International Journal of Latest Engineering Research and Applications (IJLERA) ISSN: 2455-7137

Volume – 02, Issue – 04, April – 2017, PP – 163-166

Preparing of Al7075 based Metal Matrix composites and studying their machining properties

Dr. Sumathy Muniamuthu,
Associate Professor, Department of Mechanical Engineering, Vel Tech

R Rajeesh, D M Sridhar, G R Dhaneesh, C Pavunkumar
Student, Department of Mechanical Engineering, Vel Tech

Abstract: This paper reviews the research work carried out from the inception to the development of metal matrix composites with the base metal Aluminium and some of the additional ceramics within the part decodes and also briefing the current researches conducted. Various input process parameters namely pulse on time, pulse off time, duty factor, flushing pressure, discharging current, voltage and etc., are considered. The process performance is measured in terms of output machining parameters like metal removal rate, surface quality and tool wear rate.

Keywords: Electric discharge machining, Aluminium based Metal Matrix composites, Process parameters, output machining parameters.

I. Introduction

Development of Aluminium metal matrix composite (AMMCs) with improved tribological properties as been one of the major requirements in the field of material science and technology. This paper reviews on the types of Electric Discharge Machining involved in the machining of the different Materials and various process parameters involved in the EDM also cares about the Aluminium based metal matrix composites impact on those output machining parameters.

II. Literature Review

Electrical Discharge Machining (EDM) is a metal-removal process using electric discharge that is used to remove metal by means of electric spark erosion.EDM is an unconventional machining process in which there is no contact between the tool and the work piece. With the EDM process both the work piece material and the electrode material must be conductors of electricity.

The EDM process can be used in two different ways:
1. An electrode (tool) made of copper or graphite which is preshaped is fed vertically down and the reverse shape of the electrode is eroded or burned into the work piece (mostly hard material).
2. A computer controlled machinery with a continuously travelling electrode, which follows a programmed path to cut a groove through the work piece in order to produce the desired shape.

(1) Types of EDM:[1],[2]

1. Sinking EDM-The sinker EDM machining process uses an electricity carrying electrode that is configured to a specific geometry to cut the physical shape of the work piece electrode into a metal component. The sinker EDM process is commonly used in the production of dies and tools.
2. Wire EDM-Wire EDM machining is an electro thermal production process in which has a thin metallic wire in conjunction with de-ionized water (used to pass the electricity to the wok) allows the wire to cut through metal by the use of heat from electrical sparks which passes through the dielectric. Due to its superior properties of the process, wire EDM can easily machine complex parts and precision components out of hard conductive materials.
3. Water EDM-it uses deionised water as the dielectric medium which lowers the machining time and also the introduces the vibration of frequency of about 900Hz can improve the metal removal rate but decreases the surface quality. Water as dielectric is an alternative to hydro carbon oil. The approach is taken to promote a better health and safe environment while working with EDM. This is because hydrocarbon oil such as kerosene will decompose and release harmful vapour (CO and CH4).
4. Micro EDM-It is a well-known precise machining process that achieves micro structures of excellent quality for any conductive material. Micro-EDM is a current trend to machine the mcroscoping materials in

the range of 50 μm -100 μm. Micro-EDM is an efficient machining process for the fabrication of a micro-metal hole with various advantages resulting from its characteristics of noncontact and thermal process.

5. Powder Mixed EDM-Powder Mixed Electric Discharge Machining (PMEDM) has different mechanism from conventional EDM, which can improve the surface quality distinctly. In this process different types of metal powders like Alumina,SiC,Cr,Cu are added to dielectric to increase the metal removal rate and surface finish. It is a useful finish machining method and is researched and applied by many countries.
6. Dry EDM-Dry Electric Discharge machining (dry EDM) is a modification of the oil EDM process in which the liquid dielectric is replaced by a gaseous dielectric. High velocity gas flowing through the tool electrode into the inter-electrode gap substitutes the liquid dielectric. The flow of high velocity gas into the gap facilitates removal of debris and prevents excessive heating of the tool and work piece.

Overall View on the Types of EDM:

- EDM and Wire cut EDM are the mostly used types with the benefits of designing and cutting complex shapes and tapered holes with hard metals.
- Water EDM provides the Best Metal removal rate but has poor surface quality
- Micro EDM and Powder mixed EDM has good metal removal rate and surface finish.

