Effect of Mass And Size of The Additives In Performance of Electrical Discharge Machining of Monel 400^{TM}

Dr. R. Jothimurugan
Professor,Dept of Mechanical Engg.,
Holy Mary Institute of Technology & Science

Abstract- *Electrical discharge machining (EDM) process is a most reliable technology to machine wide varieties of materials to required complicated shapes, since it is widely used in aerospace, automotive, mould making, tool and die casting industries. Many researchers have strived to improve the performance of EDM process by introducing various tool materials, dielectric fluids and additives, despite the machining efficiency of this process being much less than conventional machining processes. In general, kerosene is used as a dielectric fluid in both die sinker and wire-cut EDM applications. In general, commercial grade EDM oils is conventional dielectric fluids in electrical discharge machining (EDM), despite their poor performance measures being major drawbacks. It was focussed to develop a additive concentrated dielectric fluid offering good performance measures in the EDM process, by determining the appropriate type and mass of additive in dielectric fluid in EDM of monel 400TM. Four additives and different masses were used in this study. The six gram of graphite powder with one micron size is concentrated in dielectric fluid, which resulted in the highest material removal rate (MRR) as compared with other dielectric and tool wear rate (TWR), and surface finish (SR) are found to be enhanced in EDM process.*

Keywords- Dielectric; Electrode; Graphite; EDM oil; Material; Servotherm; Tool.

I. INTRODUCTION

EDM process is a unconventional electro-thermal process which is being widely employed Tool and Die Industries Automotive and Air craft industries, Medical equipment industries and armament industries. The major drawback found in EDM process is more time of machining and high tool wear rate, since total cost of machining is much more than conventional machining process. In addition, poor surface finish is imparted to the machined work piece coupled with showing some surface defects Singh et.al [1]. The dielectric fluid employed in the EDM process should possess high breakdown potential, instantaneous recovery of breakdown potential after ionization, high thermal steadiness, lower viscosity, the ability to keep the machining zone free from debris, lower cost, and ready availability [2]. Machining output is influenced by the type of dielectric and flushing method employed [3]. Leao et al. [4] indicated that kerosene and hydrocarbon oil are the dielectric fluids generally used in the EDM process. These contain more carbon and at high temperature they deposit an energy consuming carbon layer over the surface of the machined workpiece. This carbon layer results in a low material removal rate (MRR) and poor surface finish. Singh et al. [5] mentioned that researchers have attempted to improve the performance measures of the EDM process by introducing the additives kerosene and hydrocarbon oil.

II. EXPERIMENTAL DETAILS

In this study, kerosene-servotherm(75:25) is mixed with different additives with one micron size, The copper rod used as tool electrode was 6 mm in diameter and 5 cm in length. A Monel 400^{TM} plate was used as work piece, which was cut into 41 small pieces that were smoothed before initiating the EDM process. A hole of 6mm diameter and 3mm depth was machined in the workpiece using EDM oil – servotherm, with 10 A current. MRR and TWR were measured by electronic weight balance and a stopwatch (accuracy 0.01 s). A standard dial indicator (Mitutoyo) with a resolution of 0.001mm was employed to measure surface roughness (SR). Measurements were done in triplicate at three different sites over a length of 3mm, with average values being taken as the SR of the hole. Comparing the performance of the different additives it was observed that kerosene-servotherm(75:25) concentrated with graphite powder (1μ & 6gm) offers best performance in EDM process than other. The experiments were done using a numerically con- trolled electrical discharge machine (Glory Engineering) incorporating a stirrer, as shown in Figs. 1(a) and 1(b). Phase changes in the machined surface of work piece samples were analyzed by scanning electron microscope (SEM) and EDAX (kV 30.00; tilt 0.20; take-off 35.22; AmpT 25.6; detector type

SUTW-Sapphire; resolution 133.20). The chemical composition of the workpiece and EDM process variables are given in Tables 1 and 2,

Table 1 Monel 400™ chemical composition (wt. %)

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	2.5

Table 2 Experimental Design

Working conditions	Description
Work-piece	Monel 400™ (Density 27.68 g/cm³)
Electrode	Copper (Density 8.96 g/cm³), Melting point 1083 C
Dielectric type	EDM oil– Servotherm (75:25)
Additive	Al, Gr, Ni & Si
Current	10 A
Power supply in voltage	30 V

Fig. 1 Picture of experimental setup

III. RESULTS AND DISCUSSION

Twenty test pieces were cut from the hexagonal billet each 5 mm in thickness and 13 mm side. They were finished on both ends. Similarly copper rod of 10 mm diameter was cut into 20 pieces with each piece of 6 cm long and they were finished on both ends. In the machining test a hole of 3 mm depth was machined in workpiece using mixture of kerosene-servotherm (75:25) concentrated with 2 gram silicon powder per litre under the operating conditions as given in Table 7.2. The procedure was repeated using kerosene-servotherm (75:25) concentrated with 4 g, 6 g, and 8 g of silicon powder per litre subsequently.

