

Analysis of copper mixed kerosene servotherm in EDM of Monel 400TM

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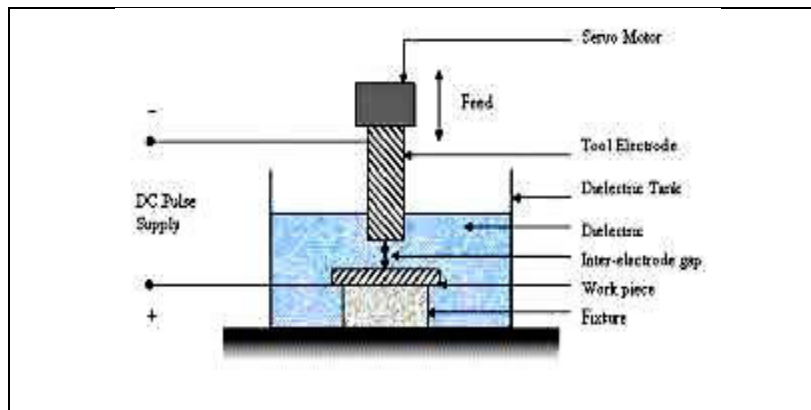
Abstract : Powder mixed electro discharge machine process (PMEDM) is a hybrid machine process where a conductive powders is mixed to the dielectric fluid to facilitate effective machining of advanced material. This present study focused on performance of copper mixed kerosene servotherm as dielectric medium in EDM of Monel 400TM. The ratio of kerosene servotherm is 75 : 25. The copper powder was mixed with dielectric medium of kerosene servotherm of 6g, 8g and 10 g respectively. This mixture was analyzed using different current rate of 8 amps, 10 amps and 12 amps to know the performance characteristics by using material removal rate, tool wear rate, diameter overcut, surface finish and dimensional accuracy. Based on the experimental investigation it is concluded that copper powder of 10g with 10 amps performed well than that of all other parameters.

Keywords : Electrical discharge machining, copper powder, material removal rate, tool wear rate, diameter overcut

Introduction

It is used for produced automobile components and in clinical equipment's. Edm tool is not directly contact with the work piece due to this one it can reject the mechanical stresses chattering and vibrant problems in the time of machining [1]. We can machine any harden and conductive type material only can be machined in Edm machine [2]. The Edm machine working in the principle of thermoelectric energy. It is formed between the work and tool submerged in the dielectric fluid with the supplying electric current. In this process the energy concentrated and repetitive spark discharge is maintain between work piece and tool electrode causing melting and evaporation work piece. Electrode travel towards the work piece till the opening is small enough so that the fascinated voltage is great enough to ionize the insulator medium [3]



**Fig 1**

To consider the result of silicon powder adding into dielectric fluid, the surface finish of H-13 die steel. Machining with adding up of silicon powder mixed with dielectric fluid produces fine and corrosion-resistant surfaces having roughness of $2\text{ }\mu\text{m}$. [4]. In this EDM process kerosene and distilled water as a dielectric medium. In the operation MRR is more and TWR is less in the time of distilled water as dielectric medium compare to the kerosene in Ti-6Al-4V. [5].

In the present work, the Ti-6Al-4V alloy was machined by electrical discharge machining process with different machining conditions and electrode materials. Summarizing the mean features of the results, the following conclusions may be drawn. The surface integrity of ED Ti-6Al-4V includes roughening because of decomposition of recast layer on the surface, surface microcracks, debris and melted drops. Below the recast layer a slightly softening or tempered layer is occurring due to the low thermal conductivity of Ti6Al4V. The microstructure of white layer may be hexagonal martensitic as zero based on the cooling diagram.

The hardness of white layer is significantly higher than the bulk material due to the Ti₂C₁₅ carbides. The material removal rate, surface roughness and electrode wear are increasing with process parameters for each electrode material except the prolonged pulse duration of 200 ms. Graphite electrode gives the highest material removal rate, followed by electrolytic copper and aluminium. Graphite exhibits the lowest wear rate due to higher melting point at all the applied condition. Aluminium electrode exhibits the best performance with regard to surface finish [6].

In machining parameters for EDM of 94WC-Co. In the case of the Ra parameter the most influential factors were intensity, followed by the pulse time factor, while the duty cycle factor was not significant at the considered confidence level. When either intensity or pulse time were increased, the roughness value also increased. Furthermore, a significant interaction effect was observed between the intensity and pulse time factors. Therefore, in order to obtain high values of material removal rate for the case of tungsten carbide, within the work interval considered in this study, one should use, above all, high values for intensity and duty cycle. Furthermore, although to a lesser extent, low values of the pulse time factor should also be used. [7]

The results of the experiments on EN-31 tool steel with different electrode materials, the following conclusion are arrived at For the EN-31 work material, copper and aluminium electrodes offer higher MRR. Diametral overcut produced on EN-31 is comparatively low

when using copper and aluminium electrodes, which may be preferred for En-31 when low diametral overcut (higher dimensional accuracy) is the requirement. Copper and copper-tungsten electrodes offer comparatively low electrode wear for the tested work material.

