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Optimization of EDM Process of (Cu-W) EDM Electrodes on Different Progression

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Abstract –
The purpose of this research work is to determine the optimal cutting condition of EDM process of different work piece materials using different compositions of Cu-W tool Electrodes. The key cutting factors such as Discharge Current, Voltage, Pulse- On – Time, Duty Cycle, Spark Gap and flushing pressure will be optimized.
Keywords- Electrical Discharge Machining, MRR, SEM

I. INTRODUCTION

Electrical Discharge Machining (EDM) is a unconventional manufacturing process based on removal of material from a part by means of a series of repeated electrical sparks created by electric pulse generators at short intervals between a electrode tool and the part to be machined immersed in dielectric fluid [1]. At present, EDM is a widespread technique used in industry for high precision machining of all types of conductive materials such as metallic alloys, metals, graphite, composite materials or some ceramic material. The selection of optimized manufacturing conditions is one of the most important aspects to consider in the die-sinking electrical discharge machining (EDM) of conductive steel, as these conditions are the ones that are to determine such important characteristics: surface roughness, electrode wear (EW) and material removal rate (MRR). A study will be perform on the influence of the factors of peak current, pulse on time, interval time and power supply voltage. Design of experiments (DOE) technique to select the optimum machining conditions for machining .

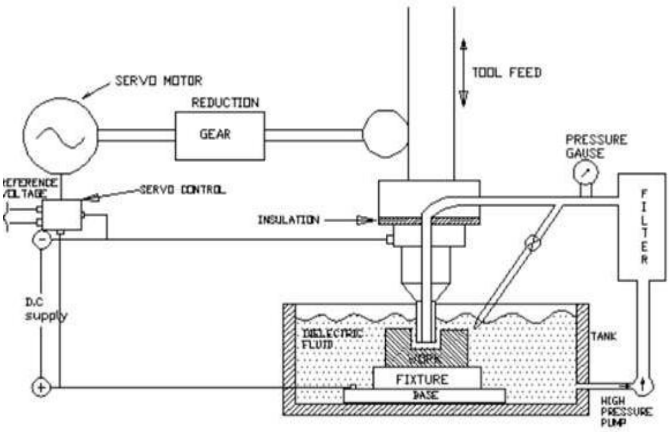


Fig1.pricipal of EDM

A. Mechanism And Evaluation of Material Removal Rate -

The MRR is defined as the ratio of the difference in weight of the work piece before and after machining to the density of the material and the machining time.

$$MRR= \frac{Wi - Wf}{T^* \rho}$$

Where
W i = initial weight before machining
Wf = final weight after machining
T = machining time
ρ is the density

B. Mechanism And Evaluation of Tool Removal Rate-

TWR is expressed as the ratio of the difference of weight of the tool before and after machining to the machining time. it is written as –

$$\frac{\mathrm{Wtb} - \mathrm{Wtb}}{\mathrm{T}}$$

Wtb = weight of tool before machining
Wta = weight of tool after machining
T =Machining time

C. Mechanism and Evaluation of Surface Roughness

Surface Roughness is the measure of the texture of the surface. It is measured in μm. If the value is high then the surface is rough and if low then the surface is smooth. It is denoted by Ra.

D. Scanning Electron Microscope

A scanning Electron Microscope produces images of a sample by scanning it with a focused beam of electrons. The electrons interact with atoms in the sample, producing various signals that can be detected and that contain information about the sample's surface topography and composition.

II. LITERATURE SURVEY

José Carvalho Ferreira 2006 three consider Cu-W electrodes .Cu30%-W70%,Cu25%-W75%,Cu20%-W80% on AISI H13. He considering following

Electrode material	Unit	Cu20W80	Cu25W75	Cu30W7(
Density	[g/cm^3]	15.4	14.7	14.1
Hardness, Brinell (min.)		2,160	1,940	1,720
Hardness Rockwell B		103	98	93
Heat capacity	[J/g-K]	0.178	0.192	0.208
Thermal conductivity	[W/m-K]	210	230	260
Solidus temperature	[K]	1,353	1,353	1,353
Liquidus temperature	[K]	3683	3683	3683
Melting point	[K]	1,353–3,683	1,353–3,683	1,353–3,683
Tensile strength, Ultim	[MPa]	793	690	587
Tensile strength, Yield	[MPa]	614	524	433
Modulus of elasticity	[GPa]	241	234	226
Flexural modulus	[GPa]	1.17	1.03	0.89
Electrical resistivity	[Ω-cm]	5.1e–006	4.5e–006	4.1e–006

