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EFFECT OF ELECTRODE WEAR RATE ON MACHINING OF STAINLESS STEEL – 202 USING COPPER ELECTRODE IN EDM

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Abstract:In electrical discharge machining (EDM), Copper and Graphite are commonly used as electrode (tool) materials. EDM process is based on thermoelectric energy between an electrode and workpiece. In this paper, the effect of electrode wear rate (EWR) in 202 stainless steel is observed. Copper Electrode is used as tool material and SS-202 is used as workpiece. Copper electrode possess high structural integrity, so it can produce very fine surface finishes, even without special polishing circuits.

***Keywords*– Electrical Discharge Machining (EDM), Electrode Wear Rate, Copper Electrode, SS-202**

I. INTRODUCTION

In the Electro-discharge machining (EDM) heat is devloped with the application of electric current. The surface of the electrode material is heated at a very high intensity in the area of the discharge channel [1].When current is interrupted, due to which the discharge channel collapses immediately, as a result of that the molten metal on the surface of the electrode and the work piece both evaporates at a very high intensity and send liquid material into the dielectric [2]. The process forms craters on the surfaces of the work piece and the electrode [3], new craters are formed at the work piece surface is continuous eroded, if one discharge is followed by another. The shape of craters and depth are responsible for surface roughness. [4]. The higher rate of material removal with desired accuracy and the minimal surface damages help the EDM more economically important [5].In EDM process the performance is determined by Material removal rate (MRR), Electrode wear (EW), Surface roughness (SR), Surface quality (SQ) and Di-mensional accuracy (DA). Soni and Chakraverthi the surface quality, material removal rate, electrode wear rate, and dimensional accuracy of die steels and alloy steels in EDM [6]. The effect of the machining parameters on material removal rate, relative wear ratio, and surface roughness in EDM of SS-202 had been studied using copper electrode. With the help of transistorized pulse generators in an EDM, due to which we can vary the frequency and energy of discharge with a greater degree of control. In 1770, English chemist Joseph Priestly found the erosive effect of electric discharges, after that in 1943 Lazarenko and Lazarenko at Moscow University found the destructive properties of electric discharge for the use of constructive work [8]. After that in 1980 the use of CNC (computer numerical control) brought various advances in working of EDM. With the help of CNC there is a tremendous advance in efficiency of EDM [8].

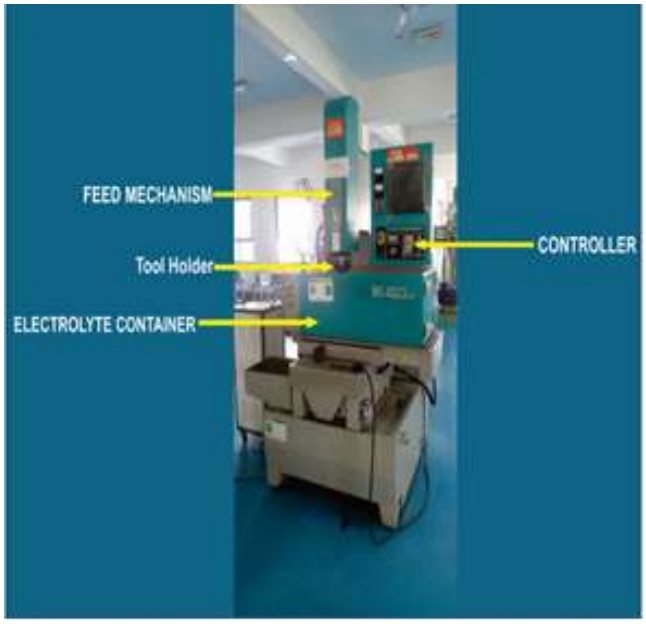

Fig.1 Die-sinking EDM machine

II. EXPERIMENTAL PROCEDURE

A. Work Piece Material

The work material used in this experiment is stainless steel 202. The chemical composition of the material is given in **Table 1.** The circular work piece is 76 mm in diameter and 4 mm is thickness. Electrical Discharge Machining will be done on this work piece. **Fig.2**explain about the work piece of this experiment. In this experiment the electrode wear rate of **SS-202**will be determined.

