International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Effect of Sizes of the Additives in Performance of Electrical Discharge Machining of Hastelloy Using Ionized Water – Servotherm

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A B S T R A C T

.Electrical discharge machining (EDM) process is a highly opted process so as to machine wide varieties of materials which are being used for modern applications in defence, automotive industries, space and aircraft industries. It is strived to introduce various dielectric media, additives and tool materials in EDM process, still performance measures found to be lesser than conventional processes. In general, kerosene and commercial grade EDM oil are used as a dielectric fluid in both die sinker and wire-cut EDM applications, 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 Hastelloy. Four additives and different masses and sizes were used in this study. The six gram of graphite powder with two micron size is concentrated in dielectric fluid, which resulted in the highest material removal rate (MRR) as compared with other di electric and tool wear rate (TWR), and surface finish (SR) are found to be marginally increased in EDM process.

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

1. Introduction

EDM process is a non-traditionalelectro-discharge 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 Ionized water 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 Ionized water.

2. Experimental Details

In this study, Ionized water–Servotherm (70:30) is mixed with different additives with different micron sizes, The copper rod used as tool electrode was 6 mm in diameter and 5 cm in length. The work pieces made of Hastelloy which was cut into 32 small pieces that were smoothed before initiating the EDM

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process. A hole of 6mm diameter and 3mm depth was machined in the work piece Ionized water–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 Ionized water–Servotherm (70:30) concentrated with graphite powder (1µ & 6gm) offers best performance in EDM process than other. The experiments were done using a numerically controlled 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; Amp T 25.6; detector type SUTW-Sapphire; resolution 133.20). The chemical composition of the work piece and EDM process variables are given in Tables 1 and 2,

Table 1 Hastelloy chemical composition (wt. %)

Elements	Composition (wt. %)
Molybdenum, Mo	15-17
Chromium, Cr	14.5-16.5
Iron, **Fe**	4-7
Tungsten, W	3-4.50
Molybdenum, Mo	15-17
Chromium, Cr	14.5-16.5
Iron, **Fe**	4-7

Table 2 Experimental Design

Working conditions	**Description**
Work-piece	Hastelloy (8.89 g/cm(3))
Electrode	Copper (Density 8.96 g/cm^3), Melting point 1083 C
Dielectric type	Ionized water–Servotherm (70:30)
Additive	Al, Gr, Ni & Si
Current	10 A
Power supply in voltage	30 V

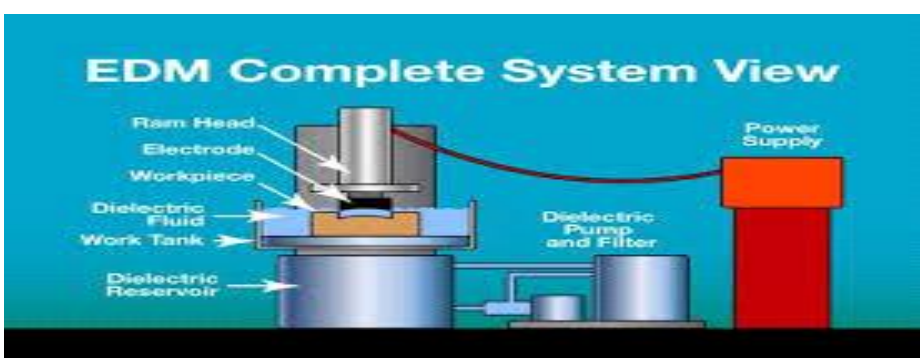

Fig. 1 Picture of experimental setup

3. Results and Discussion

Effect of size:

Additives with different sizes (1µ, 2µ, 3µ & 4µ were employed to conduct the machining tests. The silicon powder with one micron size used and performance measures were observed, it is found that M.R.R., T.W.R and SR are increased as size increased from 1µ to 2µ, after it is decreasing,. The increased in TWR and SR found to be marginal. The machining tests were conducted using different additives like Graphite, Al, Cr & Ni, the trend has been found for same as shown in figure 3.1 – 3.3.

