An Effect of EDM on AL6061-5% SiC as stir cast MMC

S.Bharani kumar 1&3, Dr.S.Arul 2

1 Research scholar, SCSVMV University, Kanchipuram, Tamil Nadu, India.
2 Professor, Annamacharya Institute of Technology and Sciences, Tirupati, Andhra Pradesh, India
3 Assistant professor, Rajalakshmi Institute of Technology, Kuthambakkam, Tamil Nadu, India.
1* Corresponding Author: sanbharani@gmail.com

Abstract. Usage of advanced machining method in the formation of composites made of aluminum metal matrix (Al-MMC) has produced substantial ability because the manufacture of intricate die shapes in these tough material is of elevated precision and surface finish Impossible. EDM has proven to be one of the many unorthodox processing techniques that are successful in shaping these materials which are difficult to process. The main aim of this investigation work is to find the outcome of Pulse ON-time (Pon), Current (Cu) and flushing pressure (Fp) on tool wear rate (TWR), metal removal rate (MRR) taper (T), radial overcut (ROC), and surface roughness (SR) on machining Al6061 with 5% SiC reinforcement. [1, 2] On this Investigation we are deputed Electronic PSR 35 and dielectric fluid was used as kerosene with the help of flushing machine to pump out the dielectric fluid. Copper is used as the electrode and it also used as a tool of diameter 3mm to pierce the work piece for the required length. Three machining parameter at each having three stages was used to perform the experiment on the orthogonal array of L27 taken into account. The experiments are conducted for three following trials in random order. The maximizing taken into account for optimization and ANOVA statistical tool is used and to find out the surface morphology SEM is taken on different parts of the work piece. [3]

1. Introduction

Expeditious advances in materials expertise are currently being encountered concurrently with various shifts in performance and economic demands on new resources. A compound material is a comprehensive mixture of more than two unlike materials with a familiar line. Since composites are typically use of their properties like structural, however the term can be limited to simply these materials that include reinforcement supported by a combination of material. So merged materials usually have a stiffer and stronger broken fibre or unit phase than the permanent matrix stage. Metal Matrix Composites are other resources that are centered on the metal matrix, typically aluminium, which is reinforced by aluminium oxide, silicon carbide or boron carbide ceramic fibres, particles or whiskers [4]. Any diamond-plated grinding wheel or polycrystalline diamond cutting machines with carbide can be machined with them. With traditional machining, given the heavy tool wear and high tooling costs, the non-contact material removal process provides an acceptable alternative. Along with
the countless numbers of unorthodox processing methods for the composite materials, EDM has proved successful. This present study some of the findings of the ongoing new examination of 5 per cent EDM-related SiC reinforced Al6061-MMC. The intention of this effort is to scrutinize and report on the responses viz the impact of Cu, Pon and Fp on. MRR, TWR, T, ROC and SR for Al–5 per cent SiC electrical discharge machining.

2. Experimental Procedure

The input parameters of this experiments are defined as three parameters and the stages are set as given in Table 1, and the output variables and their reaction are TWR, MRR, ROC, T & SR; symbol

| Symbol | Current | Pulse on time | Flushing Pressure |
|--------|---------|---------------|------------------|
| Units  | Cu      | Pon           | Fp               |
| Stage 1| 5       | 250           | 5                |
| Stage 2| 10      | 500           | 10               |
| Stage 3| 15      | 750           | 15               |

Table 1: Machining inputs and stages

i) Material Removal Rate is taken as the ratio of the weight dissimilarity of the workpiece to the machining time before and after machining,

\[ \text{MRR} = \frac{M_{rb}-M_{ra}}{t} \]

\( M_{ra} \) = Workpiece weights before machining
\( M_{rb} \) = Workpiece weights after machining
\( t \) = Time of Machining

ii) Tool Wear Rate is is taken as the ratio of the weight difference of the workpiece to the machining time before and after machining,

\[ \text{TWR} = \frac{T_{wb}-T_{wa}}{t} \]

\( T_{wa} \) = Tool weights before machining
\( T_{wb} \) = Tool weights after machining
\( t \) = Machining time

iii) From the expression \( T \) can be computed:

\[ \theta = \tan^{-1}\left(\frac{d_{b}-d_{t}}{2h}\right) \]

\( d_{b} \) = Machined hole diameters at the bottom of the material
\( d_{t} \) = Machined hole diameters at the top of the material
\( h \) = height of the material removed

iv) The ROC is expressed as half the diameter variation of the Holes created to the diameter of the tool

\[ \text{ROC} = \tan^{-1}\left(\frac{d_{b}-d_{ti}}{2h}\right) \]

