UNIT IV

CHEMICAL AND ELECTRO-CHEMICAL ENERGY BASED PROCESSES

CHEMICAL MACHINING AND ELECTRO-CHEMICAL MACHINING (CHM AND ECM) :

Chemical Machining Processes (CHM) :

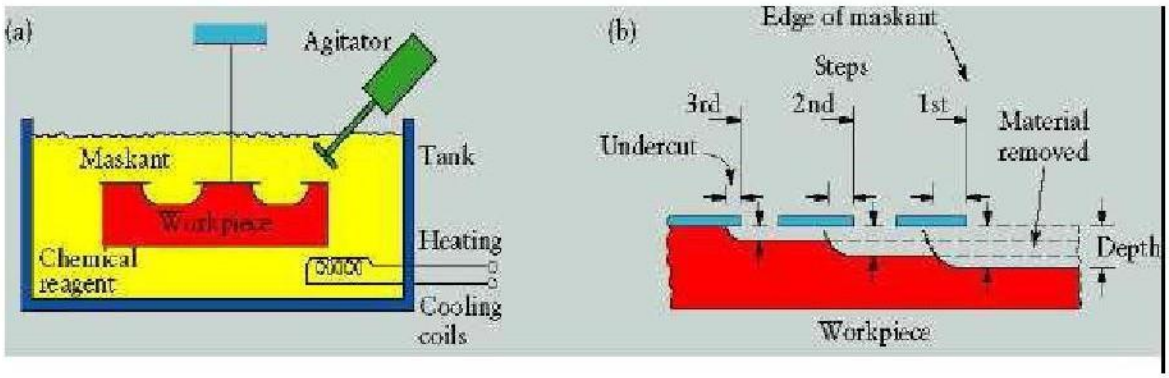
Chemical machining is one of the non-conventional machining processes where material is removed by bringing it in contact of a strong chemical enchant. There are different chemical machining methods base on this like chemical milling, chemical blanking, photochemical machining, etc.

Working Principle of CHM :

The main working principle of chemical machining is chemical etching. The part of the workpiece whose material is to be removed, is brought into the contact of chemical called enchant. The metal is removed by the chemical attack of enchant. The method of making contact of metal with the enchant is masking. The portion of workpiece where no material is to be removed, is mashed before chemical etching.

Process Details of CHM :

Following steps are normally followed in the process of CHM :



Cleaning

The first step of the process is a cleaning of workpiece, this is required to ensure that material will be removed uniformly from the surfaces to be processed.

ETCHANTS :

In this step the material is finally removed. The workpiece is immersed in the enchant where the material of workpiece having no protective coating is removed by the chemical action of enchant. Enchant is selected depending on the workpiece material and rate of material removal; and surface finish required. There is a necessity to ensure that maskant and enchant should be chemically in active. Common enchants are H2SO4, FeCL3, HNO3. Selection of enchant also affects MRR. As in CHM process, MRR is indicated as penetration rates (mm/min).

MASKANT TECHNIQUES OF APPLYING MASKANTS :

Masking is similar to masking action is any machining operation. This is the action of selecting material that is to be removed and another that is not to be removed. The material which is not to be removed is applied with a protective coating called maskent. This is made of a materials are neoprene, polyvinylchloride, polyethylene or any other polymer. Thinkers of maskent is maintained upto 0.125 mm. The portion of workpiece having no application of maskent is etched during the process of etching.

Demasking

After the process is completed demasking is done. Demasking is an act of removing maskent after machining.

PROCESS PARAMETERS :

- Electrolyte
- Concentration
- Etchants

SURFACE FINISH AND MRR :

Surface finish tolerance of the order of ± 0.05 to 0.13 mm are commonly achieved,in normal production and with extra care,tolerance of ±0.003 to 0.013 mm are possible.

$$MRR = 40\ I / Tm^{1.23}\ (cm3/min)$$

APPLICATIONS :

- Creating shallow, wide cavities on plates, sheets, forgings and castings to reduce weight.
- Very heavily used in electronics manufacturing – as we shall see later.
- Hydrogen Flouride gas, or Hydrofloric acid is commonly used to etch fogged surface or cut-outs in glass.

Electro chemical Machining (ECM) :

Electrochemical machining (ECM) process uses electrical energy in combination with chemical energy to remove the material of workpiece. This works on the principle of reverse of electroplating.

PRINCIPLES OF ECM :

Electrochemical machining removes material of electrically conductor work piece. The work piece is made anode of the setup and material is removed by anodic dissolution. Tool is made cathode and kept in close proximity to the work piece and current is passed through the circuit. Both electrodes are immersed into the electrolyte solution. This works on the basis of Faraday's law of electrolysis. The cavity machined is the mirror image of the tool. MRR in this process can easily be calculated according to Faraday's law.

EQUIPMENTS :

Work piece

Workpiece is made anode, electrolyte is pumped between workpiece and the tool. Material of workpiece is removed by anodic dissolution. Only electrically conducting materials can be processed by ECM.

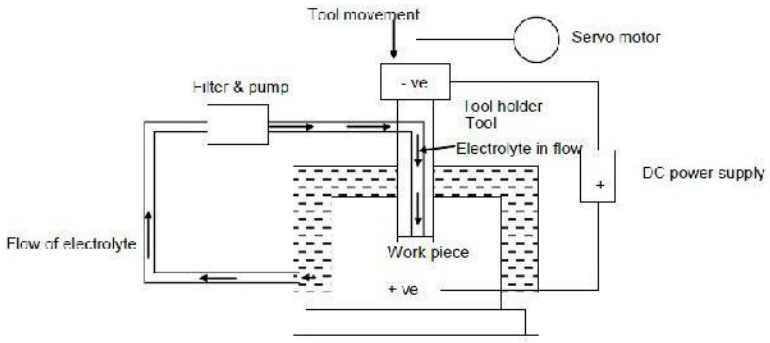


Fig : Electro chemical Machining

Tool

A specially designed and shaped tool is used for ECM, which forms cathode in the ECM setup. The tool is usually made of copper, brass, stainless steel, and it is a mirror image of the desired machined cavity. Proper allowances are given in the tool size to get the dimensional accuracy of the machined surface.

SURFACE ROUGHNESS AND MRR :

The material removal rate by ECM is given by:

$$MRR \quad C\,I$$

where,

MRR=mm3/min,

I=current in amperes,

□=current efficiency, which typically ranges from 90-100%,

C is a material constant in mm3/A·min.

ELECTRICAL CIRCUIT :

Power Supply

DC power source should be used to supply the current. Tool is connected with the negative terminal and workpiece with the positive terminal of the power source. Power supply supplies low voltage (3 to 4 volts) and high current to the circuit.