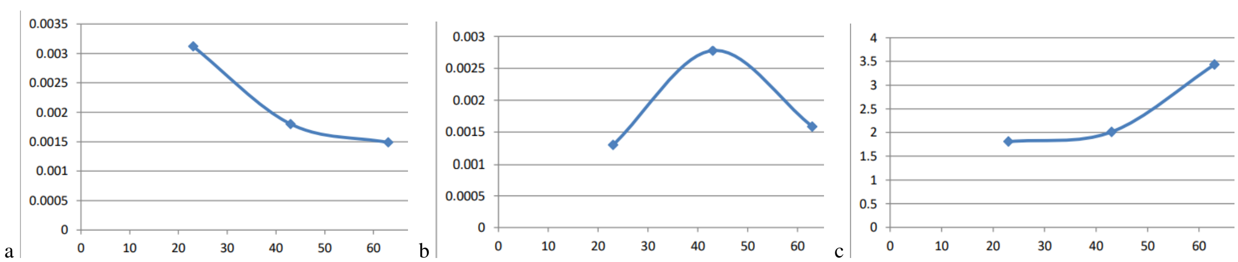


Figure 5. The electrode used is Bronze and a graph is drawn by taking input current on x axis with (a) MRR (b) TWR (c) Surface roughness

IV.CONCLUSION

In this study the influence of significant EDM process parameters like current and type of electrodes on response parameters Material removal rate (MRR), Surface roughness and Tool wear rate (TWR) while machining Aisi310 has been investigated. The major conclusions drawn from this study is that the EDM is an adequate process to machine AISI 310 with good MRR and surface finish. When current is increased surface finish and MRR value was found to be increased. Copper electrode has better Material removal rate as compared with Aluminium and Bronze under the same conditions. For better investigation and optimization, more input parameters can be considered and statistical analysis can be done by using different techniques.

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