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Analysis of Nickel Lead- Lead Mixed Sprit Servotherm in EDMA of Monel 600^{tm}

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ABSTRACT: Technologies to improve the material removal rate and reduce the tool wear rate, achieve the good surface finish and dimensional accuracy are very demanding in electrical discharging machining (EDMA). The work focused on performance of Nickel Lead mixed with Sprit servotherm as dielectric medium in electrical discharge machining of Monel 600^{TM}. The optimum range of Nickel Lead powder, Graphite powder 6g mixes with the dielectric medium of Sprit servotherm (75:25) were developed experimentally. It was reported slightly more material removal rate, very low tool wear rate, better dimensional accuracy and good surface finsh in Monel 600^{TM}.

KEYWORDS: Electrical discharge machining, Spritservotherm, material removal rate, , surface roughness tool wear rate.

I. INTRODUCTION

The advanced materials have attractive properties i.e., high strength, high bending stiffness, good damping capacity, low thermal expansion, better fatigue characteristics which make them potential for modern day industrial application. Present manufacturing industries are facing challenges from these advanced materials viz. super alloys, ceramics, and composites, that are hard and difficult to machine, requiring high precision, surface quality which increases machining cost. To meet these challenges new process with advanced methodology and tooling needs to be developed [1].
The Powder mixed electrical discharge machining (PMEDMA) is a relatively new material removal process applied to improve the machining efficiency and surface finish I presence of powder mixed dielectric fluid [2].The surface modification using by EDMA, details are given of operations involving powder metallurgy (PM) tool electrodes and the use of powders sus-pended in the dielectric fluid, typically aluminum, Nickel Lead, titanium, etc. [3].
To carried out the research by the addition of fine graphite powder into Sprit oil on the machining of tool steels. It was resulted out that the addition of 4 g/l of graphite powder increases the interspaced for electric discharge initiation and lowered the breakdown voltage. [4]. Tool wear rate and metal removal rate are affected by the type of dielectric fluid used for flushing. Commonly used dielectric media are hydrocarbon compounds and water. The hydrocarbon compounds are in the form of refined oil.

[5].To studied the effect of silicon powder addition into dielectric fluid on the surface finish of H-13 die steel. Machining with addition of silicon powder produces fine and corrosion-resistant surfaces having roughness of 2 µm. [6]. The investigated the effects of suspended powder in dielectric fluid on surface roughness. It was reported that the surface finish os SKD-61 material is improved with the use of silicon powder. Yan et al. studied the effect of suspended aluminum and silicon carbide powders on EDMA of SKD11 and Ti-6A1-4V. Improvement in metal removal rate was observed at the cost of surface finish. [7]. The result out that Nickel Lead powder mixed EDMA modifies the surface of aluminum bronze components. Nickel Lead powder deposit a layer on an EDMA surface to make the surface abrasion-resistant. [8].
To observed that machining of SKH-54 tool steel in addition of graphite powder particles results in higher material removal rate and better discharge dispersion. [9]. The EDMA process by adding Sic and aluminum powders into Sprit for the micro-slit machining of titanium alloy. Mixed Nic and aluminum powder to the Sprit enhanced the gap distance, resulting in higher debris removal rate and material removal depth. The uses of Sic powder in wate as dielectric for micro slit operation.

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They concluded that the addition of Nic powder increases the electrical conductivity, enlarge the inter electrode gap, removes debris easily and increases MRR. Till very few researches has been seen in grooving and slitting machining operation with addition of powder mixed EDMA. [10]. The result out the effect of Nickel Lead powder mixed dielectric on EDMA. Improvement in surface finish was assessed through quality surface indicators and process time measurements over a set of different processing areas. The EDMA with silicon powder mixed fluid produced better surface finish.