Aluminium electrode also shows good results while brass wears the most, of all the tested electrodes. Of the four tested electrode materials, Cu and Al electrodes produce comparatively high surface roughness for the tested work material at high values of currents. Copper-tungsten electrode offers comparatively low values of surface roughness at high discharge currents giving good surface finish for tested work material. Copper is comparatively a better electrode materials as it gives better surface finish, low diametral overcut, high MRR and less electrode wear for En-31 work material, and aluminium is next to copper in performance, and may be preferred where surface finish is not the requirement [8].

From the literature review, it has been observed that more extensive work has been done with different tool electrode materials on the Monel 400TM. There exists a great need for investigating the effects of various electrode materials and pulsed discharge currents on material removal rate, electrode wear and surface roughness in electric-discharge machining of Monel 400TM.

Experimental Investigation

The experiments were carried out that EDM spark erosion machine mounted on custom built dielectric cyclic system. The experiment carried out the following conditions

Table 1, Experimental conditions

Work piece	: Monel 400 TM
Dielectric type	: Copper powder mixed Kerosene + Servotherm oil,
Electrode materials	: Copper
Polarity	: Standards for positive on work piece, negative on electrode
Flushing	: Side flushing
Supply voltage	: 110 V
Average current	: 0.1 to 500 A
Machining Time	: 45 Minutes
Spark gap	: 0.013 to .13 mm



Figure : 2

The chemical composition of the work material is as follows: C – 0.30 max, Mn – 2.00 max, S – 0.024 max, Si – 0.50 max, Ni – 63.0 min, Cu – 28.0-34.0, Fe – 2.50 max. The dimension of the work material was 75mm in diameter and 6mm in thickness. The mean hardness value of the one end work material was 32 HRC. The EDM experiments were performed on NC EDM Glorv Engineering. The concentration of the copper powder is varied 6 g / lit, 8 g / lit and 10 g / lit

The chemical composition of MONEL 400 is given in Table 2

Element	Ni	Fe	Si	Mn	C	Cu	S
%	66.50	2.50	0.50	2.00	0.300	31.00	0.024

The machining tests were performed with copper electrode, The tool and material were fixed in the machine and immersed about 5 cm in copper powder mixed kerosene + servotherm (75: 25) as dielectric mediums. Machining test was carried out for 3 mm depth of cut at three different current settings, 8A, 10A and 12A. The mass lost was measured in every current setting. The mass lost from the electrode and work material was weighed using a digital weighing pocket scale and recorded. Machining procedures were repeated for different current rating and various g / lit of copper powder mixed dielectric mediums

Metal is removed from work in the form of crater due to machining and can be estimated for single pulse rate.

Material removal rate (MRR) = (A-B)/T g/min

Where,

A – Initial weight of work piece

B – Weight of work piece after machining

T – Machining time

The tool wear rate is required to account for tooling cost, machining accuracy and estimate the time of machining for desired depth of cut.

However, there are three types of wear observed in an electrode, end, corner and side.

Tool wear rate (TWR) = $(D-E)/T$ g/ min.

Where,

D – Weight of tool electrode before machining

E – Weight of tool electrode after machining

T – Machining time

Result and Discussion

It was observed that the energy intensity and size of the spark increases with an increase in current, which ultimately affects the surface finish and dimensional accuracy. The material removed rate and tool electrode wear have been measured by using Fig 3. It shows the influence of pulsed discharge current and liquid dielectric media on MRR for the Monel 400TM using copper tool electrode. From these figure, generally, the trend of the curves is resemblance i.e material removal rate increase with increasing the discharge current is due to fact that the high energy intensity is the spark. The copper electrodes acquire the best material removal rate with the 10 g / lit copper mixed kerosene + servotherm liquid dielectric compared to 6 g / lit and 8 g / lit copper mixed kerosene + servotherm liquid dielectric.

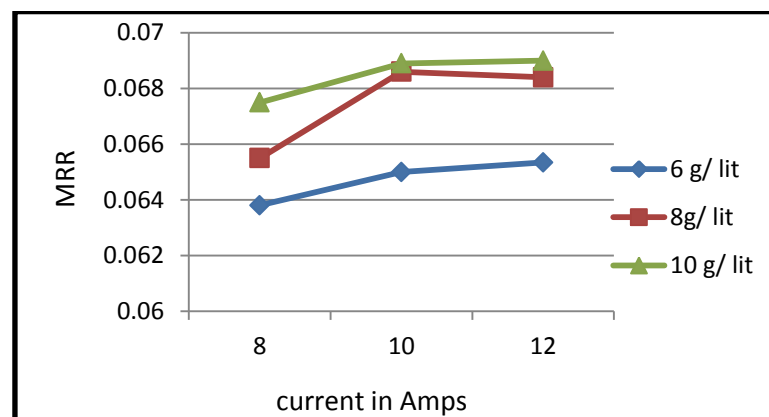


Figure : 3

Fig- 4 show the effect of discharge current and dielectric media on wear of copper tool electrodes while machining of Monel 400TM. Generally tool wear rate is due to impingement of positive ions which are being generated during ionization of dielectric and also melting and evaporation of work material, when straight polarity is impressed.