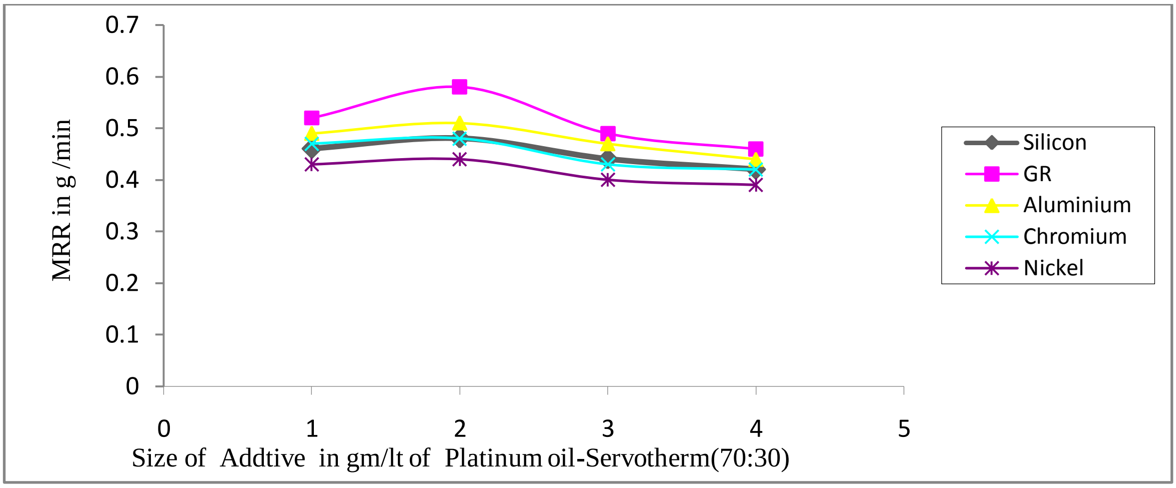

Figure 3.1 Effect of size of additives in MRR

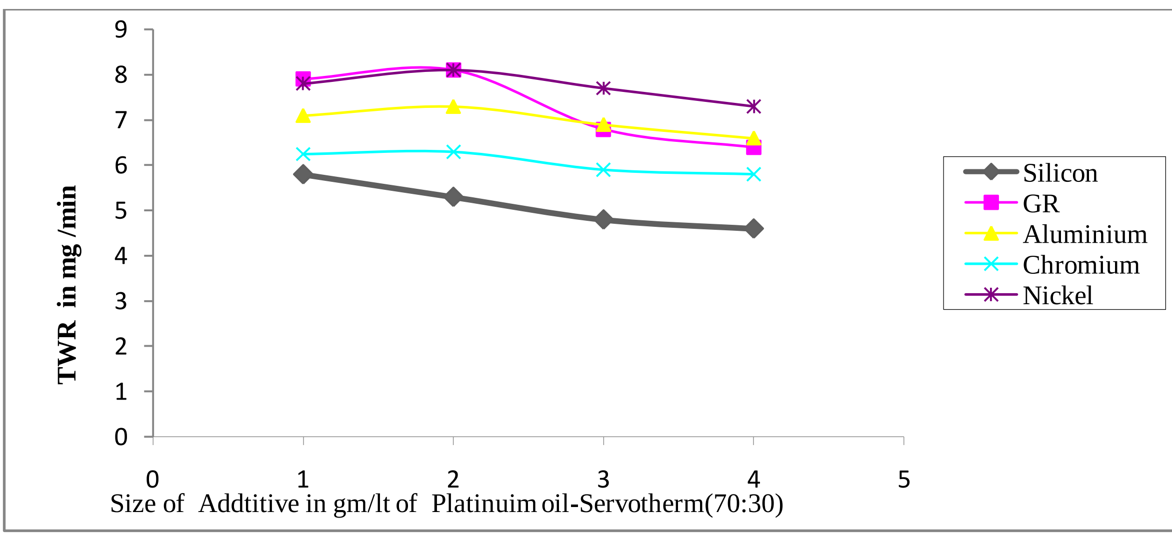

Figure 3.2 Effect of size of additives in TWR

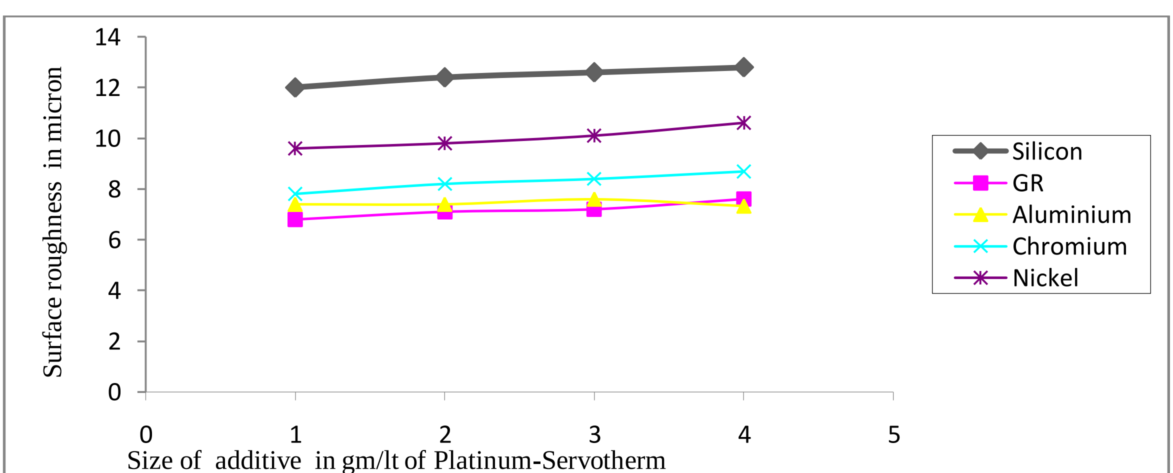

Figure 3.3 Effect of size of additives in SR

4. Conclusions

Ionized water–Servotherm (70:30) concentrated with Si, Gr, Al, Cr and Ni powders of different masses i.e. 2 g, 4 g, 6 g and 8 g and sizes 1μ, 2μ, 3μ & 4μ, their effect on MRR, TWR and SR were studied in EDM of Hastelloy. One litre mixture of Ionized water–Servotherm (70:30) concentrated with six grams and 2μ size of graphite shows significant improvement in material removal rate than kerosene and commercial grade EDM oil. Further, it offers superior surface finish coupled with marginally increased tool wear.

REFERENCES

- Singh et al. (2006) conducted experimental investigation in AEDM of cast aluminium metal matrix composites (Al/Al_2O_3P-20%) using silicon carbide powder in dielectric and reported better machining rate as compared to simple die sinking. Further, they optimized the process parameters using Taguchi methodology and published" Electrical discharge machining (EDM) of aluminium metal matrix composites using powder-suspended dielectric fluid", Journal of Mechanical Engineering 2006, vol. 57, no. 5, pp. 271-290.
- Singh et al. (2006) conducted experimental investigation in AEDM of cast aluminium metal matrix composites (Al/Al_2O_3P-20%) using silicon carbide powder in dielectric and reported better machining rate as compared to simple die sinking. Further, they optimized the process parameters using Taguchi methodology.
- Chow et al. (2008) observed the influence of aluminium powder on MRR. One gram of aluminium is added to the one litre of dielectric, results in high MRR due to an increase in the discharge gap and dispersion of the discharge energy. Pecas et al. (2008) observed that the polishing capability of EDM is influenced by dielectric flow rate. The use of Si C powder in water as Dielectric for Micro-slit EDM", Journal of Material Processing Technology vol.195, pp.160-170.
- Zho et.al (2005) observed effecting mechanism of particles in powder-mixed EDM and concluded additive concentrated dielectric fluids offers much better performance than conventional fluid and published Research on effecting mechanism of particles in powder-mixed EDM", Dalian LigongDaxueXuebao Journal of Dalian University of Technology, vol. 45, pp. 668-671.
