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Review Article

INVESTIGATION OF MATERIAL REMOVAL RATE IN ELECTROCHEMICAL PROCESS

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ABSTRACT
Electrochemical machining has established itself as one of the major alternatives to conventional methods for machining hard materials and complex contours without the residual stresses and tool wear. Studies on Material removal rate (MRR) are of utmost importance in ECM, since it is one of the determining factors in the process decisions. This paper deals that to investigate the improvement in the material removal rate of electrochemical machining. Experimental MRR has been calculated for different electrolytes condition on aluminum and stainless steel. The experimental results indicate that by using sea water as an electrolytein electrochemical machining on aluminum alloyand steel alloygives better MRR.

Keywords:*Electrochemical Machining, Material Removal Rate (MRR)*

INTRODUCTION

Electrochemical Machining ECM is a process based on the controlled anodic dissolution process of the work piece anode, with the tool as the cathode, in an electrolytic solution. The electrolyte flows between the electrodes and carries away the dissolved metal. The main advantages of ECM are:
1. Machining does not depend on the hardnessof the metal;
2. Complicated shapes can be machined on hard surfaces;
3. There is no tool wear;
4. It is environmental friendly.

When this process is applied to the micromachining range for manufacturing of micro components or features, it is referred as electrochemical micromachining EMM.

Principle of ECM

Electrochemical machining is developed on the principle of Faradays and Ohm. In this process, an electrolyte cell is formed by the anode (work piece) and the cathode (tool) in the midst of a following electrolyte. The metal is removed by the controlled dissolution of the anode accordingto the well known Faradays law of electrolysis. When the electrode are connected to about 24velectric supply source, flow of current in the electrolyte is established due to positively charged ion being attracted towards cathode and vice-versa. Due to electrolysis process at cathode hydroxyl ion are released which combine with the metal ions of anode to form insoluble metal hydroxide. Thus the metal is removed in form of sludge and precipitated in electrolytic cell. This process continues till the tool has produced its shape in work piece.

MATERIALS AND METHODS

EQUIPMENT

The electrochemical machining system has the following modules:
• Power supply
• Electrolyte filtration and delivery system
• Tool feed system
• Working tank

Figure 1 shows the schematic set up of ECM (Rajkumaret al., 1999) in which two electrodes are placed at a distance of about 0.5to 1mm & immersed in an electrolyte, which is a solution of sodium chloride (Sekar andMarappan, 2008).When an electrical potential of about 24V is applied between the electrodes, the ions existing in the electrodes migrate toward the electrodes. Positively charged ions are attracted towards the cathode & negatively charged towards the anode. This initiates the flow of current in the electrolyte. This process continues and toolreproduces its shape in the work piece (anode). The high current densities promote rapid generation of metal hydroxides and gas bubble in the small spacing between the electrodes.

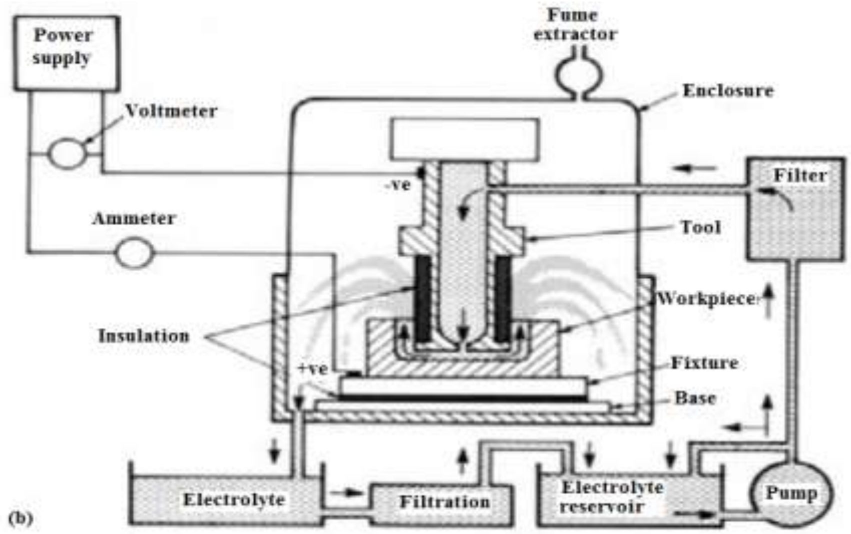

Figure 1: Shows the schematic set up of ECM

Experimentation Work

Experimental runs are taken on ECM setup by various electrolytes and keeping IEG, voltages are constant. Actual MRR is calculated for various readings