II. MATERIALS AND METHODS

In these investigations, Sprit servotherm mixed with graphite powder of 6g and Nickel Lead powder of (2, 4, 8, and 16g).the properties of Nickel Lead are given below in the table:

Table 1: Properties of Nickel Lead

Sl.no	Name of the property	Specification
1	Phase	Solid
2	Density(near r.t)	8.908 cm^{-3}
3	Liquid density atm.p.	7.81 $g.cm^{-3}$
4	Melting point	1728 K,
5	Boiling point	3186 K,
6	Heat of fusion	17.48 $KJ.mol^{-1}$
7	Heatof vaporization	377.5 $kJ.mol^{-1}$

The physical properties of copper and graphite electrodes are given in the below table:

Table 2: Physical properties of copper and graphite electrode

Sl.no	Name of the Property	Specification
1	Electrode	Copper
2	Electrical resistivity	0.96μΩ/cm
3	Thermal Conductivity	380.7(W/mK)
	Melting point	1083°C
5	Specific heat	0.092 (cal/g°C)
6	Coefficient of thermal Expansion	6.6×10^{-6} °C-1

Table 3: CHEMICAL COMPOSITION (WT. %) OF MONEL 600™

Elements	Composition (wt. %)
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

III. ANALYSIS OF MATERIALS

Evaluation of MRR

The material MRR is expressed as the ratio of the difference of weight of the work piece before and after machining to the machining time and density of the material [1-3].

MRR = (M1-M2)/ (TXP)

M_1 = Weight of work piece before machining.

M_2 = Weight of work piece after machining.

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T = Machining time in mins.
P = Density of Monel 600™ =8.80 gm/cm^3

Evaluation of TWR

TWR is expressed as the ratio of the difference of weight of the tool before and after machining to the machining time. That can be explain this equations

TWR = (WT1-WT2)/T
Wt1 = Weight of the tool before machining.
Wt2 = Weight of the tool after machining.
T = Machining time.

Evaluation of Overcut (OC)

OC is expressed as half the difference of diameter of the hole produced to the tool diameter that is shown in these equations.

OC = (D1-D2)/2
D1 = Diameter of hole produced in the work piece.
D2 = Diameter of tool.

Machining parameters

Machining parameter	Symbol	Unit	Value
Machine Voltage	V	Volts	125
Gap voltage	V	Volts	36
Current	I	Amps	14
Work piece Diameter	D	Mm	15
Thickness	T	Mm	8
Tool diameter	D	Mm	10
Tool length	L	Mm	75

IV. RESULTS AND DISCUSSION

The studies on Monel 600™ with Sprit servotherm of different combinations and Cu tool electrode are shown in figure 4.1, 4.2. Figure 4.1 shows that the Sprit servotherm, graphite powder, Nickel Lead powder with different combination evolved in different metal removal rate (MRR).

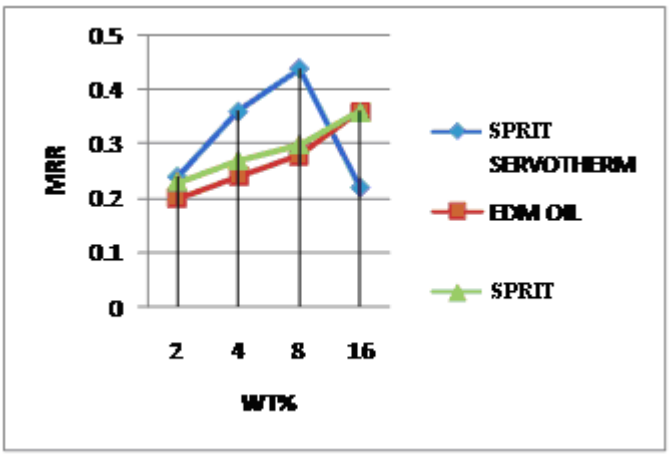

Figure 4.1: MRR VS WT% OF NICKEL LEAD

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In this investigation the mixture of Nickel Lead powder 8g shows the more metal removal rate (MRR) than the other combination of rest of mixture. The Sprit servotherm combination 75:25 yields the MRR as 14% more than the Sprit and EDMA oil [4-6].

