ELECTROCHEMICAL GRIDING MACHINING

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ABSTRACT

Electrochemical Machining (ECM) has established itself as one of the major alternatives to conventional methods of machining difficult - to - cut materials of and/or generating complex contours, without inducing residual stress and tool wear. The need for complex and accurate three dimensional (3-D) micro components is increasing rapidly for many industrial and consumer products. Electrochemical machining process (ECM) has the potential of generating desired crack free and stress-free surfaces of micro components. This paper reports a study of pulse electrochemical micromachining (PECMM) using ultra short (nanoseconds) pulses for generating complex 3-D microstructures of high accuracy. A mathematical model of the micro shaping process with taking into consideration unsteady phenomena in electrical double layer has been developed. The software for computer simulation of PECMM has been developed and the effects of machining parameters on anodic localization and final shape of machined surface are presented.

Keyword : - *Electrolyte, Power supply(DC), Electrode conductive wheel, Work piece.*

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1. INTRODUCTION

Present day construction scenario has been come complex and day by day demand for faster and economical viable. Construction option growing today. Many construction industries uses different kinds of modern machine, thus making themselves more efficient and reducing time required. Our project electrochemical grinding machine is such on unit which finds extensive application machining workplace that are frigate or susceptible to head damages. Although our project is lab testing assembly unit still the basic concept is quite inventive. This machine is more precise than that of conventional grinding. A suitable shaped tool can produce a desired form on a hard metal in very short time. The high surface finish can be obtained by this machining. Tool wear is not there as there is no direct contact between tool and work piece. The electrolyte is usually potassium nitrate with a concentration of 150-300 gm/liter of water is wetted through nozzles into the wheel rather than the work and the wheel is submerged. Unnecessary and hence the lift of the wheel w.r.t. The volume of material removed is 8-12 times that of conventional grinding even under heavy duty grinding work. Metal removal rate is higher as compared to the conventional grinding machine. The typical electrochemical grinding machine consist of following components-

- Machine
- Electrolyte
- Power supply(DC)
- Electrode conductive wheel
- Work piece

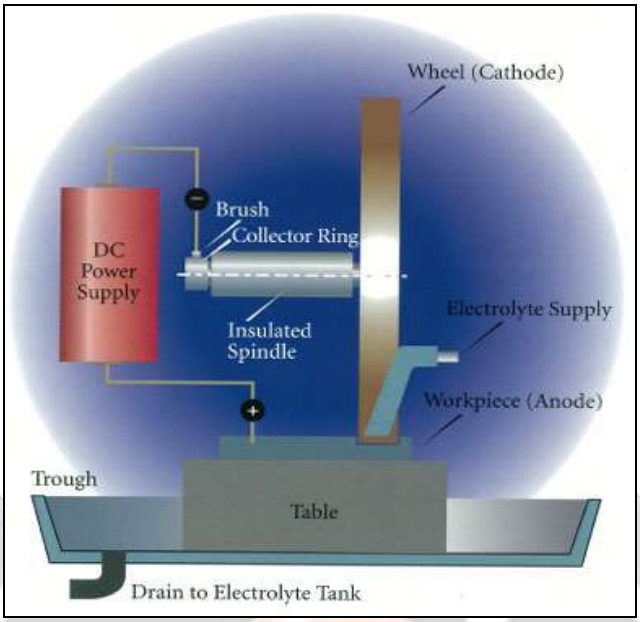

Figure 1: Basics of E.C.G.M

2. DESCRIPTION

The electrochemical grinding is also called as electrolyte grinding. It is a combination of conventional grinding operation in co-operation with electrochemical action. In E.C.G.M the metal boned grinding wheel impregnated with diamond abrasive is made cathode and the work piece is the anode. The electrolyte is usually potassium nitrate with a concentration of 150-300 gm/liter of water is wetted through nozzles into the wheel rather than the work and the wheel is submerged. Actually abrasive grains on the surface of the wheel. Serve to cut as paddle, which pick up the electrolyte and cause a pressure to build up at work area. The metal removal is largely brought about by electrochemical action and only10% of volume of material is removed by abrasive action of the wheel. Therefore pressure between wheel and work piece is only about 10% of conventional grinding process, enabling fragile materials to ground frequent wheel dressing is unnecessary and hence the lift of the wheel w.r.t. The volume of material removed is 8-12 times that of conventional grinding even under heavy duty grinding work.

