Available online at
www.mdl.mazedan.com

MTESD

www.mazedan.com

www.mazedan.com/mtesd

Effect of Nickel Micro Powder and Tetraethylene Glycol Dielectric Fluid on Performance Characteristic of AISI D3 Steel Using Rotary PMEDM

JITENDRA KUMAR, NITESH KUMAR DIXIT, DEEPAK AGRAWAL

MAZEDAN TRANSACTIONS ON ENGINEERING SYSTEMS DESIGN

Article id-MTESD0101001

Vol-1, Issue-1

Received: 01 Dec 2019

Revised: 24 Dec 2019

Accepted: 05-Jan 2020

Citation: Jitendra Kumar, Nitesh Kumar Dixit, Deepak Agrawal "Effect of Nickel Micro Powder and Tetraethylene Glycol Dielectric Fluid on Performance Characteristic of AISI D3 Steel Using Rotary PMEDM" Mazedan Transactions on Engineering Systems Design, Vol-1, Issue-1, pp-1-5, 2020.

ABSTRACT

The impact of nickel micro powder blended tetra ethylene glycol dielectric liquid on machining qualities of AISI D3 pass on steel has been examined. Pulse current, pulse on time, pulse off time, the convergence of powder are the procedure parameters. The procedure execution is estimated as far as material removal rate (MRR), tool wear rate (TWR), and surface roughness (Ra). The examination result will recognize the critical procedure parameters that augment MRR, limit TWR, and Ra. The plan of analysis has been embraced utilizing the Taguchi strategy. ANOVA examination has been utilized to research the rate commitment of each procedure parameter for advancing the execution. The examination demonstrates that all the chose parameters except pulse off time significantly affect MRR. Current is observed to be the hugest factor for MRR and TWR. With the increment in current, TWR increments. Likewise, surface harshness increments with increment in pulse off time. The investigations are being carried out on the EDM process outputs for the influence of Nickel powder in tetra ethylene glycol dielectric fluid. The experimental parameters and targeting outputs are the material removal rate (MRR) and surface roughness (Ra). Electrical discharge machining (EDM) is one of the oldest non-traditional machining processes, which is based on the thermoelectric energy between the workpiece like AISI D3 Steel and an electrode rod.

KEYWORDS-

Rotary PMEDM, tetraethylene glycol, nickel powder

1. INTRODUCTION

The machining of amazingly hard and weak materials by customary machining forms like a machine, boring and processing, and so forth is troublesome or practically inconceivable with conventional machining forms. To address present issues and prerequisites a non-regular machining forms are utilized. The non-regular machining procedures can create any mind-boggling shape on any workpiece regardless of the hardness, weakness of the material. Electrical release machining (EDM) is a standout amongst the most acknowledged techniques in the non-traditional machining process. Electrical Discharge Machining (EDM) is nontraditional, with no physical cutting powers between the apparatus and the workpiece, high accuracy metal expulsion process utilizing warm vitality by producing a flash to dissolve the workpiece. The workpiece must be a conductive power material which is submerged into the dielectric liquid for better disintegration. EDM machine has wide application underway of bite the dust hole with vast segments, profound little width gap, and different mind-boggling gaps and another accuracy part. In the ongoing past, powder blended EDM (PMEDM) has risen as one of the propelled methods toward the upgrade of the abilities of EDM. In this procedure, an appropriate material in fine powder structure is blended into the dielectric liquid of EDM. The flash hole is topped off with added substance particles. The additional powder essentially influences the execution of the EDM process. The electrically conductive powder lessens the protecting quality of the dielectric liquid and expands the sparkle hole remove between the instrument terminal and workpiece. Subsequently, the procedure turns out to be progressively steady, in this manner improving machining rate (MR) and surface completion. Electrical release machining (EDM) can machine high-quality temperature safe combinations and troublesome to machine materials having exceptionally unpredictable and advanced shapes. Powder blended electro-release machining (PMEDM) is another method that defeats the confinements and improves the machining abilities of EDM.

In this procedure, a reasonable material in the powder structure is blended into the dielectric liquid. For a better flow of the powder blended dielectric, a mixing framework is utilized Different powders molecule that can be included in the dielectric liquid are Aluminum (Al), Graphite, Copper (Cu), Nickel micro(Cr), Silicon, Tungsten and so on. The voltage is connected to both the terminals. An electric field is produced in the flash hole.

Dept. of Mechanical Engineering, Institute of Engineering & Technology Faizabad India 224001

*Corresponding author email- jitenderku1994@gmail.com

The flash hole is topped off with powdered particles and the hole removes setup among device and the workpiece increments. The setup is submerged under a dielectric liquid. The electric field empowers the powder particles and they move in a crisscross way. They organize to shape chains at better places amid starting, which cross over any barrier between the anodes what's the more, workpiece. Therefore, the hole voltage and protecting the quality of the dielectric liquid abatements. Short out happens effectively also, the arrangement of release begins under the cathode. With an increment in recurrence of releasing.