Figure 4.2 shows that the Sprit servotherm, graphite powder and Nickel Lead powder with different combination evolved in different tool wear rate (TWR). In this investigation the reduced tool wear rate has been obtained by different range of mixture of Nickel Lead powder in dielectric medium [7-9].

Specifically the 8g of Nickel Lead mixture shows the (3.6%) better result compare than the other mixture. It is clear that Sprit servotherm could be considered as best performed combination. This may be due to optimum combination of thermal, electrical conductivity and viscosity [10-12].

Increasing in the discharge current from 1 to 3 A the tool wear rate is decreasing, but discharge current in the range of 3 to 5 A the tool wear rate is increasing because of lp increases the pulse energy increases and thus more heat energy is produced in the tool work piece interface leads to increase the melting and evaporation of electrode [6]. That's why in this work the current range as 4A constantly through out the process.

Figure 4.3 shows when the machining time is varied by the even quantity of Nickel Lead powder mixture. As per the figure 4.3 Nickel Lead 8g gives the better machining time.

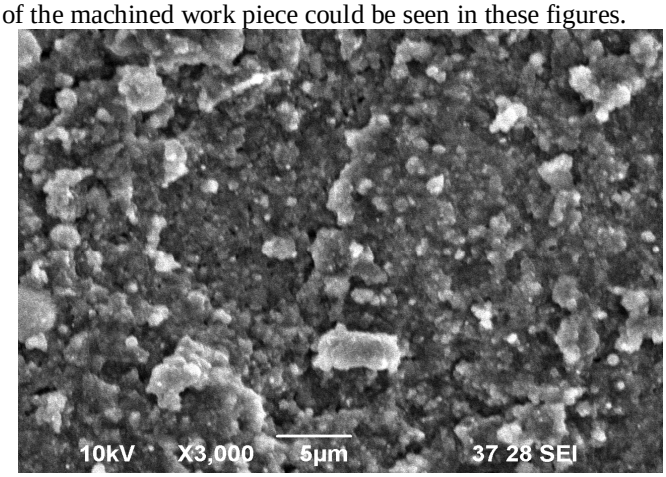
The over cut between the dimension of the electrode and the size of the cavity it is inherent to the EDMA process which is unavoidable though adequate compensation are provided at the tool design [8]. To achieve the accuracy, minimization of overcut is essential. Therefore factors affecting of overcut is essential to recognize. The over cut are effect to each parameter such as diameter of tool, discharge current and pulse on the time [9].

The diameter of tool is directly proportional to the overcut [7]. So the figure 5 represents the various overcut dimensions in the 10mm diameter of tool electrode with various mixture of dielectric medium.

As per the figure 4.4 represent the minimum overcut has been obtained by 8g mixture of Nickel Lead powder in dielectric medium.

V. SEMIMAGES FOR MACHINED WORKPIECE

Figure 5.1 shows that machined surface image of Monel 600™ taken by Scanning Electronic Microscope (SEM) [13-15]. From the figure shows the surface of various micro meter distances like 5 µm, 10 µm and 100 µm distances. The clear surface of the machined work piece could be seen in these figures.



IV. CONCLUSIONS

The EDMA performance of Cu tool electrode using optimum proportionate Sprit servotherm (75:25), graphite powder (6g) and different range of Nickel Lead powder (2, 4, 6 & 8g) dielectric was analyzed with Monel 600™. The important results are summarized as follows:

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- The experimentally observed performance of Sprit-servotherm of different proportion of Nickel Lead powder found that better machining output in EDMA of Monel 600™.
- The surface smoothness and diameteral accuracy reported by Sprit servotherm of 8g Nickel Lead mixed dielectric medium gives better result.
- After than draw all graphs which shows the optimum proportion mixture of Nickel Lead powder influences the MRR, TWR and OC.
- 8, 6g of Nickel Lead and graphite powders are mixed with Sprit-servotherm (75:25) gives better results of MRR, TWR and OC.

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