Selection of the Best EDM Electrode on the Basis of Analysis of Performance Measures and Cost Associated with Manufacturing and Machining for Copper, Copper-Tungsten and Graphite Material

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Abstract- In this research work one common workpiece SS-316 has been used for three different electrodes . The best possible combination elaborates the various material used for machining in order to measures the performance and authenticate using graphical analysis. The important process parameters selected are peak current, pulse on time pulse off time and time of machining. The analyzed performance measures are Tool wear rate(TWR), Electrode wear rate(EWR), Surface roughness(SR),and cost associated with manufacturing and machining .Cupper, Cupper -Tungten and Graphite material electrodes have been used to machine the SS-316 workpiece. The comparison of performance parameters have been studied in order to obtain the maximum MRR, minimum EWR, and minimum SR and cost associated with the machining.

Keywords - EDM Electrode, Copper, Tungsten, Graphite, Material.

I. INTRODUCTION

Electrical discharge machine (EDM) is a widespread technique used in industry for high- precision machining of all types of conductive materials such as: metals, metallic alloys, graphite, or even some ceramic materials, of whatsoever hardness[1-6]. Electrical discharge machine (EDM) technology is increasingly being used in tool, die and mould making industries, for machining of heat treated tool steels and advanced materials (super alloys, ceramics, and metal matrix composites) requiring high accuracy, intricate shapes and high surface finish[2-4-7]. Electrical discharge machining (EDM) actually is a process of utilizing the removal phenomenon of electrical-discharge in dielectric. The workpiece and tool electrode both are immersed in oil which acts as a coolant for the region. The oil used in EDM should have high flash point as the temperature developed is very high. The dielectric fluid flushes away the removed particles. The components produces are exact replica of the tool electrode Therefore; the electrode plays an important role, which affects the material removal rate and the tool wear rate[4]. So in this research three different materials (Cu,Cu-W & Graphite) have been used for EDM electrodes. All these electrodes have been manufactured on Vertical Milling Centre machine and have been treated against the SS-316 Workpiece for output measures. The work piece has been tested at constant 10 A Current.

II. SYSTEM MODEL

This methodology helps in fabricating metal electrode by using Vertical milling machine at optimized cost with good dimensional accuracy. Three electrodes of three different materials (**Copper, copper-tungsten & Graphite**) are manufactured using this machining process. The various steps involve in manufacturing the Vertical Milling Machine electrodes are,

1) The flow diagram of electrode model manufacturing [1] gives the detail of electrode manufacturing of this project. The first step was converting jpg file CIPET logo into Coral draw file because jpg file of CIPET logo is not clear enough for solid modeling of the part. Thus first step is to Re-design college logo into coral draw software. With the Re-design of the model gives the clear & good appearance and aesthetic to the design.

2) When the component is Re-Design into coral draw software the coral draw file is directly imported to the CAD-Model by using Auto-Cad software. This CAD-Model is again imported into NX-Model by using latest Unigraphics-9 software and complete modeling of part is done. The modeling of design is done in two types for two different materials. For copper the modeling is done in projected (male part/ pattern) type and for graphite electrode modeling is done on cavity (female part/pattern) type.

   The specifications of the Electrode after Re-design for male parts are,

   i. Dimensions of electrode =100mm x 40mm

   ii. Dia of electrode =40 Φ mm

3) As the development of the Design Model (electrode) was generated by modeling software. The next stage

was the machining stage. For Vertical Milling Operation first requirement is to create NC- part program of the design. Selection of tool (mill bore) is also important part for this machining operation. This program is then transferred to WMC computer unit using software.

