Electro Chemical Machining(ECM)

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Aim of the presentation

- Give brief information about electro-chemical machining process
- Show the ECM’s working principles and tools
- Define the advantages and disadvantages
- Brief informations about application areas, economics, products and developments.

Outline

- Definition of topic
- Aims of usage
- History
- Basic working principle
- Tools of system
- Advantages&Disadvantages
- Comparing other systems
- Applications
- Economics
- Products
- Future
- Conclusion

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What is ECM ?

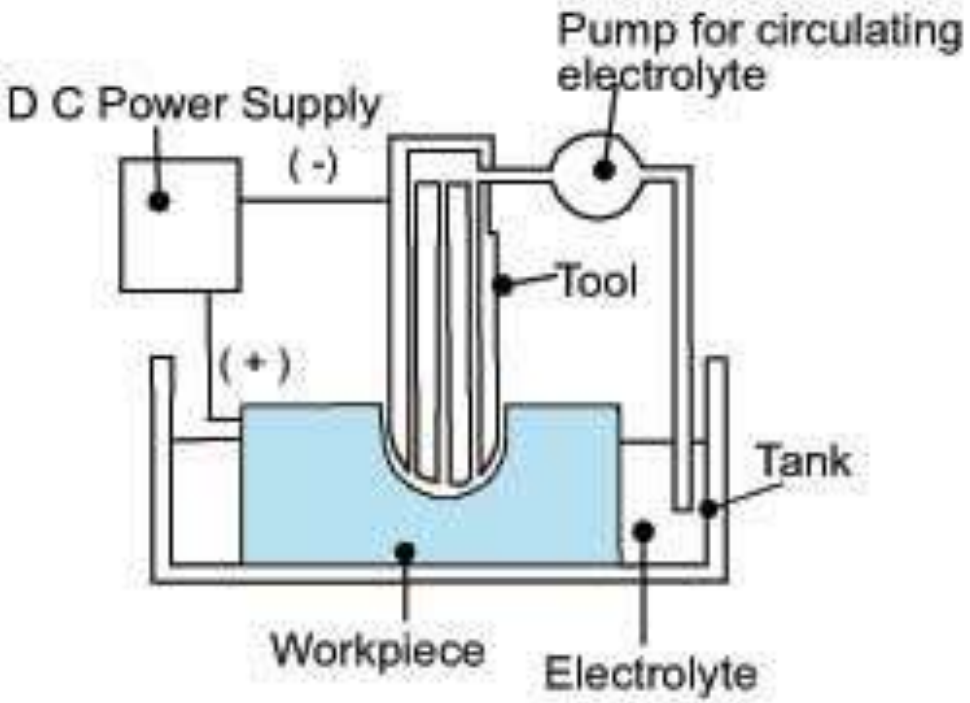
- **Electrochemical machining** (**ECM**) is a method of removing metal particules by an electrochemical process instead of standart machining methods.
- It gives a new perspective to machining process and being an iniatior of new tecnologies. (Example ;**MECM**)

Aim of usage

- To process complex materials which standard machining methods are insufficient
- Also for processing extreme hard and brittle materials with high sensivity.

History

- The first introduction of ECM in 1929 by Gusseff, its industrial applications have been extended to electrochemical drilling, electrochemical deburring, electrochemical grinding and electrochemical polishing
- The technique was applied in several ways as a machining technique in the 60’s and 70’s.



Electro-chemical Machining [1]

