Comparison of Performance Parameters of Mild Steel in EDM Process using Copper and Brass Tool

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***Abstract*- EDM is the commonly used non traditional process used for machining hard high strength materials that are not possible for machining by other process. The objectives of the study is to optimze and compare the performance parameters of mild steel using copper and brass tool. The design of experiments Taguchii is used for optimization. The experiment is carried out using control parameters such as current, time of machining and voltage on EDM machine. The L9 orthogonal array is used to find the set of parameters to conduct the experiment. Comparison is carried out for different machining parameters like MRR, TWR and SR to improve the quality of machining. Based on the experiment the graphs and comaprision tables have been developed.**

Key words: EDM, Mild Steel, copper, Brass,Taguchii

I. INTRODUCTION

Electrical Discharge Machining is a non conventional machining process which is used to machine complex and intricate shape profile such as holes, cavities, external shapes in the work piece. In EDM only electrically conductive materials can be machined and material is removed from the work piece by the spark generated between the tool and workpiece.EDM has its main application in automotive, aerospace and die making industries.

In EDM the material is removed from the work piece in the form of tiny particles by the continuous ejection of electrical current between the work piece (anode) and the tool (cathode). During the machining process both the tool and the work piece will be immersed in the di-electric fluid because the di–electric breaks and the spark ejection takes place. Another advantage of di-electric is flushing the eroded particles from the work piece and the electrode, from the machining area.

Due to the erosion action the material will be removed by keeping a small distance of 10 to 125 micro meters between the tool and the work piece. The voltage build up between the tool and the work piece increases the current density which causes the increase in temperature of around 10000 to 200000c. Due to the plasma break down the compressive force will be developed between the tool and work piece which causes the melting of the work piece and also vaporization due to which the material removal takes place. The space between the tool and the work piece also called as spark gap should be between .005mm to 1.0 mm .Also called as contact less machining since a minimum gap should be maintained between the tool and the work piece.

The machine is controlled by the servo controlled mechanism which maintains a small gap between the anode and cathode. Servo control mechanism advances the electrode into the work piece by maintain a small gap.

The main advantage of using EDM is any hard material which is electrically conductive can be removed by this process. Second the electrode can be moved in any axis(X, Y, and Z) so that complex profiles can be machined accurately. Intricate shapes, dies and moulds can be produced without any scar on the work piece. The EDM used for the analysis is the die sinker EDM. The voltage applied to this EDM is around 40-300 v which can generate a current of .5 to 400 A.

II. OBJECTIVES

The objective of the study is to compare the influence of different machining parameters i.e current, time and voltage on material removal rate, tool wear rate and surface roughness between copper and brass tool. The work material used is mild steel. The Taguchii Optimization Technique is used to make the analysis.

III . EXPERIMENTAL SET UP AND METHODOLOGY

The experiment is carried out using die sinker EDM (EDM V 5030) with mild steel work piece of dimension 100mm* 50mm *.5mm with copper and brass tool of diameter 8 mm. The marketable grade oil is used as di-electric fluid .Experiment is carried out on 9 trials for different combination of input variables.

Mild steel is the work piece used which is the versatile material used from domestic to industrial purposes and also cheaper when compared to other materials like steel.

Some of the Properties of mild steel are Tensile strength of 537 Mpa, yield strength of 525.5 Mpa with % elongation of 26%.

TABLE 1: THE CHEMICAL COMPOSITION OF MILD STEEL

Carbon	copper	Iron	manganese	phosphorous	silicon	sulpher
.25-.29%	.20%	98%	1.03%	.040%	.280%	.050%

The tool in EDM is used to wear out the material from the work piece and is directed along the required path by maintaining a small gap between the tool and work piece. In the experiment two tools, Copper and Brass of diameter 8mm are selected for comparison as shown in table 2

TABLE 2: DIAMETER AND LENGTH OF TOOLS

Tool	Diameter	Length
Copper	8 mm	150mm
Brass		

Material removal rate and tool wear rate is found by the difference of weight, before and after machining

MRR= (WBM-WAM)/(density of the material * time)

Surface roughness measurement is done by using a surface tester instrument SJ-210 which calculates the arithmetic mean Ra of the rough surface.

The Taguchii optimization technique using L9 orthogonal array is used for the design of experiments. The input or the machining parameters considered are voltage, time and current and a study of the copper against mild steel work piece is carried out.

The experiment is carried out by connecting tool to the negative side of the machine and work piece is connected to the positive side of the machine

Taguchi experimental design has been carried out in Minitab. Using Minitab series of runs for an experiment can be carried out in which flexibility is possible. Minitab is used to create output table to find the affect of different parameters on the MRR, Surface Roughness and material removal rate.

In our experiment L9 orthogonal array of 9 trails for different levels of input parameters are carried out

TABLE3: THE MACHINING PARAMETERS AFFECTING OUTPUT PARAMETERS AND THEIR LEVELS

parameters	Unit	Levels		
		Level1	*Level2*	*Level3*
Current	A	6	8	10
Time	S	200	250	300
Voltage	V	50	60	40

The calculation of material removal rate and tool wear rate is carried out after each trial by weighing the work piece and tool separately.

