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An Overview of EDM Operation on MMCs

[1]Sudhansu Sekhar Singh, [2]Ashutosh Satpathy, [3]Sasmita Kar
[123]Mechanical Department, Centre for Advanced Post Graduate Studies (CAPGS), BPUT, ROURKELA
[1]Mechanical (PEOM) Department,
[1]CAPGS, BPUT, ROURKELA, INDIA

***Abstract*:- The profound demand of metal matrix composites (MMCs) in the field of automobile, space craft and other technical sectors is due to its light weight, and advance mechanical properties. Among the non conventional machining process Electrical discharge machining (EDM) is most suitable process to cut materials and gives it a perfect shape and size with qualitative surface finish. Now in the ongoing developments of EDM mostly used to work over advanced functionally graded materials like MMCs having tremendous extensive application. In current review it is focused on most active machining parameters i.e. peak current (IP), voltage (V) ,T_{on} and pulse off time's typical impact on metal removal rate (MRR), Surface roughness (SR), Tool Bit wear rate (TWR). Optimization of process parameters is mostly studied by EDM machining in MMCs. Certain specific field of non conventional machining which is not formerly investigated have also been represented.**

KEY WORD:-EDM, W-EDM, MMC, MRR, EWR, Surface roughness.

1. INTRODUCTION

Electro discharge non conventional machining is having keen interest in the present scenario due to the higher accuracy in machining of complex shapes and hard materials are like steel, alloys, ceramic, composite, carbide being widely used in aerospace industry. Stir casting method, squeeze casting technology are the most significant composite preparation method. In EDM materials are removed from work piece by rapidly current discharge between electrode and work piece separated by dielectric medium with various types of dielectric are present petroleum based or vegetable based. Also electro discharge machining is various types Micro EDM, Die-sinking EDM, Wire cut-EDM.

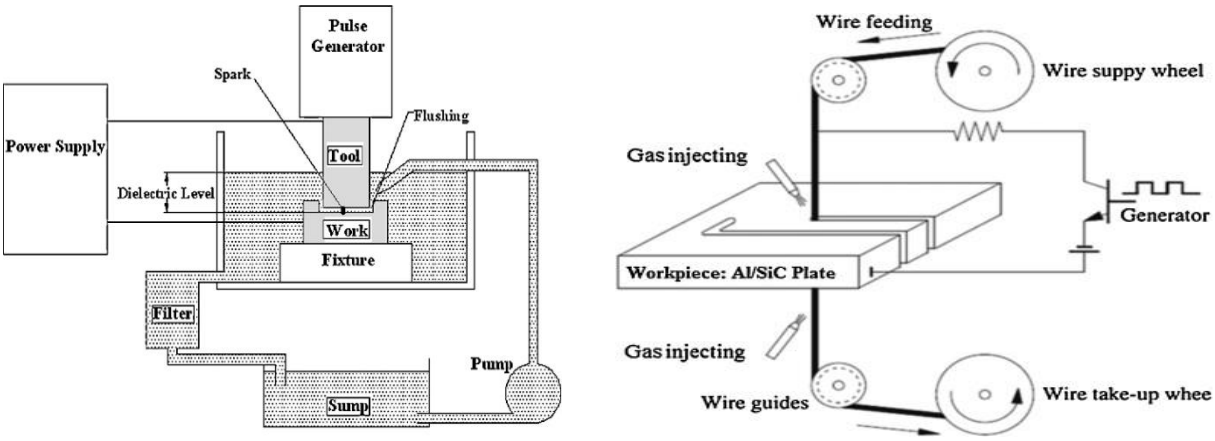

Fig-1 Schematic diagram of (a) EDM and Wire EDM (b) process

2 .CRITICAL REVIEW ON EDM OF MMC$_S$:

Various researchers provide distinct idea on influence of parameters on the time of machining metal matrix composite and different alloys in electro discharge machining and effect of MRR, EWR and SR on different type of EDM machine.

2.1 Effect of parameter in sinker EDM:

Rahman et al. [1] have determined the effect of EDM input parameter on MRR of Ti alloy and concluded that current and pulse on time was most influencing parameter on affecting material removal rate. **Wei et al. [2]** analyzed EDM performance of Sic reinforced composite and it is clear that small duty ratio and high voltage were enviable for attaining improved metal removal**. Gopalakannan et al. [3]** conducted an experiment to find relationship between EDM parameter and MRR. They reported at certain limit T_{on} is directly proportional to MRR but when pulse on time is higher, large crater is formed which hamper the path so lower MRR is produced. **Seo et al. [4**] have done an experiment EDM on functionally graded sic reinforced Al359 MMC$_S$ to assess its machinability from the experiment and conclude the significant increase in MRR with corresponding increase in peak current and pulse on time.