using of these electrode MRR are

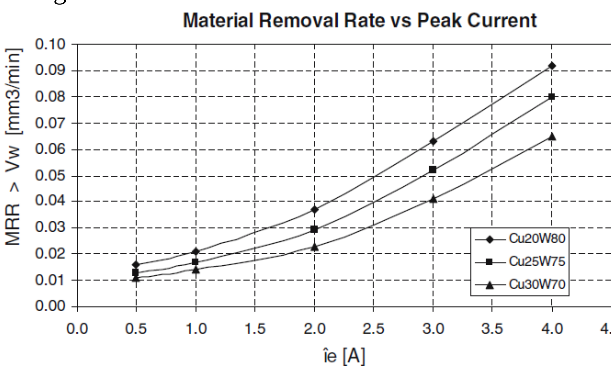


Fig-2 Effect of tool electrode composition on the material removal rate function of the peak discharge current[1]

K.Daneshjou et al,2006,found that by increasing pressuring machine machine pressure pressure, the density, relative density, hardness and electrical conductivity of tungsten copper composites will be increased. In this research the specimen size are 22millimeter diameter and 7 millimeter height were prepared with copper – tungsten and copper – tungsten-cobalt powder .the tungsten particle size 4µm. the composite comprise 0.2,0.5,0.7 to 1 present of Cobalt

Composition of Mark experimental tungsten powder

Element	W	P	C	Fe	Al	Cu	Zn	Si	Cd	Sn
Percent	99.98	0.002	0.003	0.004	0.001	0.001	0.001	0.001	0.001	0.001

To increases the temperature 1220 to 1280 seen following result .
In pressing machine pressure and density

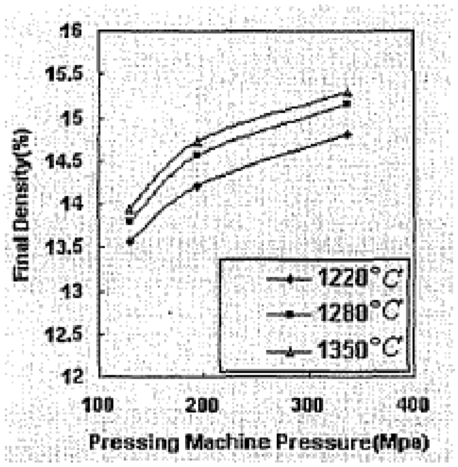


Fig-3 density and machining pressure [3]

Relation between Parentage of cobalt weight and final density

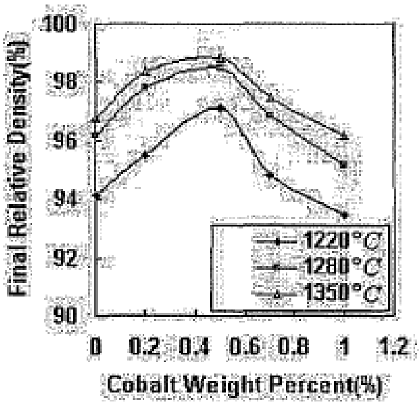


Fig-4 percentage of cobalt weight[3]

Pramod kumar et al successfully use SEM and EDX to C-40 grade plain carbon steel and to analysis it used XRD. Tool prepaid with powder metallurgy. Where Cu25% and W75% . in this experiment following parameter had selected

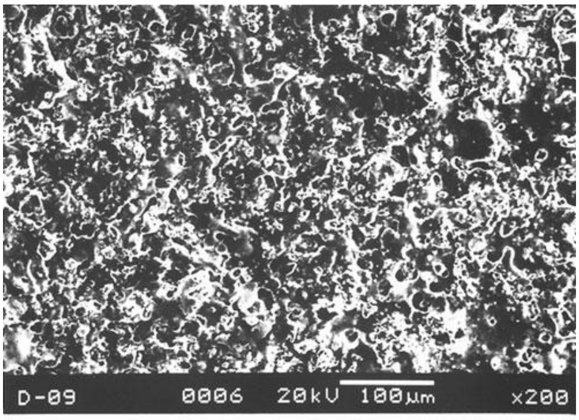
Parameters	**Value**
Compaction pressure	120,180,240,300MPa
Sintering temperature	700 and 900*C
Peak current	4A,8A,10A and 12A
Ton	19-386µs
Polarity	(-)
Duty cycle	50%-70%
Gap control voltage	45V
Process of time	5 minute

Taking these parameters preformed experiment have seen two result one on thin and other on thicklayer.

