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ELECTRIC DISCHARGE MACHINING OF AL-TIB$_2$ COMPOSITES WITH AND WITHOUT GRAPHITE POWDER SUSPENDED DIELECTRIC

M. Prabu[1], G. Ramadoss[2], C. Senthilkumar[3], S. Magibalan[1] and P. Senthilkumar[1]

[1]Department of Mechanical Engineering, KSR College of Engineering, Tiruchengode, Tamilnadu, India

[2]Department of Mechanical Engineering, Arulmigu Meenakshi Amman College of Engineering, Namandi, Tamilnadu, India

[3]Department of Manufacturing Engineering,Annamalai University, Tamilnadu, India

E-Mail: prabu1045@gmail.com

ABSTRACT

The excellent mechanical and physical properties of metal Matrix Composites (MMCs) make them very attractive for a variety of engineering applications and also yielded enormous economic benefits to manufacturing industries through improved product recital and product design. The MMCs presently attracting most interest are those based on aluminum alloys and reinforced with particulate of either aluminum or silicon carbide. Conventional machining of these composites posted difficulties due to abrasive nature of reinforcement which causes severe cutting tool wear. It is therefore essential to develop the technology of non-conventional machining processes which can be effectively used for machining such advanced materials and Electric Discharge Machining [EDM] is an important non-conventional machining process that can effectively machining these materials. EDM process is a hasty recurring spark discharge method, initiated typically between the negative tool and positive work piece, engrossed in a dielectric medium. The dielectric medium used in EDM process serves as a coolant for the tool and work piece, serves as a conducting medium when ionized and conveys spark and also as a flushing medium in removing fragments. When graphite powder is suspended into the dielectric fluid and injecting at the tool-work piece or inter electrode gap during machining, will make deionization easier and lesser the path resistance causing an increased in discharge rate. This work presents some of the investigations in machining Al-TiB$_{2p}$ MMC by EDM. The experiments are conducted on Electronica Spark Erosion Machine. This augments Metal Removal Rate (MRR), decreases Tool Wear Rate (TWR).

Keywords: electrical discharge machining, titanium boride, material removal rate, tool wear rate.

INTRODUCTION

Composites are materials with tailored properties obtained by the engineered combination of two or more materials. After more than a quarter century of energetic investigate, composites based on metals (metal matrix composites) are making significant contribution to engineering practice. Particle reinforced light metal composites with their potential as low cost, high modulus, high strength, high wear resistance and ease of manufacturing, have attained the commercial production stage. Metal Matrix Composites are organism used in aerospace and automobile industries for very vital components like pistons, turbine blades etc. due to the availability of inexpensive reinforcement and the progress of various dispensation routes. In aviation applications, diminution in weight and augment in modulus i.e., strength to weight ratio is more significant than strength deliberation alone. For instance, 50% augment in modulus and 10% reduction in weight are achieved by substituting discontinuous silicon carbide reinforced aluminium alloy composites for wrought aluminium alloy [1, 2]. An understanding of the factors that influence the physical and mechanical properties of these materials present quite a challenge because they are sensitive to the type of reinforcement, the mode of manufacture and the nature of fabrication processing of the composite after initial manufacture. While there are still many areas which are poorly understood, the work of the past several years or so, has acknowledged many of the key factors which have to be considered to achieve optimum properties [3].

Metal Matrix Composites are tailored from conventional metals and ceramics to get the unique amalgamation of high modulus, strength, high wear resistance, low ductility and good thermal conductivity [4, 5]. The ever growing demand for superior toughness, strength, wear resistance, thermal resistance, etc., has led to the search for improved new material groups.

Conventional machining of these composites posted difficulties due to abrasive nature of reinforcement which causes severe cutting tool wear. It is therefore essential to develop the technology of non-conventional machining processes which can be effectively used for machining such advanced materials and Electric Discharge Machining [EDM] is an important non-conventional machining process that can effectively machine such materials. EDM process is a rapid repetitive spark discharge method, initiated usually between the negative tool and positive work piece, engrossed in a dielectric medium. A servo mechanism is used to preserve constant gap of 0.005 to 0.05mm in between the work piece and tool. The dielectric medium used in EDM process serves as a coolant for the tool and work, serves as a conducting medium when ionized and conveys spark and also as a flushing medium in removing fragment. When fine powder is suspended into the dielectric fluid and injecting at the tool-work piece or inter electrode gap during

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machining, will make deionization easier and lesser the path resistance causing an increased in discharge frequency [6]. This increases metal removal rate (MRR), decreases tool wear rate (TWR).

Experimental Method

Design of experiment (DOE) is a powerful statistical technique; the DOE is a systematic approach to investigation of a system. A series of structured tests are designed in which planned changes are made to the input variables of a process or system. The effects of these changes on a predefined output are then assessed. Taguchi Orthogonal Array Selector and click on the area that corresponds to four levels and three parameters (P=3, L=4). The "L'16 Orthogonal Array" table that now appears lists your testing sequence. The sixteen rows on the chart correspond to the sixteen required trials for your experiment. Notice that this chart has five columns representing five distinct parameters. Since our experiment has only three parameters, we will ignore the right-most two columns. The selected work piece material is Al-TiB_2 composites.

Table-1. Process parameters and their levels.