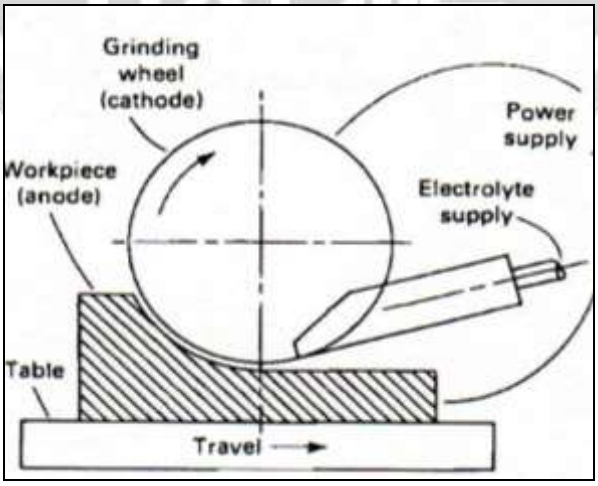

Figure 2: Schematic of Electro chemical grinding

The surface finish is held in the range of 0.2- 0.4 times on calibrated and 0.4-0.8 on steel. In electrolyte grinding, because only relative low metal removal rates are required, the important factor governing selection of electrolyte is its low corrosive property. The current applied is in the range of 50-3000 ampere at 5-20 volts (250amp/cm2) feed rate depend on current density, wheel diameter and depth of cut and is depend on current density, of 150amp/cm2 and depth of cut 2.5mm. The electrolyte flow rate of 5 liter/min or a current density of 100 amp/cm2. The E.C.G. can accomplish the E.C.G. process is similar to a conventional process.

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2.1 Mechanical Properties- The E.C.G.M. machining have no effect on mechanical properties such as yield strength, ultimate tensile strength, hardness etc.

2.2 Hydrogen Embrittlement- Hydrogen entry discharge occurs at the cathode tool surface and not at the work piece. No instant of hydrogen embrittlement resulting from E.C.G.M. action have been reported and are expected.

2.3 Machine Control- Control of many variables is need for better result in E.C.G.

- **Power Supply:** In E.C.G. the current may be of the order 50-3000 ampere at 5-20 volt dc. For a current density of 20-3000 amp/cm2across a gap of 0.5-1mm between tool and work piece.
- **Electrolyte:** Most widely used electrolyte in this process in sodium nitrate solution, sodium chloride solution and potassium solution in water is good alternative but is more corrosive than former. Some other electrolytes used are sodium hydroxide, sodium fluoride chloride potassium nitrate.
- **Work material:** The requirement of good tool material in E.C.G
- It should be good conductor of electricity.
- It should strong, rough to withstand the high hydrostatic pressure caused by electrolyte fluid.
- It should be easily machined to the required shape and size.
- The bottom face of tool should be polished to obtain good surface finish the work piece
- **Metal Removal Rate:** The metal removal rate and surface finish are directly proportional to current density. The rate is 0.01-0.07 cm3/sec 1000 ampere surface finish rate as low as 0.15 µRa are possible

3. MATERIAL REMOVAL RATE OF E.C.G.M.

The metal removal is removed by abrasive action of the wheel. Therefore the pressure between the wheel and work piece only about 10% of the conventional grinding process, enabling fragile material to be ground. It is find that at current density of 250amp/cm2 and gap between the wheel work pieces is 0.25 then the metal removal rate is 15m3 per second. The surface finish is held in the range 0.2 to 0.4µm on carbide and 0.4 to 0.8 µm on steel sharp corners are difficult to obtain and a minimum radius of 0.2mm cannot be avoided unless a final pass without electrolytic action is used.

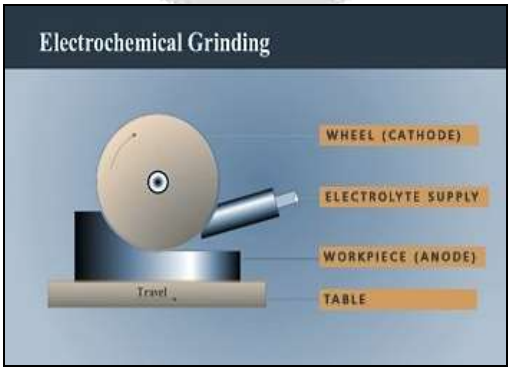

Figure 3: Material removal rate.