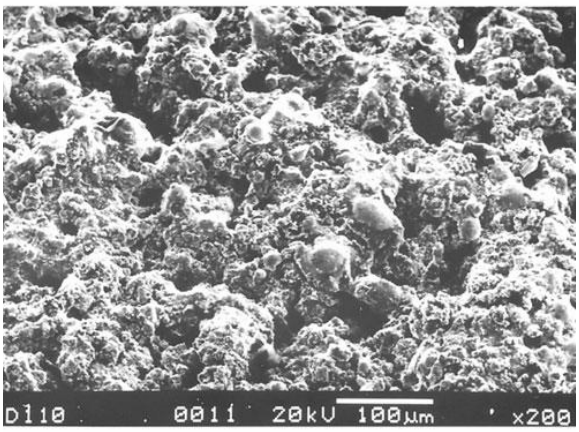
(a) (b)

*Fig-5 a is thin layer work piece where CP- 240,Sp is 700*C IP is 8A , Ton is 38µs b is thick surface where CP-120 Mpa,Sp-700*C,IP-10A ,Ton-256µs [8]*

The transient voltage and current waveforms during EDM operation were captured and analyzed. It was observed that whenever there is a uniform mass transfer, there is little chance of occurrence of arcing and short circuiting. SEM micrographs of the top surface of processed samples with a very thin and a thick deposition are shown in figure.



(a) CP: 120MPa, ST: 700^{O}C, Ip: 8A, T_{on}: 19µs



(b) CP: 120MPa, ST: 700^{O}C, Ip: 10A, T_{on}:256µs

fig-6 SEM of top surface of processed samples with a very thin and b thick deposition[8]

It is observed that at lower Ton settings, the deposited surface layer is very thin and finely distributed. It is thick and comparatively coarse at higher Ton settings for such Ip values (8A and 10A) that cause regular sparking with free flow of material from tool.

XRD analysis was carried to confirm the transfer of tool material on the work surface and also to identify. the phases of any compound formed during the EDM process. XRD plot (with cobalt target) of the top of the deposited layer of a sample processed at Ip: 10A and Ton: 256 µs with tools compacted at 120 MPa and sintered at 700°C in 'as-it-is' condition after EDM is shown in figure .

It Exploited on different parameter like CM, ST ,peak current and voltage.

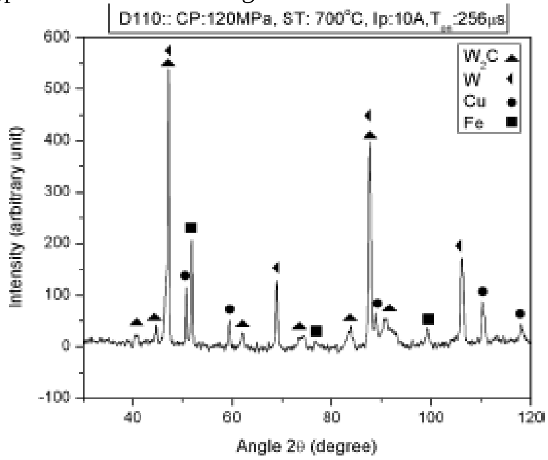


fig-7 XRD plot inIP- 10A and Ton 256 CP-120Mpa[8]

Naveen Beri et al 2008, seen' s that taguchi approach enabled the identification of significant factor and there associated result of specify the output measure. During the EDMing on AISID2 steel electrode material, duty cycle and current affect the performance. this experiment take Cu-W(30-70%) tool .