- **Simple ECM illustration schema**

- Made by ECM

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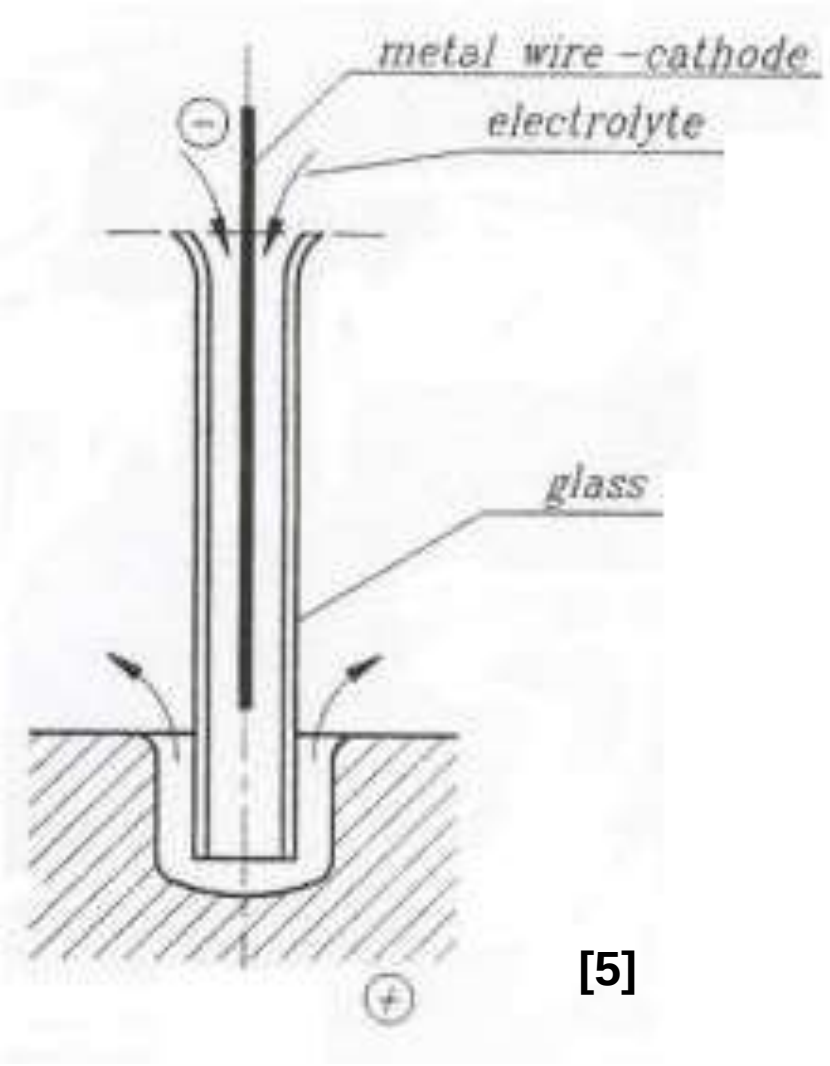
Working Principle

- As the tool approaches the work piece it erodes the negative shape of it. Thus complex shapes are made from soft copper metal and used to produce negative duplicates of it.