Mohammed B Ndalima et al. [5] identified the impact of dielectric on the surface of titanium metal where urea mixed water are used from this investigation it concluded that the water medium is produced better surface roughness and also found surface with higher micro hardness produce in the presence of urea dielectric medium. **Yonghong Liu et al. [6**] illustrated the

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consequential impact of water-oil intermixture as working fluid and from this analysis it understood that MRR &TWR reduce when emulsion temperature increase and also investigated the better performance of Water/Oil mixture as dielectric in EDM.

Ahsan Ali Khan et al. [7] investigated the performance of die sinking EDM on mild steel using different shaped Cu electrode like round, rectangular, square and diamond shape of constant cross sectional area 64 $mm^2$to evaluate its influence on material removal rate. **Pellicer et al. [8]** identified the influence of machining parameter and tool geometry on AISIH13 steel and concluded that escalate of discharge current give higher surface roughness and small size electrode give better material removal rate.

M.Tanjilul et al. [9] experimented for vacuum assisted flushing system in EDM and found that due to flushing surface roughness was improved by efficient optimization of gap, MRR increase and tool wear rate (TWR) decrease.

2.2 Effect of MRR and EWR in spark EDM:

Hany A.shehata et al. [10] have studied the effect of EDM parameter such as current (IP), pulse on time (T_{on}), duty cycle (DT), and gap voltage (Vg). To machine the work piece Al6061, Al-5%SiC and Al-10%SiC MMCs which prepared by stir-casting method and aimed at to optimize the parameter for better material removal (MRR), surface roughness (SR) and less tool bit wear (TWR). From the above critical study it is concluded that maximum MRR is acquired when high input low pulse on time and high duty cycle is provided and also TWR is found closer to minimum value.

B.c kandpal et al. [11] studied the effect of parameter in EDM while machining Al6061/10%Al_2O_3 metal matrix hybrid composite by taking the parameter current, voltage and pulse on. The result shows that pulse current has most significant parameter for influence of MRR.

Mehdi hourmand et al.[12] have done an experiment on electrical discharge machining on Al-mg-Sic MMC_S to optimised the variable for higher MRR and less EWR .In this paper he concluded that current, voltage, pulse on(T_{on}) have produce salient impact on MRR and TWR also calculate the test result which less than 6.6%.

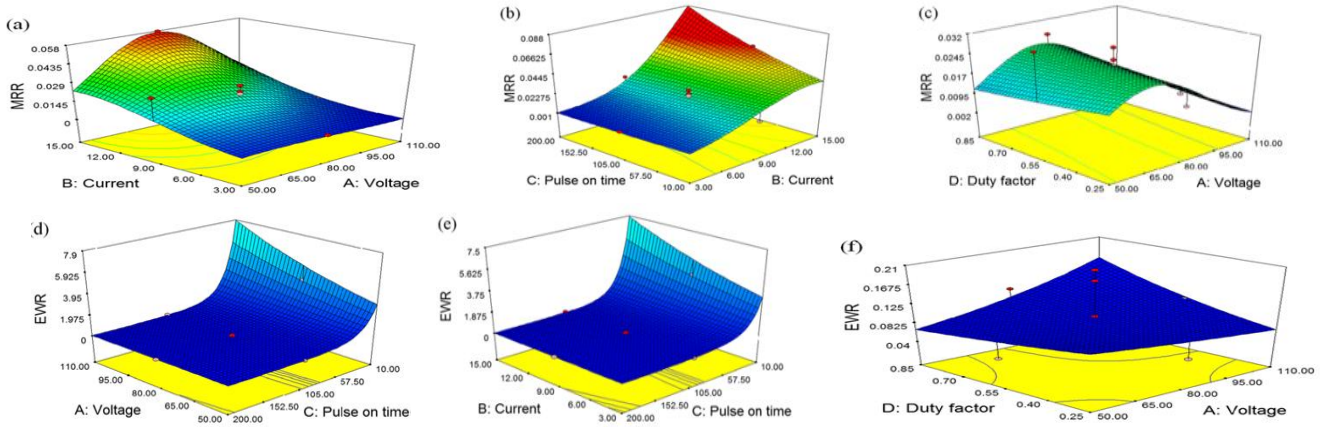

Fig-2 (a), (b), (c) Response graph for MRR and (d), (e), (f) response graph for EWR [12]

2.3 Effect of MRR in wire –EDM:

S.Tilekar et al. [13] investigated on optimization of input parameter of wire EDM on aluminium and mild steel and found that in Al spark time has major impact on the Ra and input current is major influence in case of mild steel. **Brajesh Lodhi** et al**. [14]** have examined the effect of w-EDM parameter such as T_{on},T_{off} ,wire feed rate and peak current on material removal rate(MRR) & surface roughness(SR) at time of work on AISI D3 material from this experiment he conclude that higher or lower value of T_{on} produce maximum & minimum MRR also found T_{on} , T_{off} is directly proportional to Ra and w-feed is inversely proportional to Ra.