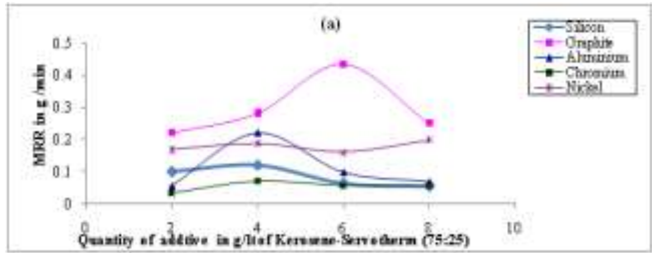

Figure 2.1 Effect of size of additives in MRR

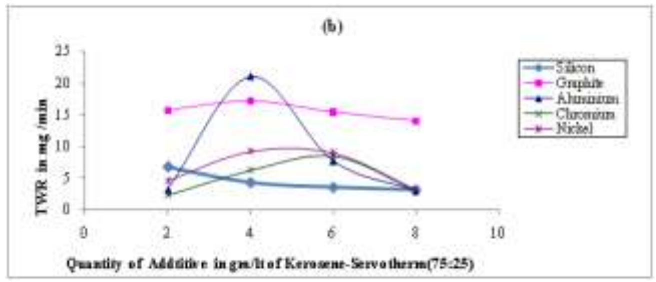

Figure 2.2 Effect of size of additives in TWR

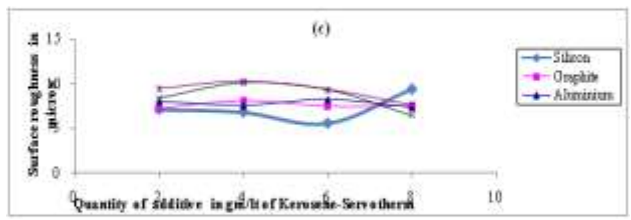

Figure 2.3 Effect of size of additives in SR

Entire cycle was repeated using Gr, Al, Cr and Ni additives, and 20 tests were carried out. The values of performance measures were observed for each test. It is noted from the plots 2.1-2.3 that kerosene-servotherm concentrated with 6 g of graphite powder per litre offers highest MRR than other additives. It may be attributed that Gr powder has high electrical resistivity, since it develops energy intense spark, resulting highest MRR and more TWR. Further, this combination yields fine surface finish, since graphite is a lighter particle which could easily penetrate into the holes of recast layer. The level of surface finish is confirmed from SEM image.

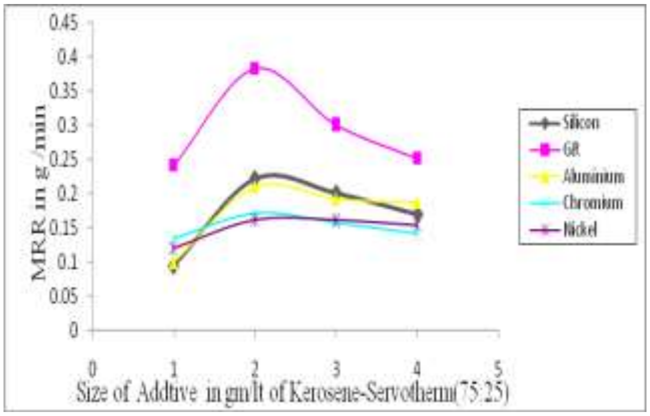

Figure 3.1

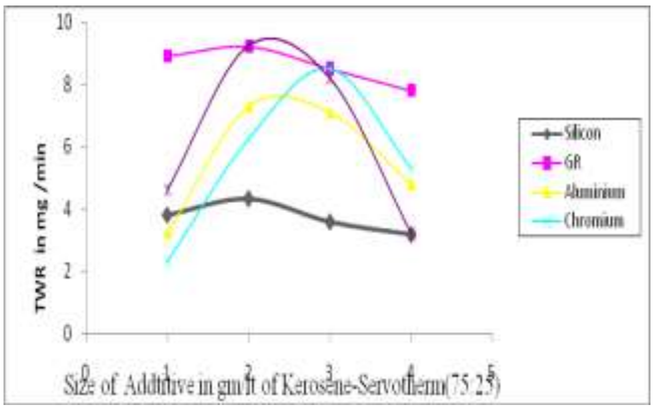

Figure 3.2

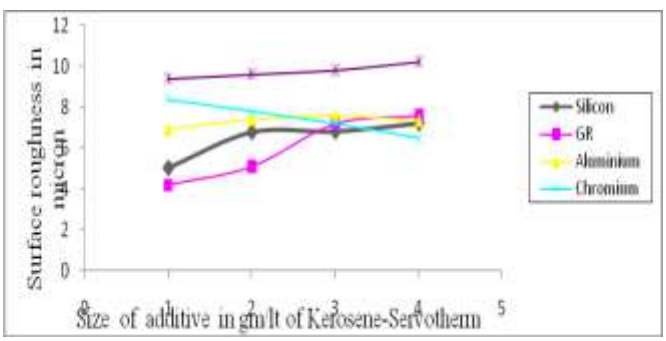

Figure 3.3

From the graph 3.1-3.3 it is that two micro size of the abrasive offering best performance in EDM process.As the size of the particle increases the performance attributes found to be poor

IV. CONCLUSIONS

Kerosene–servotherm (75:25) concentrated with Si, Gr, Al, Cr and Ni powders of different masses i.e. 2 g, 4 g, 6 g and 8 g and their effect on MRR, TWR and SR were studied in EDM of Monel 400^{TM}. One litre mixture of kerosene–servotherm (75:25) concentrated with six grams of graphite shows significant improvement in material removal rate than kerosene and commercial grade EDM oil. Further, it offers superior surface finish coupled with enhanced tool wear. Next chapter deals with the result and discussion of experimentation.

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