\( d_{b} \) = Machined hole diameters at the bottom of the material
\( d_{ti} \) = diameter of the tool

For a setting of three factor-three levels, sum of experiment to be performed shall be 27. An L27 OA, in this investigation was selected. With a few additional factors to be applied Studying with the same form of material, the decision was made to use Setup L27, which in turn reduces the number of subsequent experiments. Also the comparison That would be simpler outcomes[5,6]
Al-MMC was drilled with 5 per cent SiC using a 3 mm diameter copper tool. For the workpiece positive polarization was connected, and for the tool negative polarization was connected. Kerosene was used as dielectric fluid with the help of flushing. The workpiece and tool material particularization are given below to know the material characteristics, work piece particulars for Al6061 are Al- 92.5%, SiC- 7.1% and Mg – 0.4 and the strengthening material of SiC is 5% and this percentage by volume and particle size is 20 micrometre. Tool materials particles for copper is copper 70% and Zinc 30%[7,8] investigational details

| Trail no | Machine Settings |  |  |
| --- | --- | --- | --- |
|  | Current | Pulse on Time | Flushing Pressure |
| Cu (A) | Pon (µs) | Fp (Lb in-2) |  |
| 1 | 5 | 250 | 5 |
| 2 | 5 | 250 | 10 |
| 3 | 5 | 250 | 15 |
| 4 | 5 | 500 | 5 |
| 5 | 5 | 500 | 10 |
| 6 | 5 | 500 | 15 |
| 7 | 5 | 750 | 5 |
| 8 | 5 | 750 | 10 |
| 9 | 5 | 750 | 15 |
| 10 | 10 | 250 | 5 |
| 11 | 10 | 250 | 10 |
| 12 | 10 | 250 | 15 |
| 13 | 10 | 500 | 5 |
| 14 | 10 | 500 | 10 |
| 15 | 10 | 500 | 15 |
| 16 | 10 | 750 | 5 |
| 17 | 10 | 750 | 10 |
| 18 | 10 | 750 | 15 |
| 19 | 15 | 250 | 5 |
| 20 | 15 | 250 | 10 |
| 21 | 15 | 250 | 15 |
| 22 | 15 | 500 | 5 |
| 23 | 15 | 500 | 10 |
| 24 | 15 | 500 | 15 |
| 25 | 15 | 750 | 5 |
| 26 | 15 | 750 | 10 |
| 27 | 15 | 750 | 15 |

Table 2: Experimental outline
3. Results and discussion

3.1 Effect of current (Cu) and pulse ON-time (Pon)

EDM's mach inability based on the electric supply of the material at work. Despite low power supply Reinforced SiC conductivity and high thermal resistance Particulate matter, which eventually reduces electrical conductivity. The results obtained indicate that of the work material That Al–5 per cent SiCP can be efficiently machined with EDM. They output shows that superior concurrence with the explanation of a lot of researchers.

With current and pulse ON time, the material removal rate (Fig 1) began to increase. It is also apparent that with current and pulse ON, the surface roughness is increased. The current flows high results in increased thermal output load to copper tool electrode followed by loading superior quantity of stuff detached from mutually copper tool and thus guide also to high Metal Removal Rate and Tool Wear Rate (Fig 2) [9]. So this will leads to high yield volume and surface roughness would be rougher from earlier stages and in addition of greater pulse on duration results in large removal of stuff in larger hollow size and tends to higher end of roughness of the surface.
At the beginning, due to the entanglement of SiC particles in the spark gap, the material removal rate was noted to be faster and slightly lower. This experience was seen in this practice to be higher at superior machine settings. Later, surface sparking was induce a TWR has also been found to rise with current and pulse on-time increases. The high wear rate is due to the presence of the copper tool with a low melting alloy, zinc. (Fig 3 & Fig 4) However, with the copper tool, the machining stability is satisfactorily accomplished, as its high erosion rate makes zinc vapours in the plasma tube, which can decrease arc resistance and help speed up ionisation, so the decrease in dimensional stability was realistic. [10]

