www.ijmer.com Vol.2, Issue.6, Nov-Dec. 2012 pp-4462-4464 ISSN: 2249-6645

Wear Behavior of AISI D3 Die Steel Using Cryogenic Treated Copper and Brass Electrode in Electric Discharge Machining

Harpreet Singh, [1] Amandeep Singh[2]

[1]Department of mechanical Engg YCOE Talwandi Sabbo

[2]Department of mechanical Engg FCET Ferozepur

ABSTRACT: *Electric discharge machining is used for machining of hard materials. Tool material is of great importance because it affects material removal rate as well as surface finish of work piece. In this article we study the wear behavior AISI D3 Die steel in EDM and compare the tool wear rate of cryogenic treated cooper and brass electrode with simple copper and brass electrode on machining of AISI D3 die steel using current setting as 4A and 8A. The electrolyte is used kerosene oil.*

Keyword: *Current, EDM, surface finish, Wear*

I. Introduction

Technological advances have led to an increasing use of high strength, high hardness materials in manufacturing industries. In the machining of these materials, traditional manufacturing processes are being replaced by more advance techniques like electro discharge machining, electric chemical machining and laser machining. (Lee et al., 2003). In non-traditional processing electrical discharge machining (EDM) has tremendous potential on account of the versatility of its application and it is except to be successfully and commercial utilized in modern industries (Habib, 2009). Electrical discharge machining is highly developed technology which account about 7% of all machine tools sales in the world. (Leao et al., 2004). In EDM process the material removal is achieved by preferential erosion of work piece electrode as controlled discrete discharge are passed between the tool and the work piece in a dielectric medium (Wong et al., 1995). Electric discharge machining one of the most popular non-traditional material removals process and has became basic machining method for the manufacturing industries of areospace, automotive, nuclear and medical (Kiyak et al., 2007). In the EDM process there is no direct contact between electrode and the component during machining and therefore no deformation occurs even for thin components (Lee et al., 2003). In the EDM process to obtain the maximum material removal with minimum tool wear, the work material and tool must be set at positive and negative electrode (Che Haron et al., 2008). The EDM process is thermal energy based process in which the use of thermal energy to generate heat that melts and vaporized the work piece by the ionization within the dielectric medium. The source of energy used is amplified light, ionized material and high voltage. Examples are laser beam machining, ion beam machining, and plasma arc machining and electric discharge machining (Kiyak et al., 2007). This paper describe the wear behavior of AISI D3 Die steel in EDM and compare tool wear behavior of cryogenic treated cooper and brass electrode with simple cooper and brass electrode which Assist in choosing optimum electrode

II. Experimental detail

2. 1 Work piece material

AISI D3 die steel was used as work piece material. Sample of size 25mm×18mm×6mm were prepared by using wire EDM. The prepare sample were heat treated to improve their hardness. After heat treatment the hardness of work piece material was 58HRc. Table 2.1 shows the chemical composition of work piece material.

Table 2.1 - The chemical composition of AISI D3 die steel

C%	Si%	Mn%	Cr%	Cu%
1.88	0.5	0.38	11.5	0.16

2. 2 Tool Preparation

The electrodes having the size of 16 mm diameter and 55 mm length were prepared out of the rods of Copper and Brass for performing the experiments. After preparing the required size the face of all the electrodes was polished so as to get good surface finish using different emery papers ranges from 220 to 2000 grit size following general metallographic procedure. After that half the number of the electrodes of Cu and Br were cryogenically treated to improve properties. Following Table 2.2 and 2.3 show the chemical composition of copper and brass electrode

Table 2.2 - The chemical composition of the copper electrode

Cu%	Zn%	Al%	Bi%	Pb%
99.8	0.057	0.15	0.0011	0.0008

Table 2.3 - The chemical composition of the brass electrode

Cu%	Zn%	Pb%	Sn%	Fe%	Ni%
58.8	37.2	2.7	0.5	0.9	0.16

2. 3 Dielectric used

The commonly available kerosene oil is used as dielectric fluid for all the experiments. The properties of the kerosene oil are shown in the Table no. 2.4.

