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INVESTIGATION OF INFLUENCE OF ELECTROLYTE CONCENTRATION AND CURRENT ON MATERIAL REMOVAL RATE IN ELECTROCHEMICAL MACHINING

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ABSTRACT

Non-conventional machining processes have proved its usefulness because of its many advantages such as stress free machining, high accuracy, excellent surface finish, high precision. Electrochemical machining process falls in electrochemical category of Non-conventional Machining processes. Electrochemical machining process is used over other non conventional machining processes because of its high precision, non-dependency on material hardness, high material removal rate and low cost. An attempt has been made to develop setup for illustrating the Electrochemical machining process. The study is done to investigate the influence of different process parameters such as current and electrolyte concentration on Material Removal Rate using Mild- Steel and HCHCR Die steel are used as work-piece and hollow copper tube of 6 mm diameter as tool.

KEYWORDS: *Non-conventional Machining, Electrochemical Machining, Electrolyte Concentration, Current, Material Removal Rate.*

1 INTRODUCTION

Electrochemical machining (ECM) provides an economical and effective method for machining heat-resistant and high-strength materials into complex shapes which are difficult to machine by conventional techniques. It is based on controlled anodic electrochemical dissolution process of the work-piece with the tool .ECM generates no burrs, no chips and no thermal or mechanical stress; no heat affected zones on the work-piece and has longer tool life with damaged free machined surface, high material removal rate and surface quality.ECM is originally designed for manufacturing complex shaped components in defense, aerospace industries, automotive industries, forging dies, electrical and surgical components. Achieving desirable MRR and surface finish by controlling various process parameters is still a challenge. The material removal rate or machining is not dependent on the mechanical or physical properties of the work material. It only depends on the atomic weight and valency of the work material and the condition that it should be electrically conductive. Thus Electrochemical machining process can machine any electrically conductive work material irrespective of their hardness, strength or even thermal properties. The less hard tool can machine harder work-piece easily in Electro-chemical machining. Electro-chemical machining dissolution is governed by Faraday's law.

In this process the DC source is used for power supply in which the work-piece is anode and the tool is cathode. The feed is provided to the tool with the help of servo motor. The electrolytic solution is pumped between the working gap with the help of pump. The sludge is formed after the machining process which is to be continuously removed or filtered. The main process parameters included in this process are current, voltage, concentration of electrolyte, working gap, feed, current density, and pressure of electrolyte.

2 SETUP FOR ELECTROCHEMICAL MACHINING

Keeping in view different process parameters the entire setup for Electrochemical Machining is developed. The ECM setup consists of following sub-assemblies: 1) Main frame 2) Tool feeding mechanism 3) Work-piece motion assembly 4) Electrolyte flow mechanism 5) DC power source

2.1 Creomodel for ECM setup

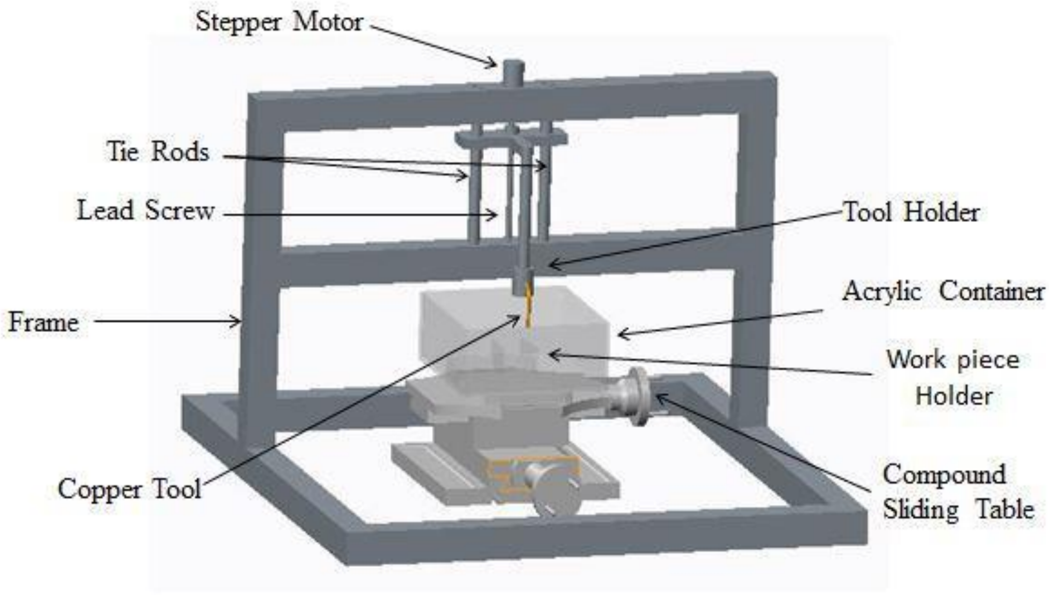

Figure 2.1 Creo model of ECM setup

Specifications of the setup

- Power Source type: Direct Current
  Voltage: 0-30 V
  Current: 0-5 A
  Current density: 0.159-0.194 A/mm^2
- Electrolyte:
  Material: NaCl
  Flow Rate: 1-2 lpm
  Dilution: 15-30% by weight
- Working gap: 0.2-0.4 mm
- Electrode material: Hollow copper tube with 6 mm diameter
- Work-piece: Mild-steel and HCHCR die-steel

The frame is made of rectangular hollow section of mild steel. The machining chamber is made of acrylic sheet with work-piece holder in it. The work-piece used is Mild-Steel and HCHCR die-steel. The tool or electrode is hollow copper tube with 6 mm diameter. The power source used is regulated DC source with voltage 0-30V and current of 0-5A. The current and voltage can be maintained through the source itself with the help of regulators. The electrolyte is fed into the gap between the work-piece and tool with the help of submersible pump by centre flushing tool. The horizontal motion to work-piece is given with the help of compound sliding table on which the machining chamber is mounted. The electrolyte used is salt solution with 15-30% concentration by weight. The feed is given to the tool with the help of servo motor to maintain the working gap during machining. The lead-screw used has a pitch of 1.5 mm. The initial gap is checked with the help of feeler gauges. The weight before and after machining are noted. The difference of these weights gives the material removal rate in weight removed per unit time.

2.2 Effect of current on MRR

In ECM, material removal takes place due to atomic dissolution of work-piece material. Electrochemical dissolution is governed by Faraday's laws. The first law states that the amount of electrochemical dissolution or deposition is proportional to amount of charge passed through the electrochemical cell. So the material removal increases with the increase in the current. Fig 3.1-3 and fig 3.2-3 shows that MRR increases with increase in current for mild steel and HCHCR die steel respectively.

2.3 Effect of electrolyte concentration on MRR

With increase in electrolyte concentration, the number of ions in the solution increases. As more number of ions is available for chemical reaction, more dissolution takes place. So MRR increases with the increase in electrolyte concentration. Fig 3.1-2 and 3.2-3 shows that MRR increases with the increase in electrolyte concentration for mild steel and HCHCR die steel respectively.

3 CONCLUSION

After conducting several experiments and various readings it is found that:

- The material removal rate increases with the increase in electrolyte concentration (i.e. 15% to 30% by weight) in mild steel and HCHCR die steel.
- The material removal rate increases with respect to the current.

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