In the observation of SEM (Fig 5) Photographs the cracks on the recast layer are formed and they are hardly ever go through beyond the layer of recast was observed damage on the surface may be taken into account at the end of the layer thickness of the recast region. It is noted that the SiC particle are smallest amount there on the recast area and that most of the particles might contain been racked up and distant in machining [11]. Also, the bottom alloy surrounding the reinforcement changed into soften for the duration of EDM. It is more obtrusive at better scores and consequently the SiC debris may want to have been deposited below the recast level. In addition, random void are determined which might also additionally were because of missing of becoming a member of of the molten droplets or which might were due to the trapped chatter during resolidification.
3.2 Effect of flushing pressure

When the dielectric fluid is compelled into the spark hole at low velocity, the gathered debris cause short-circuiting to come to be much less pronounced. This will help enhance the output of work and hence increase Metal Removal Rate. High amount of flushing impedes the development of ionized link along the slit, resulting in a larger detonation setback and reduced release force and thus low level Metal Removal Rate. In addition, the tool’s cooling pace goes up with increased flushing pressure and consequently reduced tool wear is observed.

3.3 Experimental Research

Table 3 shows A description of ANOVA findings and the parameter levels viz. To be set to maximise the individual factors viz. Cu, Pon, and Fp. TWR, ROC, MRR and to SF.

| Source of Variance       | SS (sum of square) | d.f (degrees of freedom) | M.S (mean square) | F Value | Percentage Contribution |
|--------------------------|--------------------|--------------------------|-------------------|---------|-------------------------|
| Current                  | 0.922              | 2                        | 0.462             | 18.472  | 72.72                   |
| Pulse on Time            | 0.256              | 2                        | 0.131             | 4.637   | 18.92                   |
| Flushing Pressure        | 0.061              | 2                        | 0.025             | 1.507   | 4.64                    |
| Error                    | 0.053              | 2                        | 0.024             | 1       | 3.72                    |
| Total                    | 1.292              | 8                        |                   |         | 100                     |

Table 3 – ANOVA Results

4. CONCLUSION

This experimental investigation evaluate the possibility of machining Al6061–5% SiCP Metal Matrix Composites

- For greater current and pulsed ON-time settings, the Metal Removal Rate was found to be greater at the higher rate of tapering, radial overcut and surface finish.
- Tool Wear Rate was also create to be high, superior than the Metal Removal Rate, for bigger current setting.
- The dimensional at elevated current flow and promptly ratings Precision is impacted.
- The flushing pressure used as Dielectric fluid have a significant result on both the Metal Removal Rate and Tool Wear Rate.

References

[1]. D.C. Montgomery, Design and Analysis of Experiments, fourth ed., Wiley, New York, 1997.

[2]. M. Ramulu, M. Taya, EDM machinability of SiCW/Al composites, J. Mater. Sci. 24 (1989) 1103–1108.

[3]. S. Bharanikumar, S. Arul, Examination on surface roughness in EDM of aluminium 6061 reinforced with 5% SiC using design experiments, Applied Mechanics and Materials Vols. 813-814 (2015) pp 526-530
[4]. Jong Hyuk Jung, Won Tae Kwon, J. Mech. Sci Tech. 24 (5) (2010) 1083-1090.

[5]. T. Muthuramalingam, B. Mohan, Ind. J. Eng. Mat. Sci. 20 (2013) 471-475.

[6]. Vikas, Apurba Kumar Roy, Kaushik Kumar, Proc. Mat. Sci. 6 (2014) 383-390.

[7]. S. Bharanikumar, S. Arul ,influence of silicon carbide particle addition in the aluminium (al6061) composite on edm process parameters, Int. J. Chem. Sci.: 14(4), 2016, 3157-3166

[8]. V. Senthilkumar and B. U. Omprakash, Effect of Titanium Carbide Particle Addition in the Aluminium Composite on EDM Process Parameters, J. Manuf. Proc., 13(1), 60-66 (2011).

[9]. P. Pecas and E. Henriques, Electrical Discharge Machining using Simple and Powder- Mixed Dielectric: The Effect of the Electrode Area in the Surface Roughness and Topography, J. Mater. Proc. Tech., 200(1), 250-258 (2008).

[10]. T.V.Christy, 2010. A Comparative Study on the Microstructures and Mechanical Properties of Al 6061 Alloy and the MMC Al 6061/TiB2/12P, Journal of Minerals & Materials Characterization & Engineering, 9 (1) pp.57-65.

[11]. S. Bharanikumar, S. Arul , A Comparative study on MRR, TWR and Surface Roughness properties of machined surface by electric discharge machining (EDM) in Metal Matrix composite (MMC) of Al6061-SIC, ciencia e tecnica, Vol. 34 (n. 1, 2019).