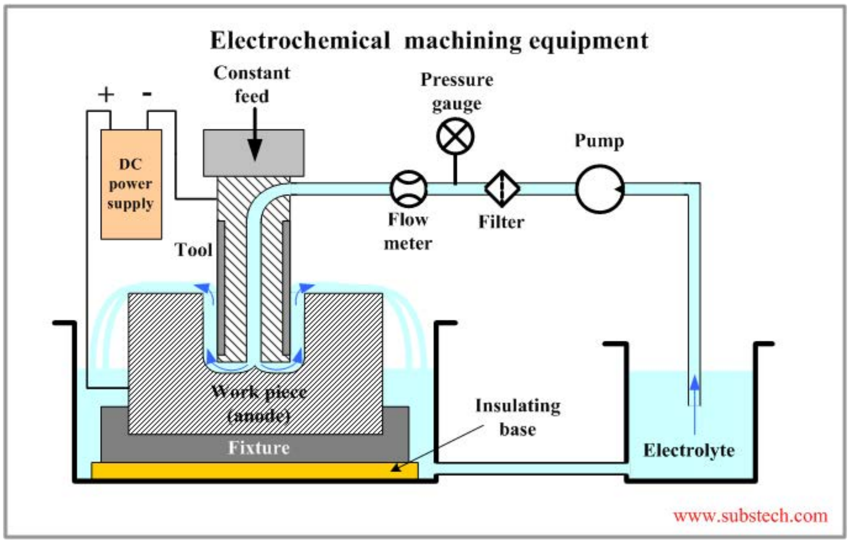

ELECTRO-CHEMICAL MACHINING (ECM)

Principle and Working : Refer to Figs.

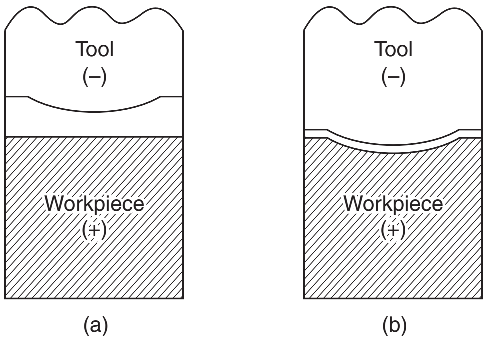

Fig. The principle of ECM process (*a*) Shape of workpiece before machining ;
(*b*) Tool shape is reproduced on workpiece after ECM.

It is an inherently versatile process of machining because of its capability of stress free machining of various kinds of metals and alloys. *It can produce shapes and cavities which are costly and extremely difficult to machine with the conventional machining processes and a true shape of the tool (or cathode) can be made on the workpiece (or anode) by controlled dissolution of anode of an electrolytic cell.*

An electrolyte (usually a neutral salt solution such as sodium chloride, sodium nitrate, sodium chlorate) is passed through a very small gap (0.05 to 0.03 mm) created between the workpiece (or anode) and the tool (or cathode) whereas a direct current flow is made between them. When sufficient electrical energy (about 6 eV) is available, a metallic ion may be pulled out of the workpiece surface. The positive metallic ions will react with negative ions present in the electrolytic solution forming metallic hydroxides and other compounds. Hence the metal will be anodically dissolved with the formation of sludges and precipitates. *The metal removal rate is governed by Faraday classical laws of electrolysis.*

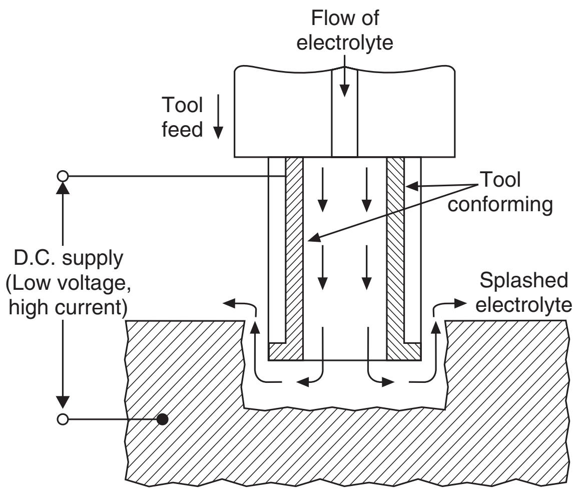

Fig. Set up for Electro-Chemical Machining (ECM).

Characteristics of ECM :

- *Tool materials* : Copper and brass.
- *Workpiece materials* : Conducting metals and alloys.
- *Process parameters* : Current, voltage, feed rate and electrolyte.
- *Material removal* : Electrolysis.

Advantages :

1. The process is capable of machining metals and alloys irrespective of their strength and hardness.
2. Fragile parts, which are otherwise not easily machinable can be shaped by ECM.
3. Intricate and complex shapes can be machined easily through this process.
4. Metal removal rate is quite high in comparison to traditional machining, specially in respect of high tensile and high temperature resistant materials.
5. Wear on tool is insignificant or (say) almost non-existent.
6. With the application of this process, many machining operations, like grinding, milling, polishing etc. can be dispensed with.
7. No cutting forces are involved in the process.
8. The machined work surface is free of stresses.
9. High surface finish of the order of 0.1 to 0.2 microns can be obtained.
10. It is an accurate process and close tolerances of the order of 0.05 mm can be easily obtained.

Disadvantages :

1. Non-conductive materials cannot be machined.
2. The process cannot be used to machine sharp interior edges and corners less than 0.2 mm radius because of very high current densities at those points.
3. Very high power consumption.
4. Larger floor space is required.
5. A constant monitoring is required to suitably vary the tool feed rate and supply pressure of electrolyte so as to avoid formation of cavitation.

6. Designing and fabrication of tools is relatively more difficult.
7. High initial investment.
8. Specially designed fixtures are required to hold the workpiece in position, because it may be displaced due to the pressure of the inflowing electrolyte.
9. Corrosion and rusting of workpiece, machine tools, fixtures etc., by electrolyte is a constant menance.