Experimental setup

Figure 2 shows the experimental set up of ECM on which the said experimentation is carried out.

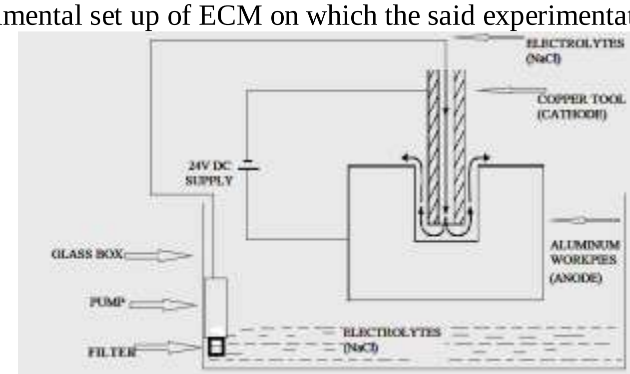

Figure 2: Experimental setup of ECM

Figure 3: Electrochemical Machining Process going on

Figure 4: Aluminum Work piece after machining

Figure 5: Stainless steel work piece after machining

Process Parameters

• Tool: copper (2mm diameter)
•Types of Electrolytes:NaCl,$KAlSO_4$,Na_2NO_3, Na_2SO_4,K_2S0_4,K_2NO_3(35gm/liter), sea water
• Flow rate: 10Ltr/hr
• Work piece: Stainless steel EN Series 58A(AISI 302B)and Aluminum 6063.

Observation table for different electrolyte

Table 1show the readings and calculated MRR for various electrolytes on aluminum while voltage, current and IEG were kept constant during all readings. MRR is given in g/sec.

Table 1: MRR for various electrolyteson aluminum

Sr no	Electrolyte	Initial weight(g)	Final weight(g)	Time(sec)	MRR(g/sec)
1	$Kalso_4$	13.2409	13.2332	20	3.85e-4
2	Kno_3	13.243	13.2055	20	1.873e-3
3	Na_2SO_4	13.6793	13.6681	20	5.6e-4
4	K_2SO_4	14.2361	14.2252	20	5.43e-4
5	NaCl	14.4769	14.4140	20	3.145e-
6	$Nano_3$	12.4438	12.3370	20	5.34e-3
7	Sea water	13.2183	13.0466	20	8.083e-3

Table No 2 shows the readings and calculated MRR for various electrolytes on stainless steel while voltage, current and IEG were kept constant during all readings. MRR is given in g/sec.

Table 2: MRR for various electrolytes on stainless steel

Sr no	Electrolyte	Initial weight(g)	Final weight(g)	Time(sec)	MRR(g/sec)
1	$Kalso_4$	25.4821	25.4664	20	7.85e-4
2	Kno_3	23.8345	23.8046	20	1.495e-3
3	Na_2SO_4	21.5112	21.5081	20	1.55e-3
4	K_2SO_4	28.4283	28.3956	20	1.634e-3
5	NaCl	21.9213	21.7265	20	8.175e-3
6	$Nano_3$	27.0121	26.9825	20	1.455e-3
7	Sea water	24.5421	24.2464	20	.010085

Conclusion

The experimentation work consists of study the influence of electrolytes in electrochemical machining. Some of the other process parameter such as machining voltage and inter electrode gap (IEG), tool diameter etc kept as constant. Theactual and theoretical material removal rates were calculated the result shows thatseawater gives the appreciable amount of MRR.

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