R.Bobbili et al.[15] determined the multi response optimization technique of wire EDM parameter he take pulse on time peak current and spark voltage as input parameter to find optimum value of metal removal rate surface roughness and gap current. From investigation he concludes that MRR is directly proportional to power supplied during this. As pulse off decreased more sparks are generated. Increase T_{on} leading faster cutting rate which improved MRR. It is served that T_{on} and IP have strong effect on MRR.

Kamal jangra et al.[16] done an experiment on wire electrical machining of Wc-Co composite material taking taper angle peak current, pulse on time, pulse off time, wire tension, dielectric flow rate as input parameter to find material removal rate, surface roughness. From this research he concludes that the optimal value MRR and SR are 2.52mm/min and 0.88micrometer.

2.4 Effect of MRR and EWR in μ-EDM:

Anand Dev et al. [17] investigated machining parameter in micro electro discharge machining of SiC-Al composite by the help of rotary electrode. Pulse on time, pulse off duration, servo speed, sparking gap is taken as input parameter to find material removal rate, electrode wear rate as response. It is observed that increase of weight percentage of Sic particle size has decrease MRR, increase EWR also found Sic particle comes the hole direction and machining becomes very less.

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Fuqiang Hu et al. [18] have done an experiment investigate the impact of electrical parameter in micro EDM while working on aluminium metal matrix composite. It is concluded from the experiment that the electrode rotating speed is higher than the feed, speed level.

2.5 Effect of MRR and EWR in rotary electrode:

Anand prakash et al. [19] have identified the tool rotation effect on MRR, TWR, SR of AISI D3 steel in Rotary EDM process and conclude that Rotary EDM tool gives better MRR and SR also found Rotary EDM reduced recast layer during machining. **Priyaranjan et al. [20]** have compared copper and brass tubular electrode in electrical discharge machining to identify the better tool for material removal rate. He found that copper electrode perform better material removal rate(MRR), less tool(electrode)wear rate and good surface quality as compared to brass electrode.

B Mohan et al. [21] have done an experiment of R-EDM (Rotary EDM) of Al-Sic composite to observed MRR, TWR, SR by considering the required parameters as peak current, pulse duration, hole diameter, electrode rotation speed, from this experiment he found that when hole diameter is less and rotating electrode speed is high at that time MRR increase & SR, EWR decrease and also tubular electrode produce higher MRR than rotating solid electrode.

2.7 Effect of MRR, EWR in powder mixed electrode

Umesh kumar vishwarama et al. [22] compared powder mix EDM with rotary EDM during machining of Al-Sic MMC and found MRR in PMEDM was higher as compared die-sinking EDM and MRR of REDM is higher compared to PMEDM process, also show that tool rotation improves the flushing efficiency.