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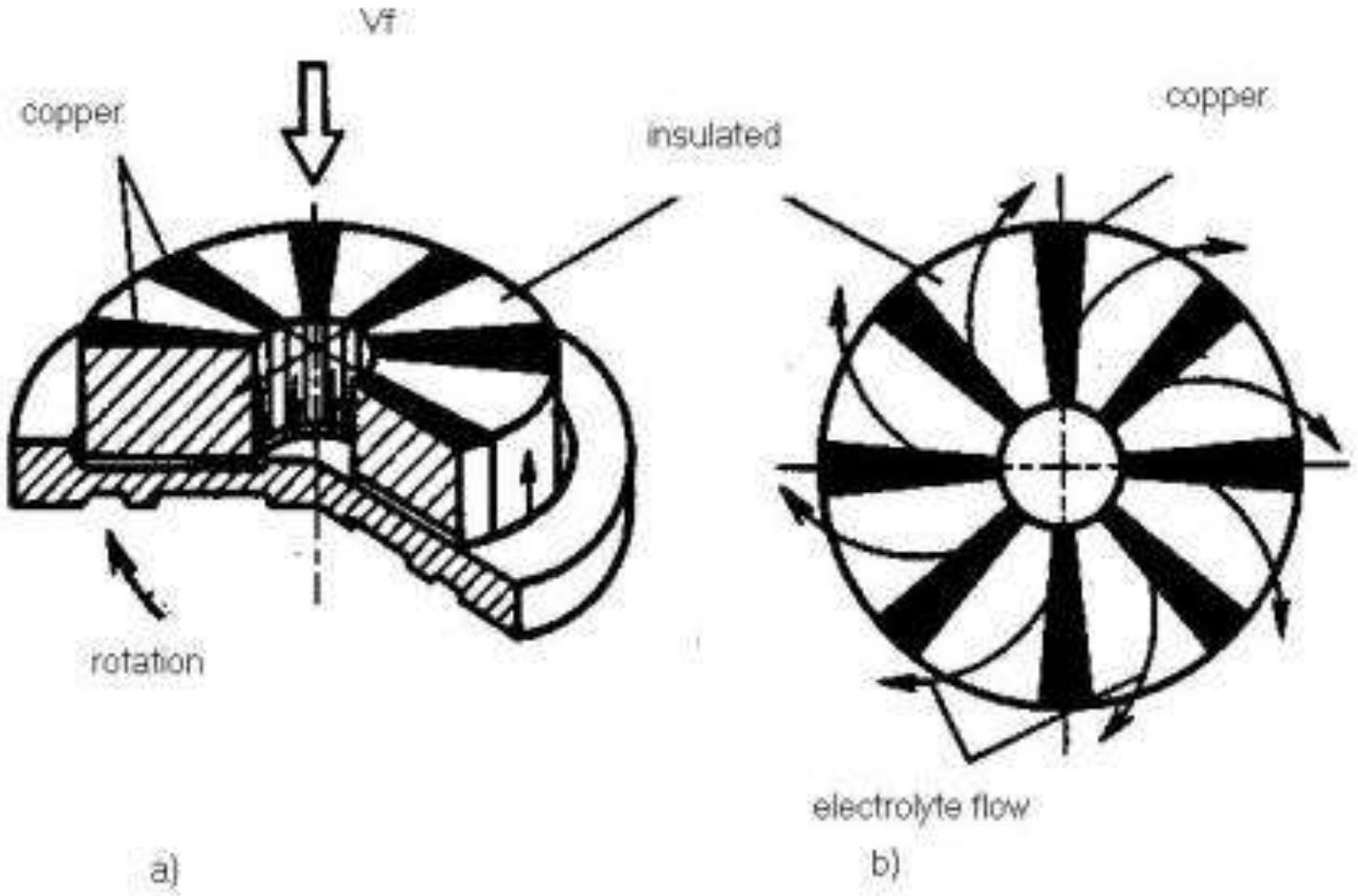

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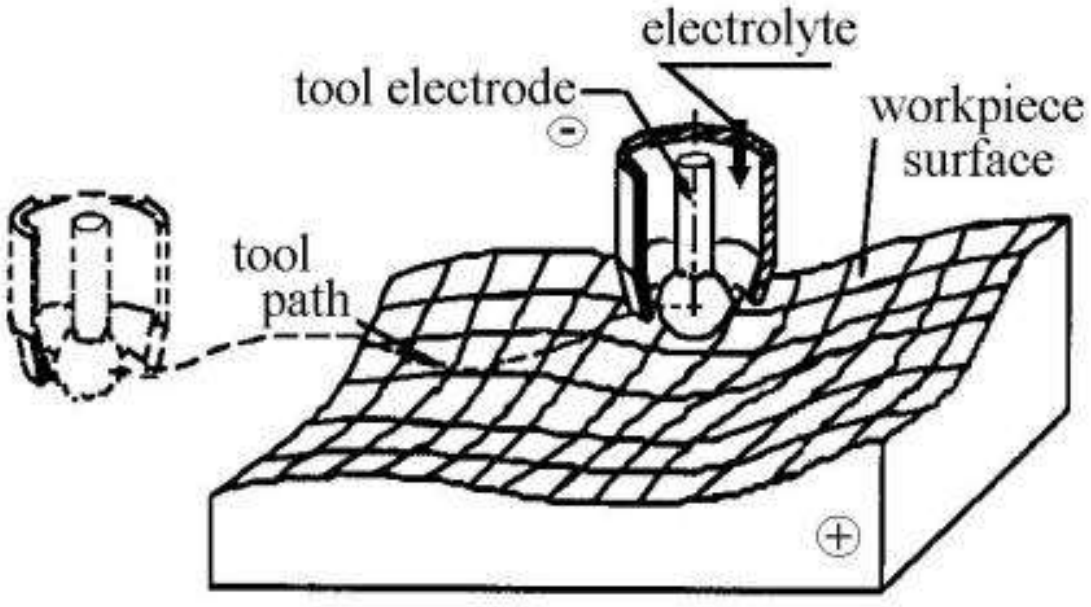
•**Electrochemical shaping of rotating workpiece**