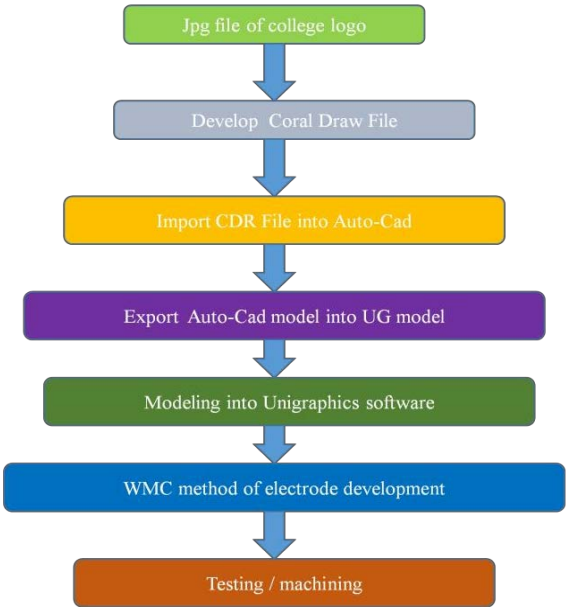

Figure- 2.1 WMC EDM Electrode manufacturing process

Figure 2.2 Coral draw model

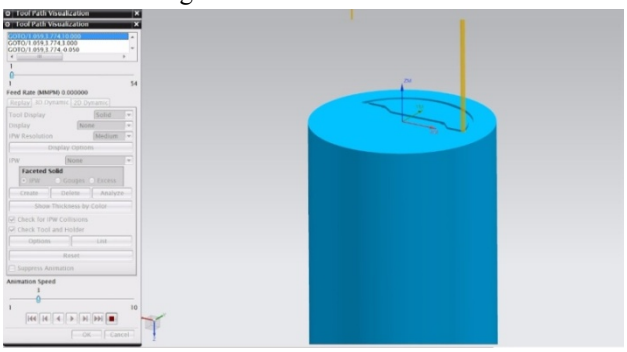

figure 2.3importing Coral draw model into Auto-cad model

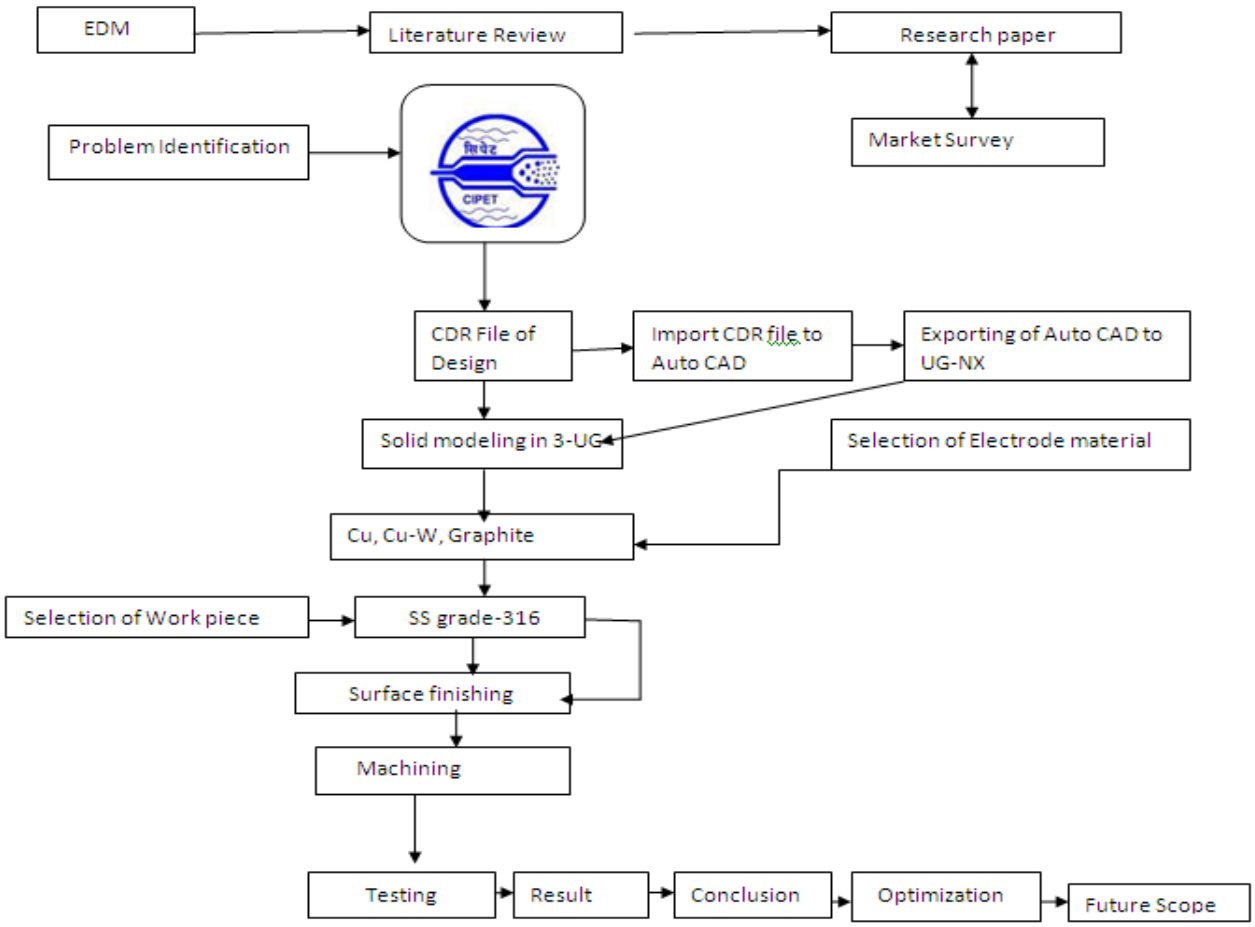

Figure: 4.1 Process flow diagram

III. PREVIOUS WORKS

Review of the research works finds that a lot of work has been done on EDM with low carbon or mild steel with different tool electrode materials. Kalyani s. kanekar [1] performed electric discharge machining on mild steel with Brass, copper and aluminium electrode and studied the optimization of best electrode under different manufacturing methods of electrode and different materials. S. Shankar [2] investigated the performance of different electrode material on EN-31 Steel and analyzed the effect of pulsed current and MRR in his work. So many works on different materials for electrodes with different manufacturing technology of making electrodes have been done but from the literature survey it has been observed that there is need of finding the best electrode for EDM among the Cu,CU-W & Graphite over the Stainless steel workpiece. In most of the organization there is need of brilliant shining logo for permanent identification of goods. So it will be possible to make the logos over Stainless steel Material.

IV. PROPOSED METHODOLOGY