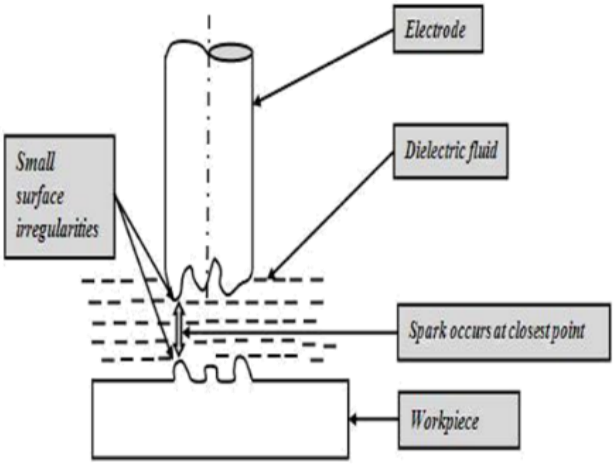

Figure 1Working principle of EDM

2. MATERIAL USED

2.1 Property of AISI D3 Steel

AISI D3 die the dust steel is chosen as a workpiece example. The substance structure of AISI D3 kick the bucket steel has been appeared in Table 1. Powdered nickel micro blended lamp oil as dielectric has been utilized to machine AISI D3 die the dust steel. Powdered nickel micro molecule estimate is in the scope of request 45-55 μm. The compound organization has appeared in Table 2. The properties of nickel micro powder have appeared in Table 3. Copper cathode with the distance across 14 is picked to machine AISI D3 bite the dust steel. Lamp oil has been utilized as a dielectric and the properties have appeared in Table 4.

2.2 Dry Machining

In dry EDM, the tool electrode is shaped to be a slim walled pipe. High-weight gas or air is provided through the pipe. The job of the gas is to expel the trash from the hole and to cool the entomb anode hole. The procedure was created to diminish the contamination brought about by the utilization of fluid dielectric which prompts the generation of vapor during machining and the expense to deal with the waste. Yu et al [1] investigated the capability of the technique in machining cemented carbide material.

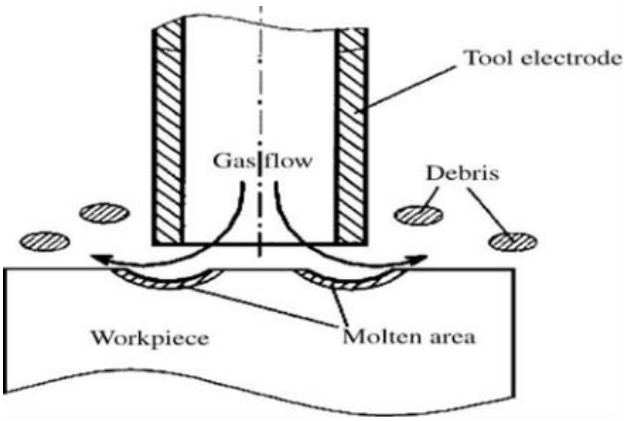

Figure 2 Dry machining process

Table 1 Chemical composition of AISI D3 die steel 2

Element	C	Si	Mn	P	S	Cr	Ni	Cu	W	V
%	2.5	0.6	0.6	0.03	0.03	13.5	0.3	0.52	1	1

Table 2 Chemical composition of AISI D3 die steel

Element	C	Si	Mn	P	S	Cr	Ni	Cu	W	V
%	2.5	0.6	0.6	0.03	0.03	13.5	0.3	0.52	1	1

Table 3 Properties of Nickel micro powder

Dielectric constant, K	Electrical conductivity, s/m	Mobility, m^2/Vs	Electric field, MV/m	Dynamic viscosity, M	Mass density, kg/m^3
15.7	1.6×10^{-14}	2.2×10^{-8}	16.6	19.83	1097

Table 4 Properties of Tetraethylene glycol

Density (g/cm^3)	Melting Point (°C)	Specific Heat (cal/g/deg)	Electrical conductivity	Electrical resistivity (μΩ m)	Thermal conductivity (w/m/K)	
8.902	1455	0.44	7.9×10^6	69.3		90.9

2.3 Tool Wear

Yu et al. [1] have considered the instrument wear during the 3D small-scale ultrasonic machining. They demonstrated that the apparatus shape stays unaltered and the device wear has been repaid by applying the uniform wear technique created for miniaturized scale EDM and it's joining with CAD/CAM to miniaturized scale ultrasonic vibration process for creating precise three-dimensional (3D) smaller scale holes.