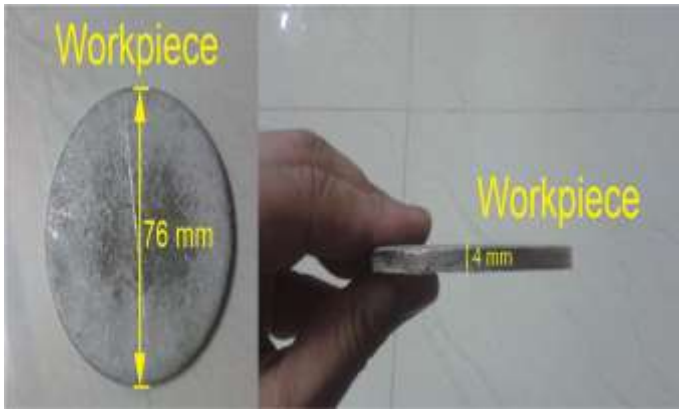

Fig.2 Work Piece of Stainless Steel - 202

Table.1 Chemical Composition of Work Material

Element	Component
Iron, Fe	68
Chromium, Cr	17- 19
Manganese, Mn	7.50-10
Nickel, Ni	4-6
Silicon, Si	≤ 1
Nitrogen, N	≤ 0.25
Carbon, C	≤ 0.15
Phosphorous, P	≤ 0.060
Sulfur, S	≤ 0.030

B. Electrode Material

In this experiment copper is selected as a electrode material. Copper is the mostly used electrode in electrical discharge machining. This is because the combination of Copper and certain power supply settings enables low wear burning. Also, Copper is compatible with the polishing circuits of certain advanced power supplies. Many shops in both Europe and Japan still prefer to use Copper as the primary electrode material, due to their tool making culture that is averse to the "untidiness" of working with graphite. Due to its structural integrity, Copper canproduce very fine surface finishes, even without special polishing circuits. The electrode of copper has 6 mm diameter and 100 mm length. The physical properties of copper electrode material in given **Table.2**

Table.2 Physical properties of Copper Electrode

Material	Copper
Composition	99.9%
Density (g/cm3)	8.96
Melting point (°C)	1084
Electrical resistivity (μΩ·cm)	9
Hardness	HB 100

C. Experimental Steps

Electrode Wear Rate (EWR) is defined as the ratio of difference of weight for tool electrode before and after machining process to the machining time.

$$\mathrm{EWR} = \frac{W_b - W_a}{T}$$

Where, W_b and W_a are weights of the copper tool electrode before and after machining in gram and T is the machining time in minutes. Following steps are involve to complete the experiment.

Step.1

Proper positioning of **Tool Holder, Work piece, V-Block** and **Copper electrode**. Work piece and Copper electrode must be in perpendicular position for proper machining. Fig.3 explains the required position of work piece and copper electrode before the machining process occurs.

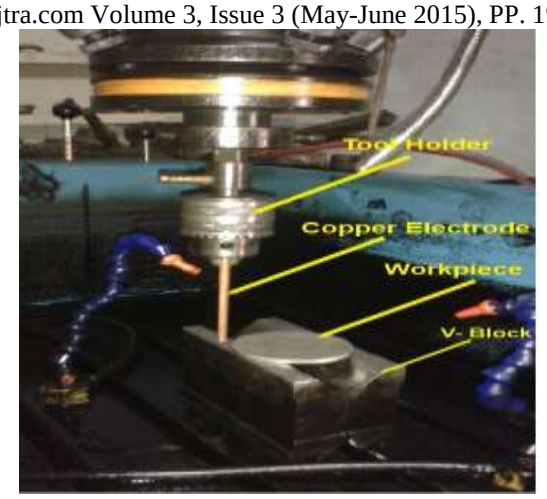

Fig.3 Positioning of Work Piece and Electrode

Step.2

In this step touch down of Copper Electrode and Work Piece, Positioning of Jet Flashing Nozzle should perform. Fig.4 explain the process of step.2