The flow diagram of methodology of this research work has been shown here. This methodology gives the idea of whole work done in this project.In this research work only we are concerned with the performance analysis by comparing the different performance parameters with respect to tool electrode materials.All the electrodes have been tested on 10 A current with SS-316 Grade workpiece. Flow process diagram has been shown in Fig.4.1.

V. EXPERIMENTAL RESULTS

COMPARISION BETWEEN PERFORMANCE MEASURES, TOTAL COST AND TIME REQUIRED FOR TESTING BY ALL THREE ELECTRODES-

In this paper electrode having maximum MRR, Low EWR, high SR, minimum time required for machining and lowest electrode cost is required. Tables and graphs given below contain all the important parameters of this project. From the tables and graphs it is clear that all the requirement of best electrode among three electrodes is fulfilled by the copper –tungsten electrode as it has highest MRR, lowest EWR , time required for testing is low on current i.e. I= 10 A . Following tables shows various parameters and total cost of all EDM electrodes.

Testing of electrode at I= 10 A

Machining parameters Manufacturin g technology	Electrode material	Workpiece material	Time Required For testing (min)	Voltage V	T_{off} (µs)	T_{on} (µs)	Spark Gap (mm)	Depth Of Cut (mm)
WMC (Vertical milling machine)	Copper	SS sheet of 10 mm thickness	72	10	40	200	0.2	0.2
WMC(Vertic al milling machine)	Copper Tungsten	SS sheet of 10 mm thickness	60	10	40	200	0.2	0.2
WMC(Vertic al milling machine)	Graphite	SS sheet of 10 mm thickness	90	10	40	200	0.2	0.2

Table-5.1 testing of electrode at I=10 A

Electrode Material	**Weight of Electrode (gms)**	**Total machining Time (min)**
Copper	238	72
Copper-tungsten(CW)	366	60
Graphite	78	90