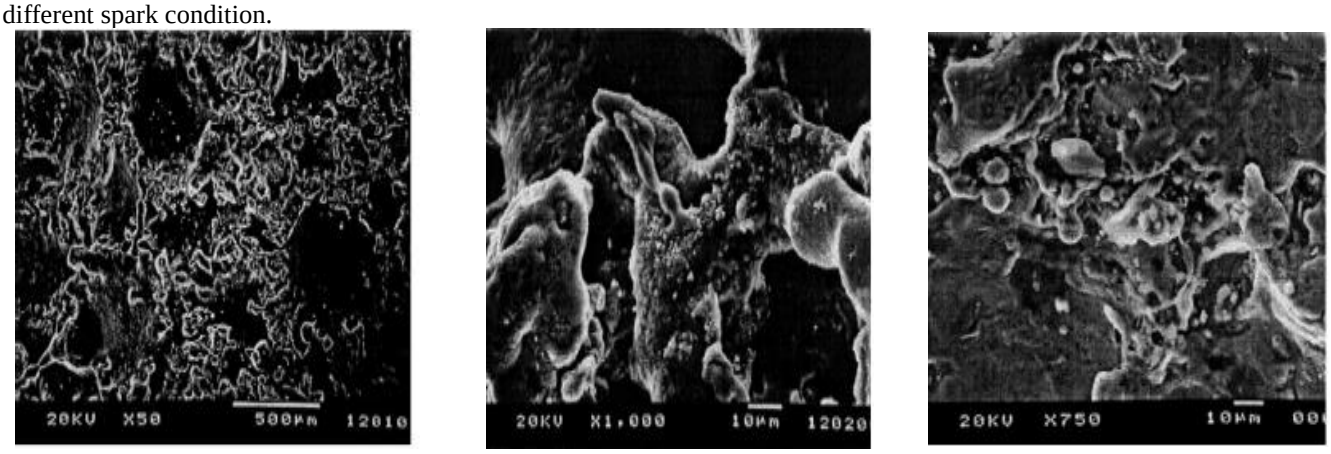
H.K Kensal et al. [23] have analysed the effect of silica-powder when mixed in EDM on machining of D2steel, the optimal parameter value produces higher MRR. **Chander Prakash et al. [24]** investigate powder mixed electrical discharge machining of MMCs and concluded when powder mixed in dielectric it reduce surface defect also found a technique to improve the surface characteristic without sacrificing machining efficiency .**J Kozak et al. [25]** et al investigate that electro discharge machine with powder suspended working fluid to obtain the relation between SR, MRR, and operating parameter in EDM at the time of using different type of powder.

3 SURFACE CHARACTERISTICS OF COMPOSITE MATERIAL IN EDM:

S.Gopalakannan et al. [26] have examined the surface roughness response on machining of Al-Sic Nano composite by taking current, voltage and pulse on time as input parameter. Here high resolution scanning electron micro graph (SEM) and FESEM are used to identify the response surface and concluded that when pulse on time and pulse current increases SR value increases and when voltage increases up to certain limit (50v) then decrease SR value also increase .The optimum values obtained are 50.00v, 8.00A pulse current and 8.00µs and pulse off time 9.00µs respectively. **S.Kashman et al. [27]** investigated on machined surface characterization of EDM for Al/B_4C composite material considering T_{on} and T_{off} as input parameter revels that the surface roughness value increased with increasing of current T_{ON} and $T_{OFF.}$

Dr Ir J.P kruth et al.[28] investigated the white layer in the surfce of iron carbides by using differ dielectric like water,oil, he found that in oil dielectric contain more carbon than water dielectric.

M Ramulu et al. [29] have defined the effect of surface roughness on EDM machine under fatigue loading condition. Here Sic_p/Al metal matrix composite is used as work piece material. From this studies they concluded that increase of SR causes slight subsurface softening in micro structure due to recast layer and fatigue strength are reduced in EDM process with recast layer in different spark condition.



(a) (b) (c)

Fig-3 Recast layer in EDM surface (a) low magnification coarse spark sample, (b) medium magnification coarse spark, (c) fine sparked condition [29]

Harpreet singh et al.[30] determined the surface roughness in C-EDM using simple and cryogenic brass and cupper tool in EDM machine for better surface roughness and reported that cryogenic copper, brass tool results better surface finish as compared to brass and copper tool and surface roughness increased by increasing pulse current time.