Fig.4 Positioning of Jet Flashing Nozzle

Step.3

In this step machine is started and spark occurs between the gap of work piece and copper electrode, this is because the energy is created between a work piece and electrode with the passage of electric current. The Work Piece and the Electrode are separated by a specific small gap called spark gap. Which is explained in the Fig.5.

Fig.5 Spark occurs between Work Piece and Electrode

Step.4

In this step Electrical Discharge machining of Stainless Steel – 202 by using copper electrode has been done. Fig.6 explains about this step.

Fig.6 Machining Process of Work Piece

Step.5

In this step we can monitor and control the input parameter such as current, T_{on} and T_{of} depth of cut, pause time of electrode and work piece. Fig.7 explain about the monitoring and controlling process of machining process.

Fig.7 Control Unit of Electrical Discharge Machining

III. DATA COLLECTION

In this paper the data from the experiment is collected put into Table.3 for 5 Amp, Table.4 for 8 Amp and Table.5 for 11 Amp in order to find out the electrode wear rate of copper electrode during machining of stainless steel – 202.

Table.3 Electrode Wear Rate for 5 Amp

Exp. No.	Time (Minutes)	Difference of weight	Electrode Wear Rate
1	14.75	0.120	0.0081
2	14.67	0.130	0.0089
3	14.63	0.105	0.0072
4	14.17	0.105	0.0074
5	14.58	0.110	0.0075

Table.4 Electrode Wear Rate for 8 Amp

Exp. No.	Time (Minutes)	Difference of weight	Electrode Wear Rate
1	8.50	0.090	0.0106
2	8.25	0.105	0.0127
3	8.75	0.105	0.0120
4	8.67	0.102	0.0118
5	8.25	0.118	0.0143

Table.5 Electrode Wear Rate for 11 Amp

Exp. No.	Time (Minutes)	Difference of weight	Electrode Wear Rate
1	5.50	0.078	0.0036
2	5.75	0.076	0.0026
3	5.25	0.076	0.0038
4	5.70	0.079	0.0044
5	5.50	0.071	0.0027

IV. RESULT AND DISCUSSION

Electrode wear is mainly due to high density electron impingement generated during machining Stainless Steel – 202. Fig.8 shows the effect of electrode wear rate (Copper Electrode)

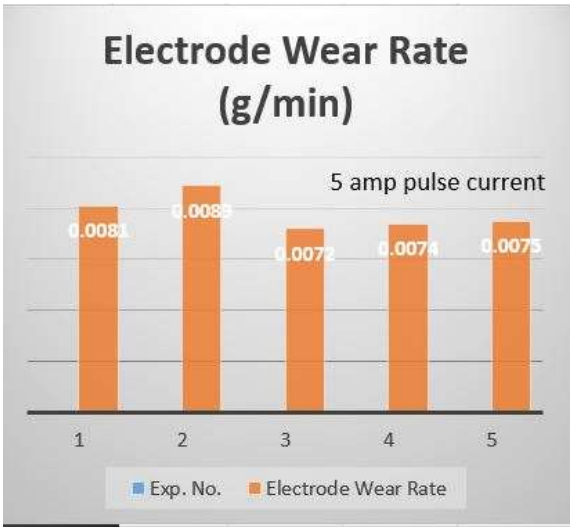

Fig.8 Effect of Pulse Current (5amp) on Electrode Wear of SS – 202

The electrode wear vs pulse current for SS-202 with respect to pulse current 8amp and 11amp is shown in Fig.9 and Fig.10