4. CONSTRUCTION

MAIN PARTS –

1. Base frame
2. Shaft
3. Ball Bearing
4. Safety cover
5. Bearing Housing
6. Shaft driven pulley
7. Abrasive wheel
8. Motor
9. V-Belt
10. Battery
11. Electrolyte Storage Tank
12. Submersible Motor
13. Work piece
14. Work piece holder

- Base frame- Base frame is used for mounting grinding wheel, tool, work piece, shaft etc. & all essential elements.
- Shaft- it is used for transmit the electric motor power to the grinding wheel.
- Ball Bearing- Bearing is used for to support the shaft and maintain its fixed position.
- Safety cover- It protects the operator from hazardous effects of chemical.
- Bearing housing- It is used for mounting of bearing and to maintaining the fix position.
- Abrasive wheel- It is mounted on the shaft. It is used for metal removing purpose.
- Battery- It is used for to give power supply to the shaft and work piece to form depletion layer.
- Work piece holder- It is used to hold the work piece. It is mounted below the grinding wheel.
- Storage tank- The use of tank is to store the chemical-water proportion.
- Submersible motor- It is used to lift the electrolyte (mixture of chemical and water) from storage tank to the grinding wheel and work piece.
- Motor- It is used to rotate the shaft. It provides rotary motion as well as power to the shaft.

5. WORKING

Working principle- Electro chemical grinding is also known as electrolyte grinding. In E.C.G.M. the metal bound grinding wheel impregnated with a non conductive abrasive is made the cathode and workplace is anode. The electrolyte (potassium nitrate or sodium nitrate) is passing through nozzle in the machining zone in order to complete the electrical bride between cathode and anode.

The work and wheel do not make contact with each other because they are kept apart by the insulating abrasive particles, which protrude from face of the grinding wheel. A constant gap of 0.25mm maintain into which a stream of electrolyte is directed. The electrolyte is carried past the work surface at high speed by the rotary action of grinding wheel metal is removed from the work piece by simultaneous electrolytic and abrasive action. Actually abrasive grains on the surface of the wheel sure to act as a paddle which pick up electrolyte and cause a pressure to built up at the work area.

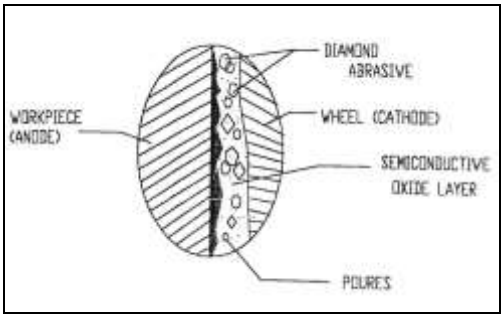

Figure 4: The wheel and Work condition in E.C.G.M.

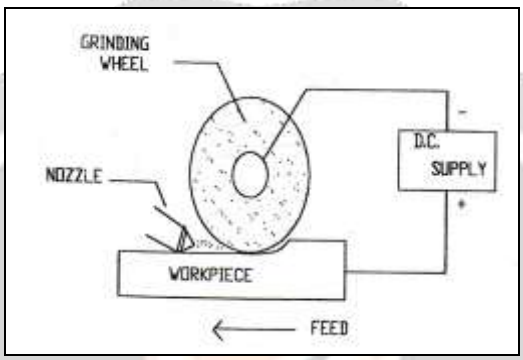

Figure 5: Working principle of E.C.G.M.

When these cells come in contact with the work the current flow from the wheel to the work and this lead to the electrochemical decomposition of work and work is prevented due to point contact made by fine abrasive particle also remove inactive layers formed on the work by abrasion order to make the surface more receptive. It can be seen that process is similar to conventional grinding in that an abrasive grinding wheel is used and the work fed again the rotating wheel. In fact 10% of the work metal is removed by abrasive cutting of 90% by electrolyte action is electrolytic and little dressing is necessary. The machine is similar in design to surface grinder is similar in design to includes a tank filter and a pump for supply of electrolyte and power unit delivering a heavy DC current. The current applied is in the range of 50 to 3000 ampere at 4 to 10 volt (250 amp/cm2).

5.1 Advantages And Disadvantages-

Advantages

- Rapid metal removal rate is possible on hard abrasive material.
- Tool wear is negligible which increases life of grinding wheel
- Because E.C.G. work is not subjected to overheating, the method is favored for grinding some metal that work hardens.
- No heat cracks, distortion are developed on the work piece.
- The work is completely free from burrs and can be machined with good surface finish.
- Tool ground by E.C.G. usually has increased life because of the absence of the saw tooth edges usually obtained.
- Greater productivity.
- Cool, burn free machining with on stressor metallurgical damage.
- Grind delicate pone and thief would section without distortion or head damage.

Disadvantages-

- High capital cost as compared to conventional grinding
- Metal removal rate is not competitive with those of conventional machining method for readily machinable metals

- Power consumption is high.
- Chemical attack on work and equipment by corrosive electrolyte need special rinsing of work.

Applications-

- E.C.G.M. is used primarily to grind carbide tools, and in method of extremely high hardness such as refractory metals, high strength steels and global base alloy.
- It is used for machine work pieces that are fragile or susceptible to heat damages.

Future Scope

- It is can be used in industry for fast finishing.
- It has better quality than conventional grinding.

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