From the four plots in Fig- 4 it laws observed that the tool wear generally increase with increasing discharge current due to enhancement in population density of positive ions and the type of dielectric also influences the tool wear. The tool electrode have minimal wear with 10 g/ lit copper mixed kerosene and servotherm liquid dielectric at all value of discharge current where acquire maximum wear compared to 6 g / lit and 8 g / lit copper mixed kerosene + servotherm liquid dielectric.

From the above arguments, it is clear to have minimal tool wear, the pair 10 g / lit copper mixture servotherm and kerosene dielectriis recommended for copper tool electrodes for Monel 400TM

From the four curves in Fig-4 it was observed that the brass tool electrode have minimal wear with mixture kerosene of servotherm liquid dielectric, followed by kerosene.

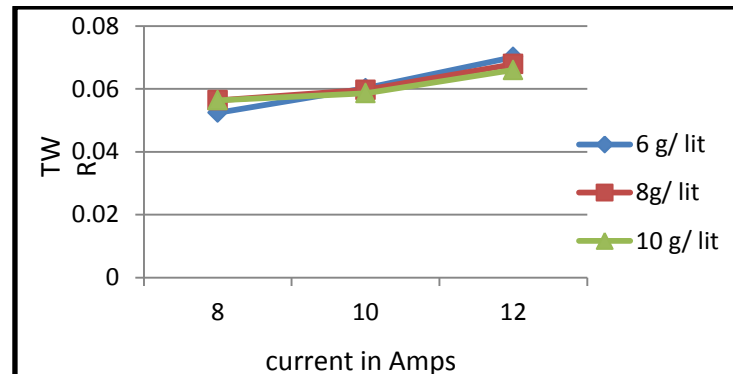
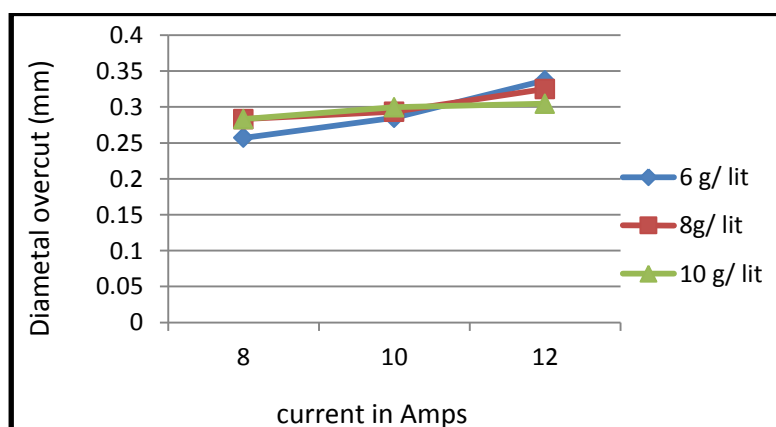


Figure - 4

Figure 5 indicate the effects of discharge current and dielectric media on surface roughness for Monel 400TM using copper tool as electrode. By comparing the three plots in figure 5 it is observed the trends of the curved for 10 g / lit copper mixed kerosene + servotherm oil low surface roughness. The surface roughness is low compared to to 6 g / lit and 8 g / lit copper mixed kerosene + servotherm liquid dielectric.

Fig 5 indicate the effects of discharge current and dielectric media on dimensional accuracy achieved for Monel 400tm when using copper electrode .

From the curves in figure 5 dimensional accuracy is decreases as the value of discharge current increases in the 6 g / lit and 8 g /lit copper powder mixed kerosene + servothermoil. Due to the fact that the increase causing enlarging the diameter of the crater formed on the surface of the work piece the dimensional accuracy achieved is good for the pair of copper tool and 10 g / lit copper powder mixed Kerosene + Serovotherm dielectric medium.



Figutr -5

Conclusion

The influence of copper powder mixed to the dielectric on material removal rate, tool wear rate, surface roughness and dimensional accuracy was studied, and the conclusions were drawn as follows,

- The copper electrodes acquire the best material removal rate with the 10 g / lit copper mixed kerosene + servotherm liquid dielectric compared to 6 g / lit and 8 g / lit copper mixed kerosene + servotherm liquid dielectric.
- The minimal tool wear, the pair 10 g / lit copper mixture servotherm and kerosene dielectriis recommended for copper tool electrodes for Monel 400TM
- The surface roughness is low compared to to 6 g / lit and 8 g / lit copper mixed kerosene + servotherm liquid dielectric.
- The dimensional accuracy achieved is good for the pair of copper tool and 10 g / lit copper powder mixed Kerosene + Serovotherm dielectric medium.

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