- **Anode Reaction**

$$Fe \rightarrow Fe^{++} + 2e$$

- **Kathode Reaction**

$$2H_2O + 2e \rightarrow H_2 + 2OH^-$$



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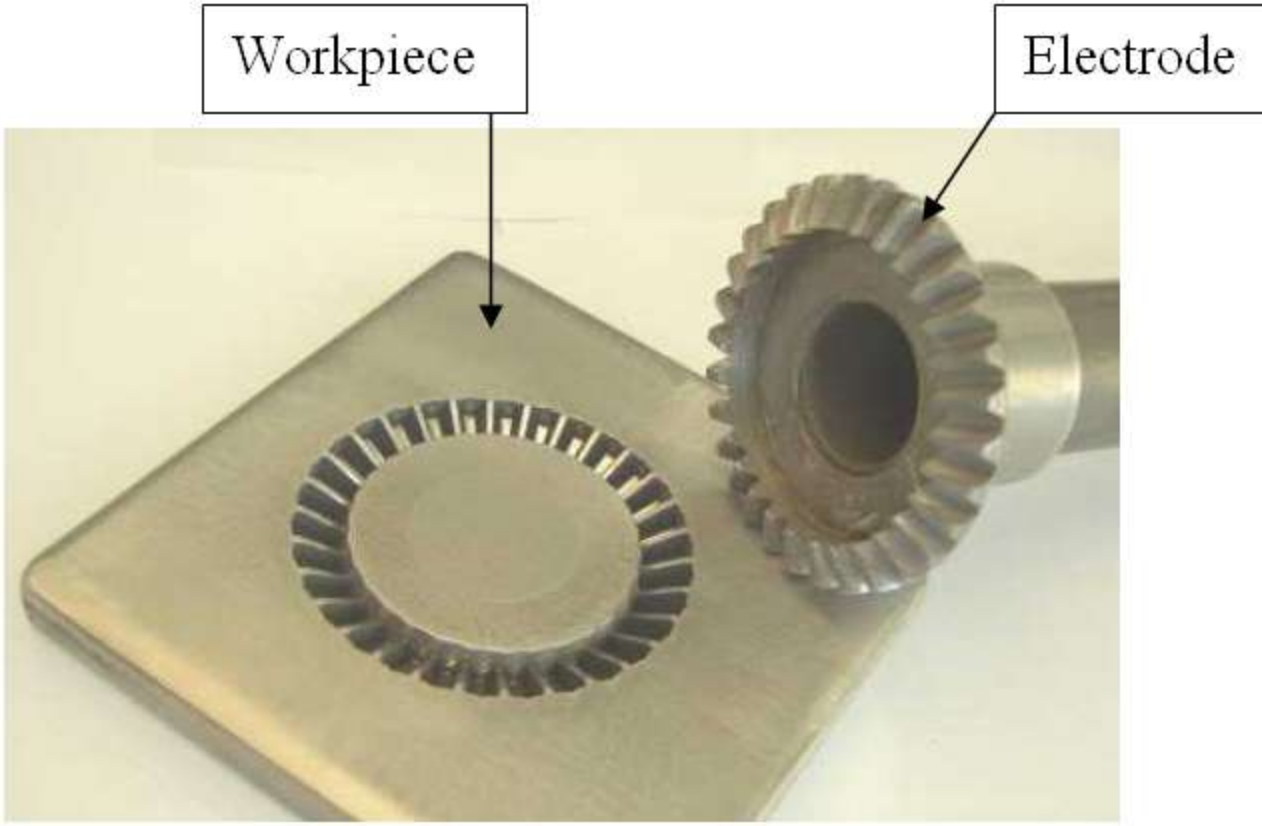
•**In ECM ,cathode part must design specially to machining workpiece**