IV. RESULTS AND DISCUSSIONS

A. Comparison between machining by using copper and brass tool

TABLE 4: MATERIAL REMOVAL RATE OF BRASS AND COPPER

Trial No	Copper	Brass
1	1.54	0.77
2	0.636	0.31
3	0.764	0.76
4	20.07	7.33
5	22.37	7.45
6	20.63	7.64
7	27.4	8.1
8	30.75	8.69
9	21.4	7.38

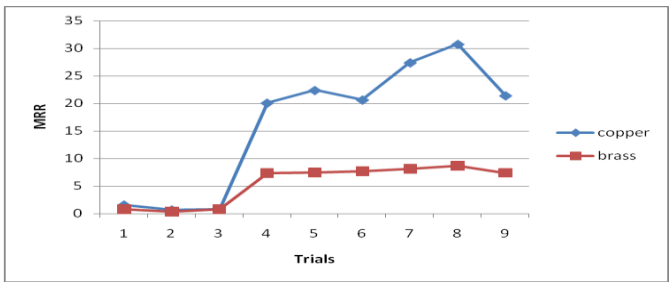

Fig 1: Graphical Comparison of MRR of Copper and Brass

From the above Fig 1, material removal rate increases with increase in current for both copper and brass. Also from the graph analysis, it is observed that more material is removed using copper tool as compared to brass tool. Hence the material removal rate is faster by using copper tool as compared to brass tool. Using brass tool change in current, time and voltage has not much effect on material removal rate. Not much variation in the MRR can be observed by changing the voltage and time

B. Comparison of Tool wear rate of Copper and Brass

TABLE 5: TOOL WEAR RATE OF COPPER AND BRASS

Trial No	Copper	Brass
1	0.338	1.04
2	10.61	0.84
3	0.446	0.91
4	21.98	30.89
5	16.07	31.29
6	21	31.38
7	14.55	31.93
8	13.08	34.08
9	17.65	29.55

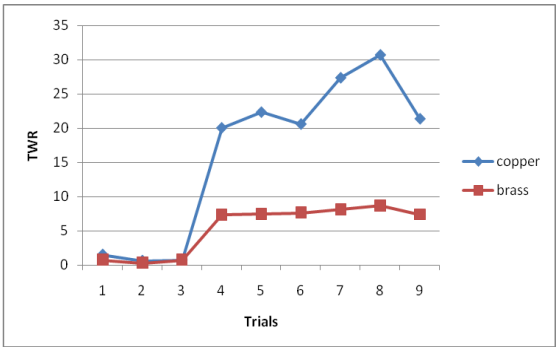

Fig 2: Graphical comparison of TWR of Copper and Brass

From the above Fig 2, In case of TWR, tool wear increases with increase in input parameter current for both copper and brass, but tool wear is quite more in copper as compared to brass .Using brass tool the change in current has not much affect and hence current can be also kept constant Hence we can conclude that using brass tool is better than to use copper tool for less tool wear. Not much variation in the TWR can be observed by changing the voltage and time

C. Comparison of SR of Copper and Brass

Table 6: SR of Copper and Brass

Trial No	Copper	Brass
1	2.335	1.763
2	2.131	1.893
3	2.332	1.534
4	2.786	2.552
5	3.014	2.511
6	2.443	2.438
7	2.541	2.076
8	3.056	2.638
9	2.206	2.594

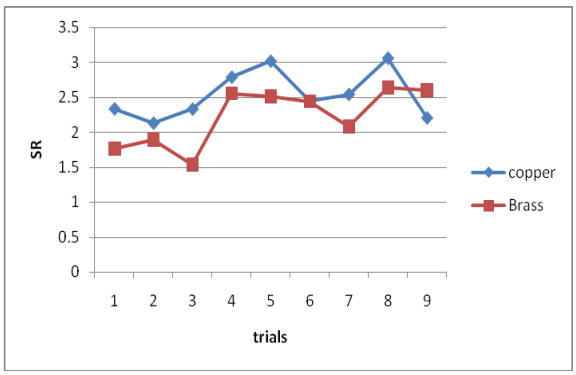

Fig 3: Graphical Comparison of SR of Copper and Brass

From the above Fig 3, it is observed that the surface roughness also increases with increase in input parameter current, but surface roughness is comparatively less using brass tool as compared to copper tool. Hence with brass tool the surface finish is better as compared with copper tool.

V. CONCLUSION

The EDM experiment is conducted to know the effect of machining parameters like MRR, TWR and Surface Roughness on Mild steel work piece against the brass and copper tool. The results are very helpful for the Research and development of tools and work piece for manufacturing using EDM machine in industries. The influencing parameters for machining are current, time and voltage. The L9 orthogonal array has been designed by Taguchi to conduct the experiment .The results of the experiment are analyzed for future reference

Some of the important results of the experiment are

1. From the analysis of material removal rate discussed between copper and brass tool in comparison, the material removal rate is more with copper tool as compared to brass tool.
2. In the case of tool wear rate also, tool wear is slightly less with brass as compared to copper tool and hence brass is the best tool for less tool wear
3. The surface roughness also increases with increase in current as compared to time and voltage, but irregularities are more by using copper tool as compared to brass tool.
4. The conclusion is since copper is having high thermal and electrical conductivity using copper is better compared to using brass tool

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