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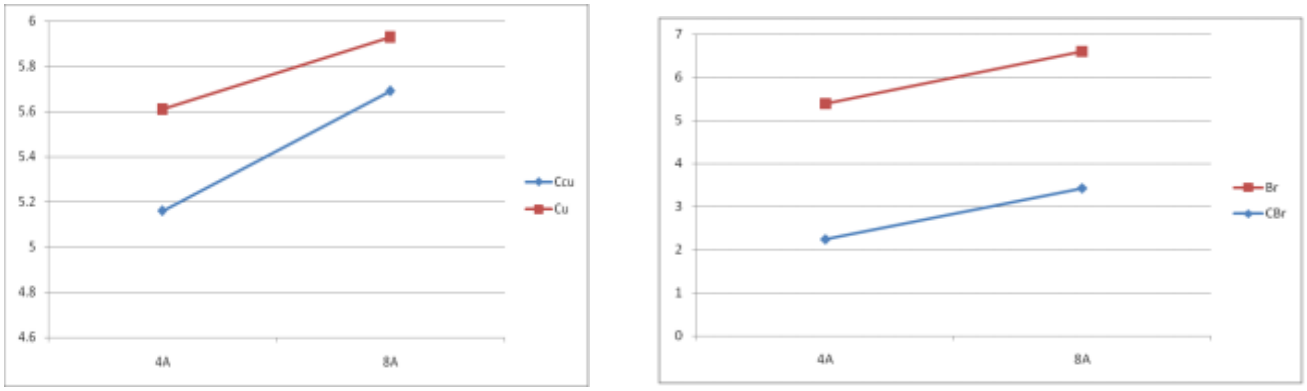
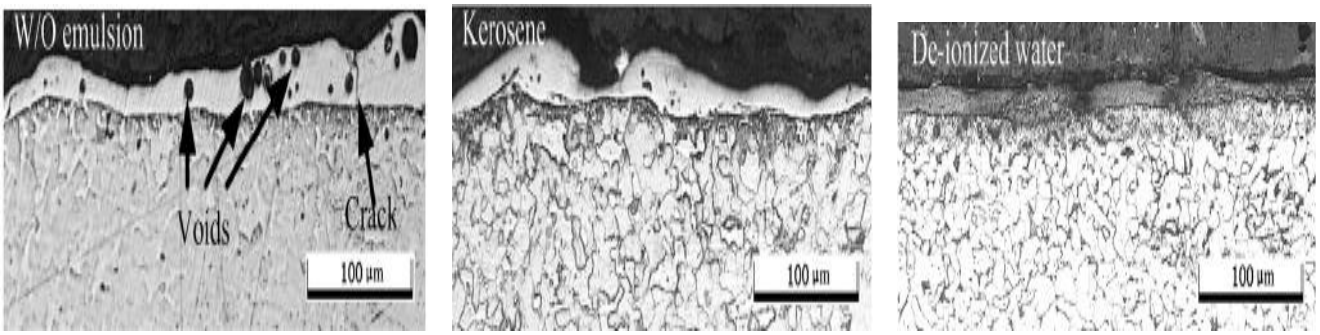


(A) (B)

Fig-4 comparison of tool(A)brass and cryogenic brass (B)copper and cryogenic copper [30]

Yanzhen zhang et al. [31]have studies EDM surface presence of different dielectric viz water-oil,kerosene and deoinised water from this experiment they found water in oil dielectric is produced higher surface roughness as compared to kerosene and de-ionised water.



(a) (b) (c)

fig-5 surface roughness (a)w/o dieleectric(b)kerosene(c)De-ionized water [31]

4 AEROSAL EMMISION:

Mathew Jose et al.[32] determined the aerosal emmision of electrical discharge machining by varying the process parameters such as current level of dielectric and flushing pressure. This analysis revels that concentration of aerosal emmision increased with increasing of peak current, pulse duration and flushing pressure. They also reported the maximum value of peak current pulse duration are 7A and 520µs and if it overcome this range fire may occure.

S.Thiyagarajan et al. [33] have examined the aerosal emmision in EDM using different workpiece material viz.tool steel, mild steel, and alluminium and analyse those material with copper electrode at the presence of different parameters like pulse on time, peak current, dielectric medium and flushing. From this experiment they reveled that alluminium aerosal emmision is low as compared to other materials.

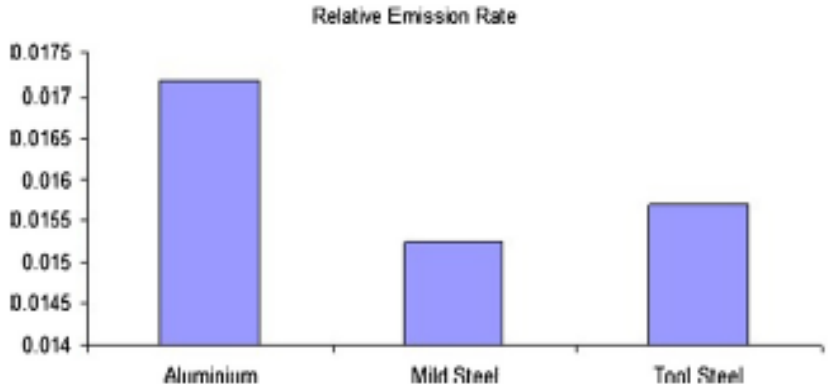


Fig-6 effect of w/p material at Aerosal emmision [33]

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5. CONCLUSION

The critical review concludes that MMCs are having immense demand in industry due to its light weight and most significant properties. The complexity in cutting of hybrid MMCs and required qualitative response is achieved by advanced EDM processing by varying different process variables. Till a lot of research can be done by controlling the temperature distribution during flushing and vibration assisted on tool. Formerly it is not under the investigation for optimization of Smoke which came in the time of machining and affects the governing parameters during machining

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