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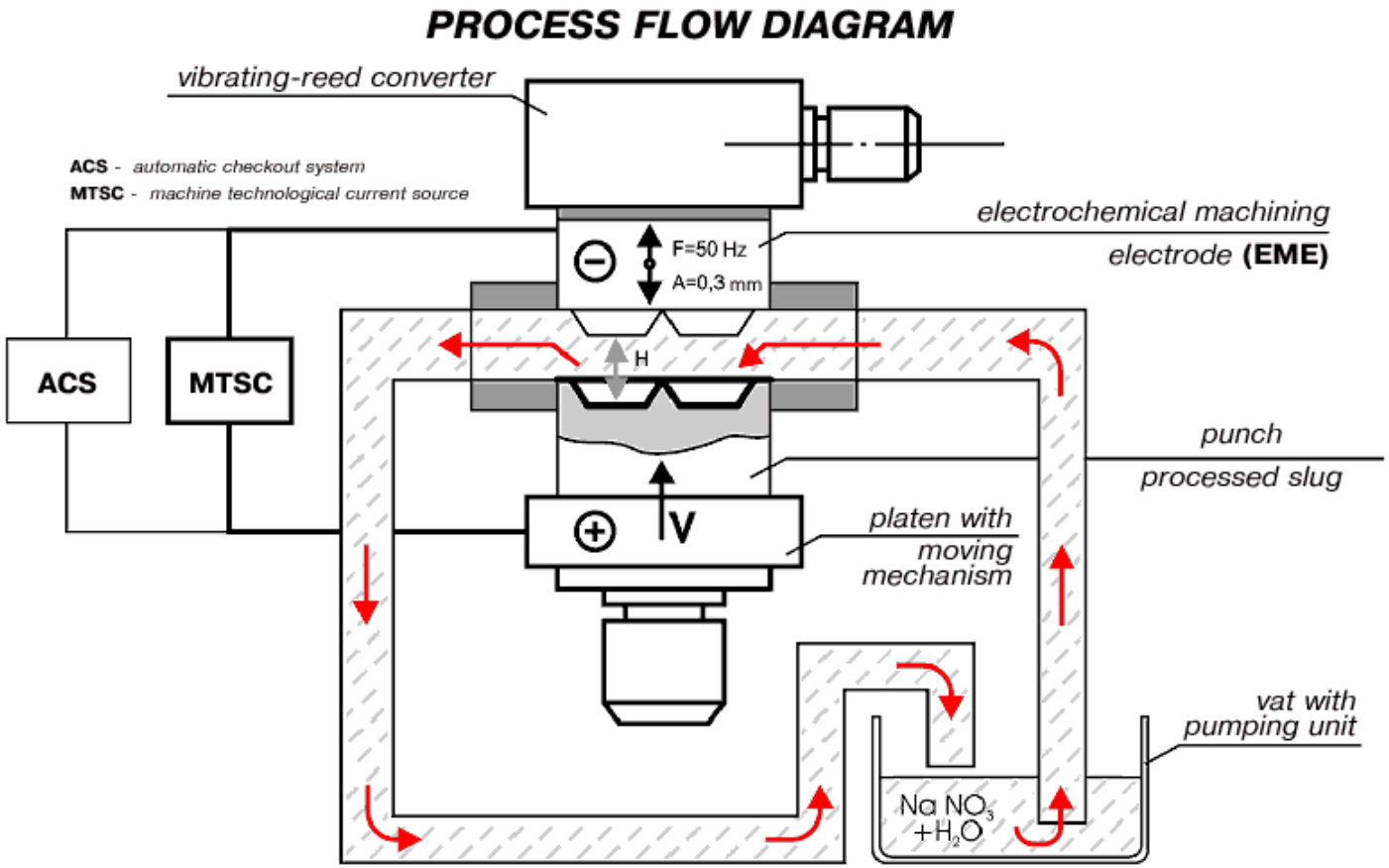
Tools of ECM