Table 2.4 - Properties of kerosene oil

Surface Tension N/M	Density Kg / M³	Dynamic Viscosity
0.028	820	2400

2. 4. Machining process

Machining was performed on the electronics CNC EDM machine Each experiment was performed for fix time period of 20 min using the input process parameters as current using four different types of electrodes i.e. Cu, cryogenic treated Cu, Br and cryogenic treated Br. The weight of the work pieces and electrodes was done before machining and after machining on the weighing machine with least count of 1 mg

III. Result and disscussion

3.1 Influence of the current and electrode material on MRR

The MRR is a measure, defining removal material volume per minute. The mass loss of the material when using different electrodes with different setting of the current i.e. 4A and 8A is shown in the Fig. 3.1. MRR is higher for the high value of the current for all the four different electrodes used. When the pulse current increases from 4A to 8A then the discharge strikes the sample with more intensity.

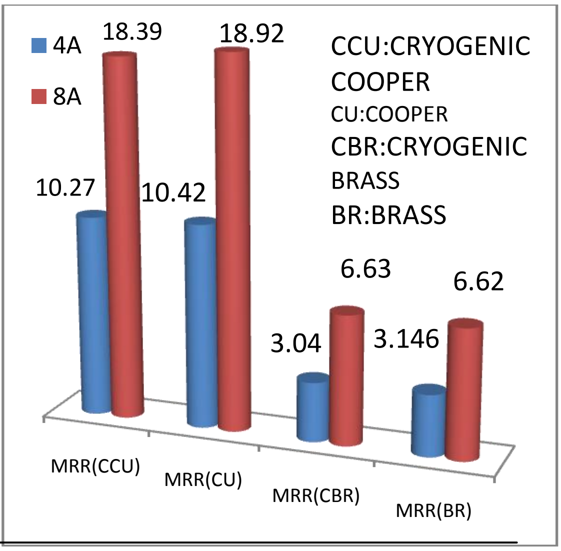

Fig. 3.1- Influence of the electrode material and current on the MRR (% of mass loss)

This result in erosion and cause more MRR (Lee et al., 2003). When the current increase from 4A to 8A then the spark energy increases, this leads to higher crater volume. This higher creator volume causes more MRR (Saha et al., 2009). This trend of MRR is in agreement with the work done by authors Kiyak and Lee (2007). As shown in Fig. 3.1 the maximum material removal is given by the copper electrode among the four different electrodes used, as copper electrode has higher thermal conductivity as compared to the brass electrode (Uhlmann et al., 2008). Further the MRR of cryogenic treated copper electrode and brass electrode is less than the non cryogenic treated electrodes. This may be due to the fact that with the cryogenic treatment of electrodes, the thermal conductivity of the electrodes increases. Due to increase in thermal conductivity of the electrode, heat applied during machining gets dissipated at a faster rate, which results in decrease in heat input at the inter-electrode gap. This further resulted in decrease in MRR. During the EDM process heat is applied for every discharge pulse and rate at which the material is removed depend upon how fast the applied heat is absorbed or dissipated (Abdulkarrem et al., 2009).

3.2 Influence of the Electrode Material and Current on the TWR

The Fig. 3.2 shows that with the increase in current there is increase in TWR for all the four electrodes used in machining. The higher value of current means higher heat energy subjected to electrode and high energy causes more volume of molten ejected material from the electrode, which results in high TWR (Saha et al., 2009). When the current increase from 4A to 8A then more ionization of the dielectric fluid occur which means that more number of the ions and electrons are striking on the tool surface, due to which more TWR occur (Singh et al., 2010).