Input parameters	Levels			
	1	2	3	4
Current (Amps)	7.5	10	12.5	15
Pulse On-Time (μs)	10 0	200	500	1000
Flushing Pressure (Kg/sq.cm)	0.2	0.4	0.6	0.8

Each experiment was performed for fix time period using brass as an electrode. Based on literature, it was decided to use kerosene as dielectric media i.e. 4g/l of graphite powder in kerosene was let into the dielectric tank and the level was maintained to not less than 50mm above the work piece.

Figure-1. Machined work piece.

Input process parameters are current, pulse on time and flushing pressure. The material removal rate and tool wear rate are evaluated by using an electronic balance machine. The EDM set-up used in this experimental study is M100 model die sinking EDM machine manufactured by Electronica Machine Tools.

RESULT AND DISCUSSIONS

Effect of Current on MRR and TWR

As current increases are increased each individual spark removes a larger crater of metal from the work piece. Although the net effect is an increases in material removal rate. With additive in kerosene, increases the electrode gap between the tool and work piece. As a result graphite powder in kerosene changes the ionization-deionization characteristic of the liquid to permit more spark discharges per unit time, leading to an increase in the metal removal rate and also increased tool wear rate.

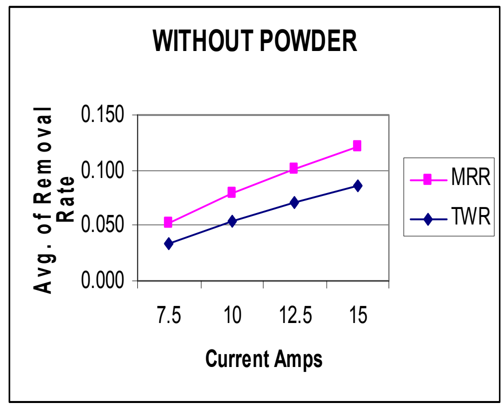

Figure-2. Plot of current against average MRR and TWR without powder suspended kerosene.

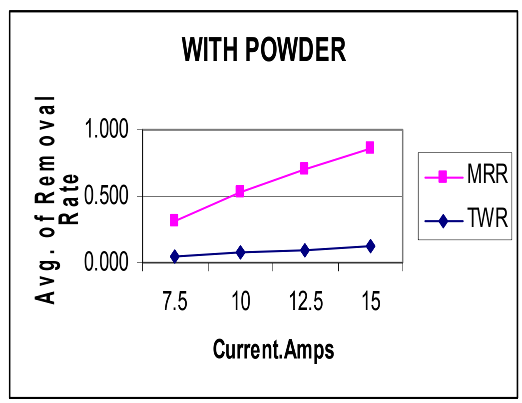

Figure-3. Plot of current against average MRR and TWR with powder suspended kerosene.

Effect of Pulse on Time on MRR and TWR

Increase in pulse on time affect the MRR, which is dependent on the energy input and proportional to the pulse on time. The addition of graphite powder, the narrow channel formation occurs in workpiece which transfers the heat directly to the work piece, by reducing the heat of the tool [7]. Increases in pulse on time for all peak current settings, increases the MRR and also decreased TWR.

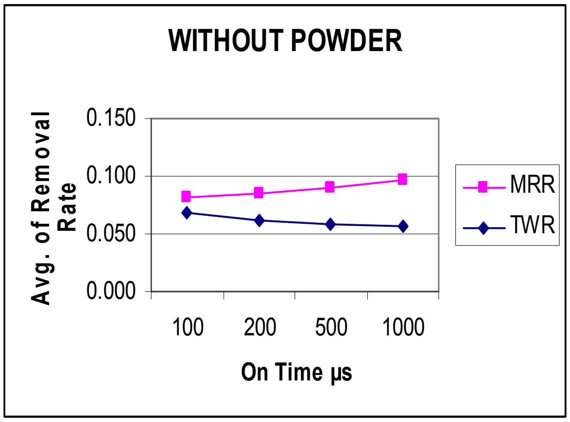

Figure-4. Plot of pulse on time average MRR and TWR without powder suspended kerosene.

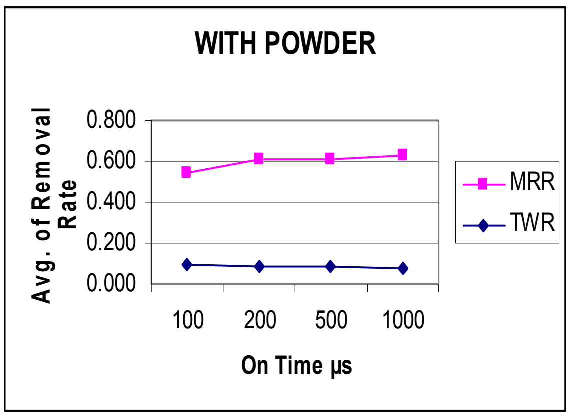

Figure-5. Plot of pulse on time against average MRR and TWR with powder suspended kerosene.

CONCLUSIONS

- This work evaluates the feasibility of machining Al-TiB_2MMC with 4g/l graphite powder suspended dielectric fluid.
- MRR was found higher for larger Current. When comparing the MRR of with powder and without powder the MRR obtained for with powder is found higher.
- TWR slightly increases with increasing the Current. When comparing the TWR of with powder and without powder the TWR obtained for with powder is found higher.
- Increase in MRR was found on increasing Pulse ON-time with powder is found superior result.
- TWR decreases with powder suspended kerosene.

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