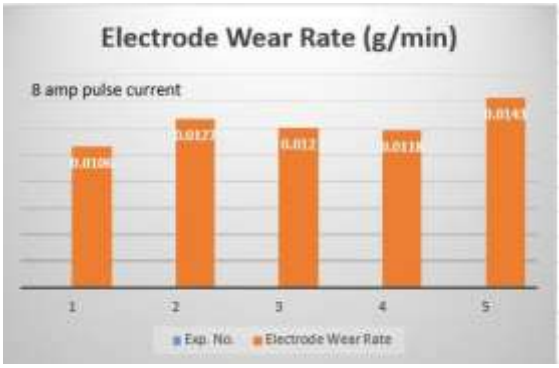

Fig.9 Effect of Pulse Current (5amp) on Electrode Wear of SS - 202

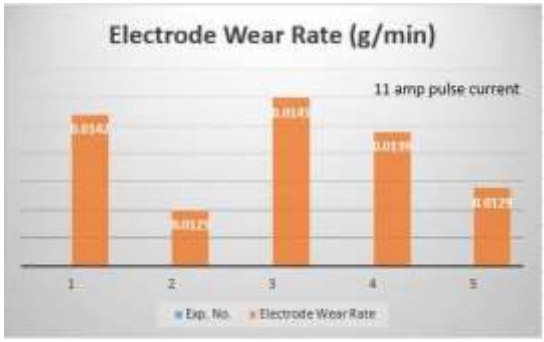

Fig.10 Effect of Pulse Current (5amp) on Electrode Wear of SS - 202

V. CONCLUSIONS

An experimental study has been conducted to investigate the Electrode Wear Rate of Stainless Steel–202 by using Copper Electrode. In this experiment Electrode Wear Rate is compared with respect to 5amp, 8amp and 11amp Pulse current. Fig.11 shows the effect of Pulse current on Electrode Wear Rate for SS-202. In Copper Electrode the Electrode Wear Rate increases as the Pulse Current is increased due to its low melting point.

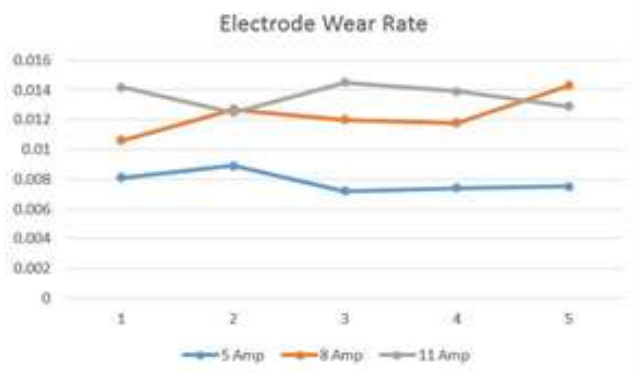

Fig.11 Effect of Pulse Current (5amp) on Electrode Wear of SS - 202

The Electrode Wear Rate of Copper Electrode is compared in Fig.12 with respect to 5amp, 8amp and 11amp Pulse current. This is because of the higher pulse current that causes rapid erosion of electrode material.

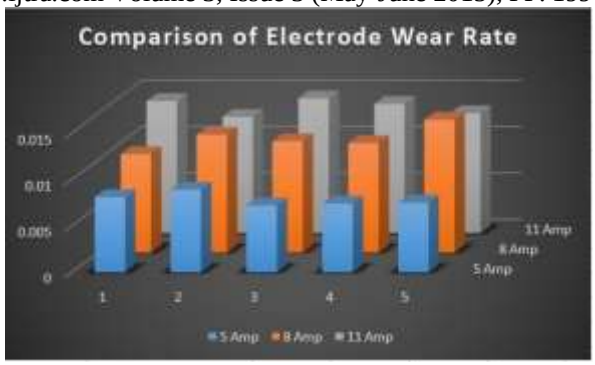

Fig.12 Comparison of Electrode Wear Rate with 5A, 8A and 11A Pulse current

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