(2) Review on the EDM of Different Kinds of Material:

1. EDM studies of Al alloy (LM24)-SiC composites developed by the vortex technique and pressure diecasting- M.Karthiresan and T.Sornakumar:

Al+ SiC metal matrix composite is developed by the combination of the Vortex technique (preheating the secondary material) and the pressure die casting method. In this method Copper is used as the tool with pulse ON time as 200μs and OFF time as 30 μs. and Dielectric used as commercial grade EDM oil and flushing pressure as 1.5kg/cm2.tand the result with the increase in the weight percentage of the SiC the hardness and the density increases, with low metal removal rate and the surface quality.

2. Some Experimental Investigation On Al Powder Nixed Edm On Machining Performance On Hastelloy Steel:

- Hastealloy- Alloy of Nickel,chromium,molybdenum,cobalt
- Powder Mixed Edm (Aluminium powder) mixed with EDM
- Dielectric- kerosene + graphite at 4g/L with pressure of 0.5kg/cm^2

The result shows that the Metal removal rate decreases with the increase in the grain size of the powder, also the tool loss and the tool high concentration of powder also affects the MRR.

3. Characteristics Of Sic+Al_2O_3:

Addition of the SiC with 20% of its composition with the Aluminium increases the hardness upto 45.40 vicker's hardness and tensile strength upto 77.56 MPa , with very high wear resistance, with porosities.

4. Experimental Investigation and Empirical Modeling of The Dry EDM:

The results shows that the Dry EDM is ecofriendly machining with no carbon deposition on the machine and no formation of cracks,corrosion unlike the liquid based EDM.

Oxygen dielectric and copper tool combination delivers maximum Metal removal rate and better surface quality. Kunieda and Furuoya employed a new method of EDM in water based dielectric with supply of oxygen, argon and nitrogen gas into the discharge gap [9]. It was found that the material removal increases with supply of oxygen compared to conventional EDM due to the enlarged volume of discharged crater and increase in discharge frequency. It was also found that too much oxygen is harmful to the stability of discharges as well as nitrogen and argon is not effective for increasing MRR.

5. Effect of Various Dielectric Fluids on Performance of EDM: A Review C.R. Sanghani1 , G.D. Acharya:

Hydrocarbon oils are generally used as dielectric fluid in EDM but it has some disadvantages such as harmful gas generation during electrical discharge machining.

Water can be used as substitute to hydrocarbon oil in EDM. It is more economic, safe and it has less negative influence on environment and health while working with EDM. For more than last 35 years, research is going on in using pure water and water with additives as dielectric fluid in EDM. Jeswani conducted

experiments and concluded that higher MRR and lower wear ratio can be obtained while machining with distilled water compared to kerosene for high pulse energy range [3].

Micro-slit EDM process along with SiC powder in pure water was investigated by Chow et al. [4]. Results showed that the pure water with SiC powder can scatter the discharging energy that improves the surface roughness and also attains a higher MRR.

The experimental investigations carried out by Syed and Palaniyandi[5] showed that addition of aluminium metal powder in distilled water results in high MRR, good surface finish, and minimum white layer thickness as compared with pure distilled water.

Kibria et al. analyzed machining of Ti-6Al-4V alloy for the study of influence of pure and boron carbide mixed kerosene and deionized water dielectrics [6]. The then Results shows that the B4C mixed kerosene has not notable effect in MRR, but B4C mixed deionized water has excellent increase in MRR. Tool wear is higher withpure and B4C mixed deionized water compared to kerosene.

Yih-fong and Fu-chen studied the effect of various powder additives or abrasives in the dielectric fluid on the surface quality of SKD-11 [7]. It was found that the smallest particle of the additives develops the best surface finish and the thickest recast layer.

Ojha et al. investicated the effect of dielectric mixed with nickel powder on the MRR and TWR. It was shown that the kerosene with increased suspended micro nickel powder increases the Metal Removal Rate but it has no dominant effect on Tool Wear Rate [8].

Liqing and Yingjie maked out the workability of the two approaches, namely oxygen-mixed dry EDM and dry EDM with cryogenically cooled work piece [10]. Oxygen-mixed EDM which is otherwise known as the dry EDM was shown to improve MRR more than 200% over non oxygen results at chosen experimental conditions.

The MRR was improved approximately 30–50%, and SR approximately 1–10%, as compared to uncooled pieces.