2.4 Wire EDM

Guo et al. [2] considered the machining component of wire EDM (WEDM) with ultrasonic vibration of the wire and found that the consolidated innovation of WEDM and ultrasonic encourages the type of various channel discharge and raise the usage proportion of the vitality that prompts the improvement in cutting rate and surface harshness. High recurrence vibration of wire improves the release focus and lessens the likelihood of brake wire. Guo et al. [2] inferred that with an ultrasonic guide the cutting efficiency of WEDM can be expanded by 30% and the harshness of the machined surface diminished from 1.95Ra to 1.7Ra.

2.5 Dry EDM

The dry EDM procedure is improved by Kunieda et al. when they presented the fast 3D processing by dry EDM. The MRR expanded when the release control thickness on the working surface surpasses a specific edge because of thermally actuated compound response between the gas and workpiece material. The most extreme expulsion rate got was practically equivalent to that of fast processing of extinguished steel by a processing machine. Most specialists manage steel as a workpiece when researching the performance of dry EDM. Using a piezoelectric actuator. Kunieda et al. [3] presented an improvement of dry EDM qualities utilizing a piezoelectric actuator to help in controlling the whole length. To clarify the impacts of the piezoelectric actuator an EDM execution test system was created to assess the machining solidness and MRR of dry EDM.

2.6 Surface Quality

The comparison of different EDM processes are given by a Pi Chart shown in Figure-3

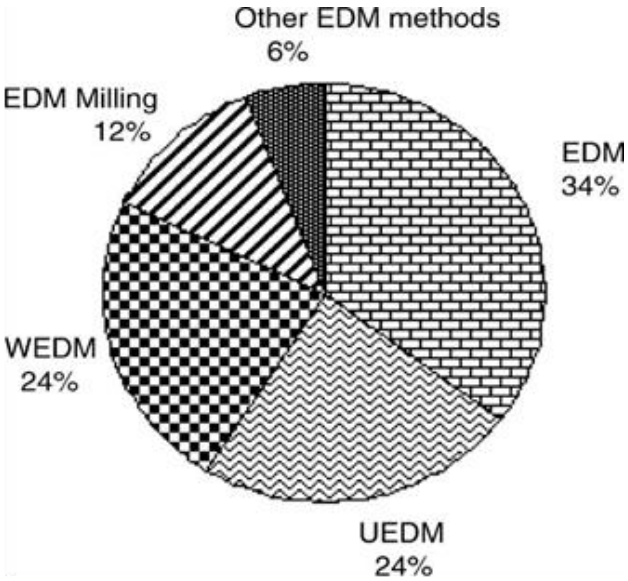

Figure 3 Comparison of Different EDM

2.7 Dielectric Fluid as a Water

Water as a dielectric is an option in contrast to hydrocarbon oil. The methodology is taken to advance superior wellbeing and safe condition while working with EDM. This is because hydrocarbon oil, for example, lamp oil will break down and discharge unsafe vapor (CO and CH4) [5]. Research in the course of the most recent 25 years has included the utilization of unadulterated water and water with added substanc**es**

2.8 Dielectric Fluid as a Water

Water as a dielectric is an option in contrast to hydrocarbon oil. The methodology is taken to advance superior wellbeing and safe condition while working with EDM. This is because hydrocarbon oil, for example, lamp oil will break down and discharge unsafe vapor (CO and CH4) [5]. Research in the course of the most recent 25 years has included the utilization of unadulterated water and water with added substances.

Table 5 Progress Report

S.No.	POWDER TYPE	TOOL ELECTRODE	DIELECTRIC FLUID
1	SILICON CARBIDE	COPPER	WATER
2	ALUMINIUM POWDER	COPPER	Oil
3	Aluminium Powder	Tungstan Carbide	Oil
4	Silicon Carbide	Tungsten Carbide	Water
5	Copper Powder	Copper	Oil
6	Al2O3 Nanopowder	Copper	Water
7	Al2O3 Nanopowder	Copper	Oil
8	Al2O3 Nanopowder	Copper	Water
9	Graphite Powder	Copper	Water

3. CONCLUSION

This paper presents a detailed summary of the research results reported in the area of Rotary powder Mixed EDM. In this' paper nickel nanopowder and tetraethylene glycol Dielectric fluid are used for Rotary EDM.then increase tool life, decrease Tool wear rate, increase MRR, better surface finish. In past research work aluminum powder, graphite powder is used and dielectric fluid as water, oil, is used. but when nickel powder and tetraethylene glycol dielectric fluid are used then rotary EDM are costly but other properties TWR, MRR, Surface Finish are improve. It can be concluded from this review that Rotary PMEDM holds a bright promise in the application of EDM, particularly about process productivity and surface quality of the workpiece. As such, extensive study is required to understand the mechanics of machining and other aspects of PMEDM

REFERENCES

[1] Z.Y. Yu, K.P. Rajurkar, A. Tandon, "Study of 3D micro-ultrasonic machining", *Journal of Manufacturing Science and Engineering* 126 (2004) 727–732.