- The power supply.
- The electrolyte circulation system
- The control system.
- The machine



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Power Supply

- Electrical energy is using to works ECM,for this power lots of specialities includes
- Electrical current density must be high
- The space between electrode and workpiece must be very short for higher accuracy

Electrolyte Circulation System

- The entering pressure must be between 0.15 and 3 Mpa
- The electrolyte system must include a strong pump
- The electrolyte is stored in a tank
- System also includes a filter, sludge removal system, and treatment units.

Control System

- Control parameters include:

  *Voltage

  *Inlet and outlet pressure of electrolyte

  *Temperature of electrolyte.

- The current is dependent on the above parameters and the feed rate.

Machine

- The machine is a major subsystem of the ECM.
- It includes the table, the frame, work enclosure (prevents the electrolyte from spilling), the work head (where the tool is mounted)
- The tools (electrodes) are also part of the machine system

Advantages

- No mechanical force
- There is no cutting forces therefore clamping is not required except for controlled motion of the work piece.
- There is no heat affected zone.
- Very accurate.
- Relatively fast
- Can machine harder metals than the tool.

- No material corrosion
- Provides smooth surfaces
- No need of harder material that is used in processing.
- More sensitive and repeatable
- Provides of processing complex geometries

Disadvantages

- Solution usage
- Pump,tank, pipe, filter and sink usage.
- Keeping the solution conductivity constant.
- More expensive than conventional machining.
- Need more area for installation.
- Electrolytes may destroy the equipment.
- Not environmentally friendly (sludge and other waste)
- High energy consumption.

- The effect of the toxic gases and aerosols produced in the course of ECM.
- Chemical attack by electrolytes.
- The risk of an electric shock.
- The danger of a burn in the case of a short circuit between the positive and negative leads. .
- Mechanical factors.
- The danger of a fire damp explosion.
- The effects of the electromagnetic field.
- Material has to be electrically conductive

Applications

- The most common application of ECM is high accuracy duplication. Because there is no tool wear, it can be used repeatedly with a high degree of accuracy.
- It is also used to make cavities and holes in various products.
- It is commonly used on thin walled, easily deformable and brittle material because they would probably develop cracks with conventional machining.

Applications in industries

- Applications are valid for highly sensitive working areas like; electronic, air and space industries.
- It has also contains many benefices that in great industries like telecommunication, automotive and defence industries.

Economics

- The process is economical when a large number of complex identical products need to be made (at least 50 units)
- Several tools could be connected to a cassette to make many cavities simultaneously. (i.e. cylinder cavities in engines)
- Large cavities are more economical on ECM and can be processed in 1/10 the time of EDM.

Products

- The two most common products of ECM are turbine/compressor blades and rifle barrels. Each of those parts require machining of extremely hard metals with certain mechanical specifications
- Some of these mechanical characteristics achieved by ECM are:

  Stress free grooves.

  *Any groove geometry.

  *Any conductive metal can be machined.

  *Repeatable accuracy of 0.0005”.

  *High surface finish.

  *Fast cycle time.

Future

- Because of being a developing machining system; provides a new tecniqual expertise areas
- With these developments; electrochemical machining system found a better condition to work in micro sizes called MECM

Conclusion

- With eliminating the disadvantages,ECM will provide a good efficiency and recycling in machining processes
- It provides a faster and accurate system for metal machining processes.
- It is an iniatior of newer tecniques that could be benefical for industries.
- Also provides faster and good quality works than conventional methods

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Thanks for your attention.