S. Tariq Jilani et al [1984]: The best machining rates have been achieved with tap water as the dielectric medium; zero TWR possible when using Cu tool with negative polarities.

Zhang et al. (2002) the increase in open voltage, amplitude of ultrasonic vibration and pulse duration can give an increase of the MRR. He also found that oxygen gas can produced greater MRR than mixed gases of air.

Chen S.L. et al [1999]: The MRR is greater and the relative wear ratio is lower when machining in distilled water or de-ionized water rather than in kerosene.

6. For Optimum Condition Of Wear Ratio And Surface Roughness:

- Gap Voltage: 120V
- Discharge Current: 24A
- Pulse Duration: 12.8µs
- Pulse Interval: 100µs
- Dielectric Flushing Pressure: 50 KPa
- Tool: Cathode
- Workpiece: Anode

III. Discussion

A Review research work on Aluminium Metal Matrix Composites on Electric Discharge Machining is presented in this paper. Majority of the research was focused on increasing the metal removal rate and improving the surfacefinish. The research work of the last 20 yrs has been discussed and the following conclusions are described:

1) Most of the work has been done on Aluminium MMC‘s reinforced with Silicon Carbide (SiC) particulate and on Alumina (Al2O3), due to their reinforcement in Aluminium composites for its excellent combination of physical properties, availability and low cost of the particulate.
2) The best material for the tool electrode is COPPER.
3) Mostly, the work has been carried out on AMMC‘s using EDM and Wire EDM, less work has been done on the other types of EDM.
4) Review revealed that, Water EDM resulted in the high MRR but it shows the poor Surface quality.
5) Micro EDM and Powder Mixed EDM indicate the improvement in the MRR and good surface finish compared to other types. More work could be done on Micro EDM and Powder Mixed EDM in future and there is enormous scope for research work in this area.

IV. Conclusion

After reviewing the papers in relative to the metal matrix composite machining EDM with respect to the input process parameters, it is concluded that the metal removal rate and the tool wear rate increases with the decrease in the weight percentage of the additional material,or with the increase in the discharge current intensity and the pulse ON time.the dielectric should be chosen according to the workpiece and as per the need and the best tool(electrode) that can be used is copper.

V. Acknowledgment

The authors gratefully acknowledge the grant provided by Department of Science and Technology, New Delhi under Science and Engineering Research Board project no. SB/FTP/ETA-0047/2014 to carry out Research on this field. The authors also acknowledge thanks to Management of Vel Tech for constant Encouraging towards research.

References

[1]. Current Advanced Research Development of Electric Discharge Machining (EDM): A Review Sushil Kumar Choudhary.
[2]. Electrical Discharge Machining Characteristics Of Aluminium Metal Matrix Composites By P.Srikanth,Ch.Pranay Kumar.
[3]. Jeswani ML. Electrical Discharge Machining in Distilled Water. Wear. 1981.
[4]. Chow HM, Yang LD, Lin CT, et al. The Use of SiC Powder in Water as Dielectric for Micro-Slit EDM Machining. J Mater Process Technol. 2008.
[5]. Syed KH, Palaniyandi K. Performance of Electrical Discharge Machining Using Aluminium Powder Suspended Distilled Water. Turkish J Eng Env Sci. 2012.
[6]. Kibria G, Sarkar BR, Pradhan BB, et al. Comparative Study of Different Dielectrics for Micro-EDM Performance during Microhole Machining of Ti-6Al-4V Alloy. Int J Adv Manuf Technol. 2010.
[7]. Tzeng YF, Chen FC. Investigation into Some Surface Characteristics of Electrical Discharge Machined SKD-11 using Powder-Suspension Dielectric Oil. J Mater Process Technol. 2005.
[8]. Ojha K, Garg RK, Singh KK. The Effect of Nickel Micro Powder Suspended Dielectric on EDM Performance Measure of EN-19 Steel. J Eng Appl Sci. 2011.
[9]. Kunieda M, Furuoya S. Improvement of EDM Efficiency by Supplying Oxygen Gas into Gap. CIRP Annals. 1991.
[10]. Liqing L, Yingjie S. Study of Dry EDM with Oxygen-Mixed and Cryogenic Cooling Approaches. The Seventeenth CIRP Conference on Electro Physical and Chemical Machining (ISEM), Procedia CIRP. 2013.
[11]. Effect of Various Dielectric Fluids on Performance of EDM: A Review C.R. Sanghani1 , G.D. Acharya.