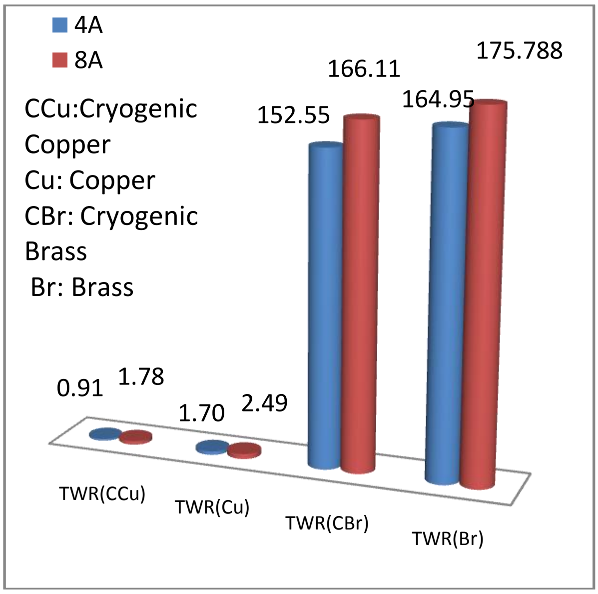

Fig. 3.2- Influence of the electrode material and current on the TWR (% of Tool wear)

Among the cryogenic treated and non cryogenic treated electrodes, the TWR of cryogenic treated electrode is less than the non cryogenic treated electrode. The cryogenic treatment improve the thermal conductivity of electrode material and due to good thermal conductivity there is a reduction is the heat entrapment at the electrode & work piece interface, due to less heat at the interface, there is less volume of metal which gets melted and evaporated, which results in reduction in the tool wear rate.

IV. Summry

- Tool wear of cryogenic treated copper electrode is approximately 50% less than copper electrode at 4 ampere current and 30% less at 8 ampere.
- Tool wear off cryogenic treated brass electrode is 8% least s than brass electrode at 4 ampere and 5% less at 8 ampere.
- Material removal rate of copper electrode is greater 1.4% of cryogrenic treated copper electrode at 4 ampere and 2.8% at 8 ampere
- Material removal rate of brass electrode is greater 3.2% of cryogrenic treated brass electrode at 4 ampere and same at 8 ampere.

V. Conclusion

Copper electrode is best electrode for high material removal rate. But cryogenic treated copper electrode has very low tool wear as compared to cooper electrode

References

[1] Abdulkareem, S., Khan, Ahsan A., Konneh, M., Reducing electrode wear ratio using cryogenic cooling during electrical discharge machining. Int. J. Adv. Manuf. Technol. 45, (2009). 1146-1151

[2] Saha, S. K., Choudhury, S.K., Experimental investigation and empirical modelling of the dry electric discharge machining process. Int. J. Mach. Tools. Manuf. 49, 2009. 297-308.

[3] Kiyak, M., Cakir, O., 2007. Examination of machining parameters on surface roughness in EDM of tool steel. J. Mater. Process.

[4] Singh, R., Singh B., Singh, H., Experimental Investigation for Tool Life Enhancement using Cryogenic Treatment. J. Eng. Sci. Tech. 4, 2010. 1-4.

[5] Uhlmann, E., Roehner, M., Investigation on reduction of tool electrode wears in micro-EDM using novel electrode materials. CIRP J. Manuf. Sci and Technol. 1, 2008. 92-96.

[6] Wong, Y.S., Lim, L.C., Lee, L.C., Effects of Flushing of Electro-Discharge Machined Surfaces. J. Mater Process Technol. 48, 1995. 299-305.

[7] Lee, H.T., Tai, T.Y.,. Relationship between EDM parameters and surface crack formation. J. Mater. Process. Technol. 142, 2003 676-683.

[8] Leao, F. N., Pashby, I. R., 2004. A review on the use of environmentally-friendly dielectric fluids in electrical discharge machining. J. Mater. Process. Technol. 149, 2003341-346.

[9] Haron, C.H Che., Ghani, J.A., Burhanuddin, Y., Seong, Y.K., S wee, C.Y., Copper and graphite electrodes performance in electrical-discharge machining of XW42 tool steel. J. Mater. Process. Techno. 201, 2008. 570-573.

[10] Habib, S. S., Study of the parameters in electrical discharge machining through response surface methodology approach. App. Math. Model. 33, 2009. 4397-4407.