For the best performance maximum MRR the parameters are

Parameter	Range
Current	10.5A
Duty cycle	0.66
Flushing pressure	0.75Kg/cm^2

For the minimum MRR the parameters are

parameter	Range
Current	4.5A
Duty Cycle	0.5
Flushing pressure	0.3kg/cm^2

To applying these parameter the material removal rate ANOVA technique

Source	DF	Seq SS	Adj SS	Adj MS	F	P
A	1	189.420	189.420	189.420	57.39	0.017
B	2	479.116	479.116	239.558	72.58	0.014
C	2	12.549	13.440	6.720	2.04	0.329
D	2	8.230	5.865	2.932	0.89	0.530
BXC	4	1.231	2.075	0.519	0.16	0.943
BXD	4	2.663	2.663	0.666	0.20	0.917
Residual Error	2	6.601	6.601	3.301		
Total	17	699.810				

Here A,B,C.D denote the parameter
And Surface Roughness are –

Source	DF	Seq SS	Adj SS	Adj MS	F	P
A	1	15.213	15.213	15.213	4.98	0.155
B	2	349.624	349.624	174.812	57.28	0.017
C	2	6.037	4.062	2.031	0.67	0.600
D	2	0.606	0.015	0.008	0.00	0.998
BXC	4	3.058	2.361	0.590	0.19	0.922
BXD	4	0.143	0.143	0.036	0.01	0.999
Residual Error	2	6.104	6.104	3.052		
Total	17	380.784				

Pramode Kumar et at2010,prove that the investigation has established the fact that it is possible to use P/M compacts as EDM tool for material removal as well as for surface modification in the same set up just by selecting appropriate process parameters .subramanyam gopaln et al,2012shows the effect of of electrode materials on machining characteristics in EDM of corrosive resistant stainless steels 316 L and 17-4PH.

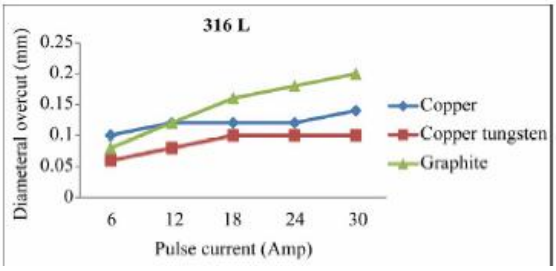


Fig8- Effect of pulse on diameteral overcut 316L[7]

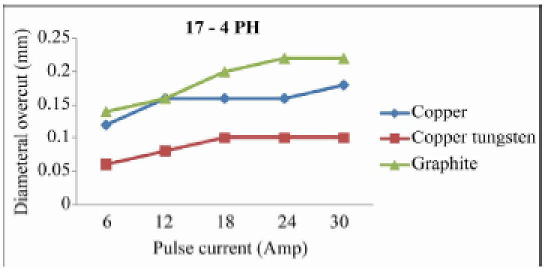


Fig9- Effect of pulse on diameteral overcut 17-4PH[7]

Sanjeev Kumar et at 2014, shows the study , In the present study, the objective function was to study the surface characteristics of three types of cryogenically treated titanium alloys.in this experiment he consider Eight factor and studying the imapact of surface fraction . by using RSM the value of parameter shown in table.

Response table using S/N value for SR

Process parameters	Levels	Average value (Ra)	S/N Ratio (dB)
Pulse-off-time (A)	1	6.19	-15.58
	2	5.25	-14.29
Peak current (B)	1	4.36	-12.77
	2	5.95	-15.41
	3	6.86	-16.63
Pulse-on-time (C)	1	4.93	-13.67
	2	5.91	-15.28
	3	6.34	-15.86
Dielectric fluid (D)	1	5.67	-14.71
	2	6.07	-15.47
	3	5.43	-14.63
Electrode materials (E)	1	5.85	-15.16
	2	5.21	-14.30
	3	6.12	-15.36
Cryogenics of electrode materials (F)	1	5.32	-14.45
	2	5.85	-15.01
	3	5.99	-15.36
Workpiece materials (G)	1	6.12	-15.35
	2	5.95	-15.38
	3	5.10	-14.09
Cryogenics of work materials (H)	1	5.71	-14.86
	2	5.91	-15.21
	3	5.56	-14.74

Tirupati p , purpose of completely hard material machining on reducing the cycle time and tool wear rate generated in copper rod by EDM, on-the machining tool composition modification technology was developed in this study. By applying this technology to a simple die, the tool wear rate defects generated by EDM could be completely removed by incorporating the copper tungsten rod Cu-w (70%-30%) composition process into EDM.The resulting tool wear rate, cycle time was reduced. So increase productions reduced cycle time, machining cost, tool wear rate and increase the surface finish.

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