[2] Z.N. Guo, T.C. Lee, T.M. Yue, W.S. Lau, "Study on the machining mechanism of WEDM with ultrasonic vibration of the wire", *Journal of*

Materials Processing Technology 69 (1997) 212–221.

[3] M. Kunieda, Y. Miyoshi, T. Takaya, N. Nakajima, Y.Z. Bo, M. Yoshida, "High-speed 3D milling by dry EDM." *CIRP Annals-Manufacturing Technology* 52 (2003) 147–150.

[4] H. K. Kansal, S. Singh, and P. Kumar, "Technology and research developments in powder mixed electric discharge machining (PMEDM)," vol. 184, pp. 32–41, 2007.

[5] Ozgedik Ali, Cogun Can (2006), "An experimental investigation of tool wear in electric discharge machining", *Int J Adv Manuf Technol* (2006) 27: 488–500.

[6] J. Fleischer. J. Schmidt. S. Haupt, "Combination of electric discharge machining and laser ablation in micro structuring of hardened steels" *Microsyst Technol*, Vol. 2006; pp. 697–701.

[7] Non-conventional Machining, "Version 2 ME, IIT Kharagpur", PP- (01- 04), http://nptel.iitm.ac.in /councellor.

[8] Tzeng, Y.F and Lee, C.Y, "Effects of Powder Characteristics on Electrodischarge Machining Efficiency", *International Journal of Advance Manufacturing Technology*, Vol. 17, 586-592, 2001.

[9] Zhao, W.S., Meng, Q.G. and Wang, Z.L, "The Application of Research on Powder Mixed EDM in Rough Machining", *Journal of Materials Processing Technology*, Vol 129, 30-33,2002.

[10] G. Singh, A. Batish, A. Bhattacharya, and V. K. Singla, "Investigations on improvement of material properties and parametric optimization of MRR, TWR, and roughness using powder mixed dielectric in EDM process," Master's Thesis, Department of mechanical (2010).

[11] W. S. Zhao, Q. G. Meng, Z. L. Wang, "The application of research on PMEDM in rough machining," *Journal of Materials Processing Technology*, vol.129, pp. 30-33, 2002

[12] P. Pecas and E. A. Henriques, "Influence of silicon powder mixed dielectric on conventional electrical discharge machining," *International Journal of Machine Tools and Manufacture*, vol. 43, pp. 1465-1471, 2003.

[13] R. Rival, "EDM of Ti alloy using copper tungsten electrode with SiC powder suspension dielectric fluid," Master's thesis, Faculty of Mechanical Engineering, Universiti Teknologi, Malaysia, 2005

[14] K. H. Syed and K. Palaniyandi, "Performance of electrical discharge machining using aluminium powder suspended distilled water," *Turkish Journal of Engineering and Environmental Sciences*, vol. 36, no.3, pp. 195-207, 2012.

[15] P. Singh, A. Kumar, N. Beri and V. Kumar, "Influence of electrical parameters in powder mixed electric discharge machining (PMEDM) of Hastelloy," *Journal of Engineering Research and Studies*, vol. 1, no. 2, pp. 93-105, 2010.

[16] Shitij Sood, "Effect of powder mixed dielectric on MRR, TWR and surface properties in EDM," Master's Thesis, Department of mechanical engineering, Thapar University (Patiala), 2008.

[17] G. Kibria, B. R. Sarkar, B. B. Pradhan and B. Bhattacharyya, "Comparative study of different dielectrics for micro-EDM performance during micro-hole machining of titanium alloy," I*nternational Journal of Advanced Manufacturing* Technology, vol. 48, no. 5-8, pp. 557-570, 2010.

[18] Miller Scott F., Shih Albert J., Qub Jun (2003), "Investigation of the spark cycle on material removal rate in wire electrical discharge machining of advanced materials", Department of Mechanical Engineering, University of Michigan, Ann Arbor, MI 48109, USA. USA *International Journal of Machine Tools & Manufacture* 44 (2004) 391–400.

[19] Moro T., Mohri N., Otsubo H., Goto A., and Saito N. (2004), "Study of the surface modification system with electric discharge machine in the practical usage", *Material Processing Technology*, Vol. 149, pp 65-70.

[20] Pham D.T., Dimov S.S., Bigot S., Ivanov A., Popov K. (2004), "Micro-EDM—recent development and research issues", *Journal of Material Processing Technology*, Vol. 149, pp 50-57.

[21] Pecas P, Henriques E (2003), "Influence of silicon powder-mixed dielectric on conventional Electrical discharge machining", Department of Mechanical Engineering, Instituto Superior Te´cnico, Lisbon, Portugal. International journal of machine tool and manufacturing, Vol. 43, pp 1465- 1471.