Table-5.2 Weight and Machining time of EDM electrode at 10 A

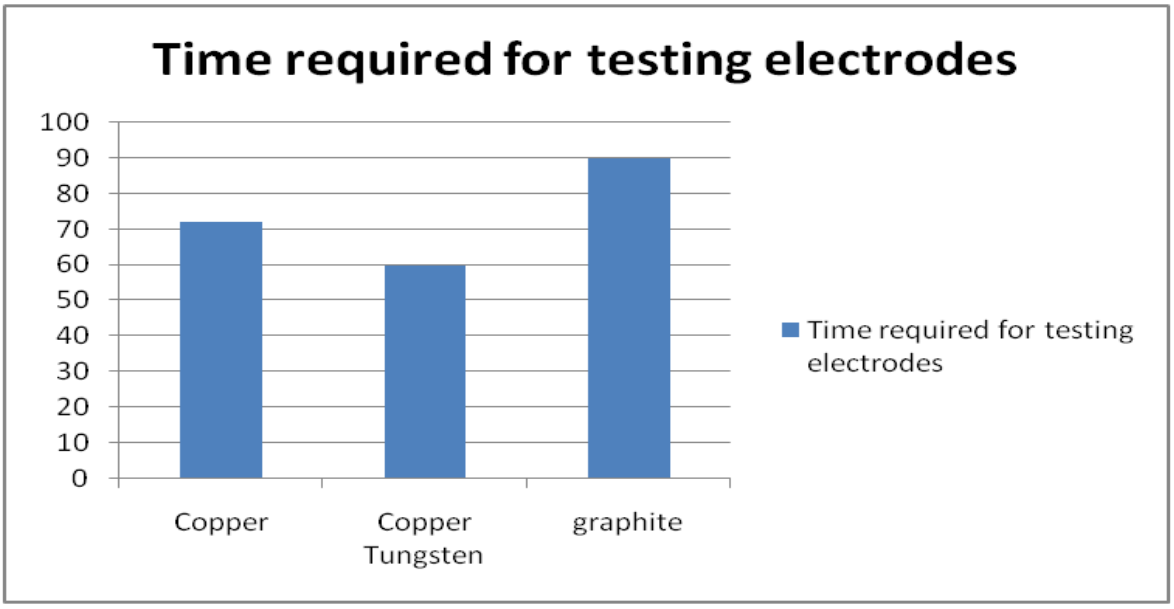

Figure:5.1 time required for testing of electrodes

Cast associated with development of all three electrodes-

Cost required for fabrication Of electrode(A) Rs/-	Cost required for testing of electrode (B) Rs/-	Cost required For modelling Rs/-	Cost required for Workpiece Material (C) 333x2=666Rs/-	Total cost (D) D= A+B +C Rs/-
586	2034	800	666	4086
1868	1634	800	666	4968
1068	2650	800	666	5184

Table-5.3 Cost associated with fabrication, testing, modeling of electrodes & overall Cost

Calculation formula used for MRR and EWR:

Material Removal Rate(MRR) = Weight of Electrode (gms)

Total machining Time (min)

EWR= Weight of Electrode before machining (gms) (A)

Weight of Electrode after machining (gms)(B)

MRR	EWR	SR	Time for Testing of electrode	Total cost (Rs/-
3.3055	1.0223	2.498	72	4086
6.1	1.0113	1.67	60	4968
0.8666	1.0641	19.654	90	5148

Table-5.4 various parameters and total cost of all EDM electrodes

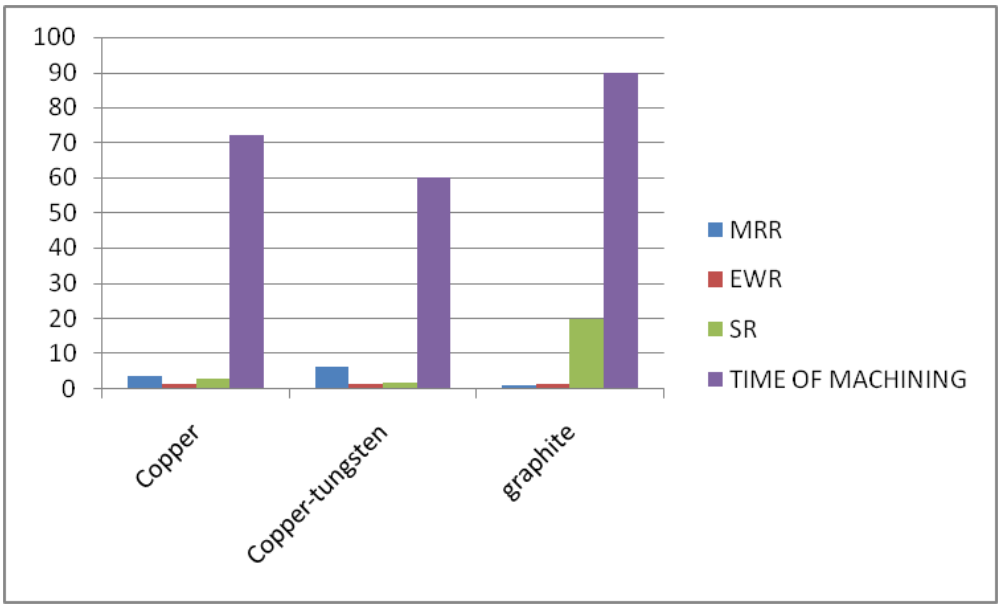

Figure 5.2 Electrode material Vs MRR, EWR, SR, and Time required for testing at I= 10 A

VI. CONCLUSIONS

Manufacture of Electrical-Discharge Machine Electrode with vertical milling manufacturing methodologies was achieved. The total three electrodes were manufactured successfully to perform the experiments and the outcome results shows the machining time, material removal rate, tool wear rates, total manufacturing time and surface roughness at standard machining settings. From graphical comparison and test results obtained it is clear that Copper tungsten is the best material with high MRR, low EWR, and better Ra values at I=10 A.. But fabrication cost required to developed copper-tungsten by WMC method is highest than copper and Graphite electrode. Cost required to developed the graphite electrode is higher than copper electrode but its performance is poor than copper .From the experimental results in form of the tables and pictures shown above reveals that Copper-Tungsten is the best electrode for SS-310 at 10 A current.

VII. FUTURE SCOPE

Exhaustive study can be done at different currents in order to find the best optimum current value for better MRR,EWR and SR.

Research can be extended to the complex shapes like curved contours etc on wire cut EDM machine.

Different Manufacturing methods can be applied to different tool electrode and can be tested on various workpiece materials.

Five axis machines can be used for complex three dimensional parts.

This will help in reducing the manufacturing time and cost for electrode.

VIII. REFERENCES

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