- Tzeng& Lee (2005) carried out EDM of SKD 11 steel using various additives like aluminium, chromium, copper and silicon carbide and revealed that aluminium and chromium yield best and worst surface finish respectively, however copper imparts the surface finish, which is intermediate between aluminium and chromium and published Investigation into some surface characteristics of electrical discharge machined SKD-11 using powder-suspension dielectric oil", Journal of Materials Processing Technology, vol. 170, pp. 385-391.
- Pecas&Henriques,(2001) Electrically-conductive powder reduces the insulating strength of the dielectric fluid and increase the spark gap between the tool and the work-piece. EDM process becomes more stable and improves machining efficiency, MRR and surface quality. However, more studies were conducted to evaluate the surface finish, which is a challenging issue in EDM. The characteristics of the powder such as the size, type and concentration influence the dielectric performance.
- Shankar Chakra bort et. al. (2015) studied the effect of dielectric fluid in EDM process and reviewed that the dielectric fluid plays a vital role for improving performance measures of EDM process and publishedA review on the use of dielectric fluids and their effects in electrical discharge machining characteristics in precision Engineering, vol. 40, pp. 1-6.
- Jothimurugan et al. (2014) conducted study on mixture of dielectric fluid in which found that Kerosene-Servotherm (75:25) offered better performance in EDM process than kerosene alone.
- Kumar et al. (2011) experimentally found that the concentration of additive particles in dielectric and their size significantly affect machining efficiency of EDM process and published Analysis of machining characteristics in additive mixed electric discharge machining of nickel-based super alloy Hastelloy 718, " Materials and Manufacturing Processes", vol. 26, pp. 1011 – 1018.
- Chow et al. (2008) observed the influence of aluminium powder on MRR. One gram of aluminium is added to the one litre of dielectric, results in high MRR due to an increase in the discharge gap and dispersion of the discharge energy. Pecas et al. (2008) observed that the polishing capability of EDM is influenced by dielectric flow rate.