Advanced Manufacturing Processes (AMPs)

Electrochemical Grinding (ECG)

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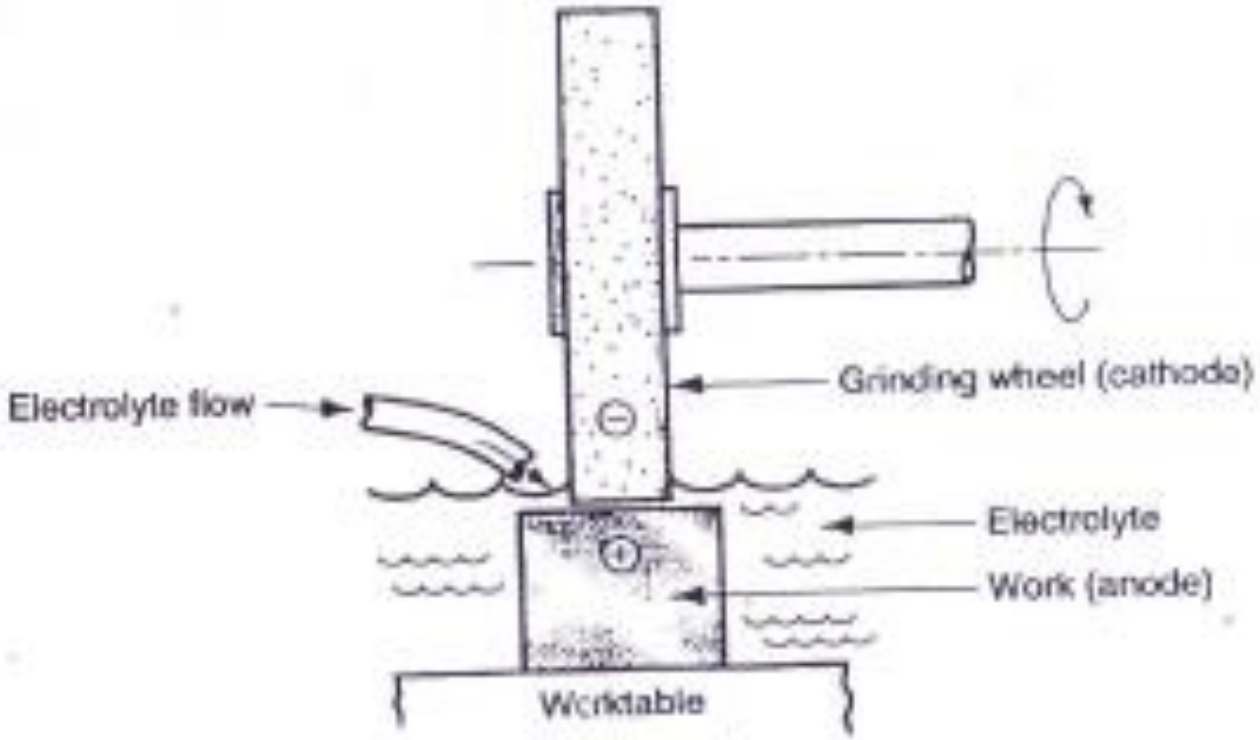
Chapter Description

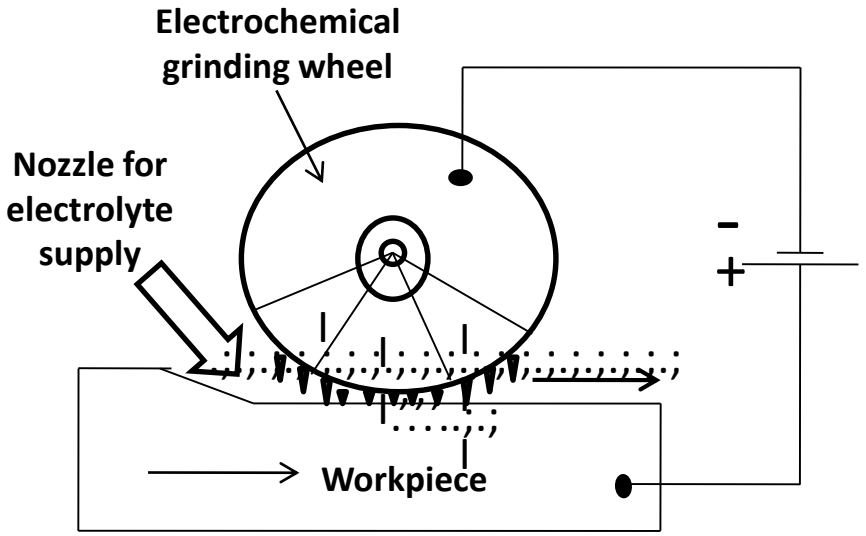
- Aims
  - To provide and insight on Electrochemical Grinding
  - To provide details on why we need ECG and its characteristics
- Expected Outcomes
  - Learner will be able to know about ECG
  - Learner will be able to identify role of ECG in todays sceneries
- Other related Information
  - Student must have some basic idea of conventional manufacturing and machining
  - Student must have some fundamentals on materials
- References
  - Dr. Sunil Pathak (Notes)

ELECTROCHEMICAL GRINDING (ECG)

ECG	=	ECM	+	GRINDING (Abrasive Machining)
(100 %)		(75 – 90%)		(10 – 25%)



- Electrochemical grinding (ECG) is a hybrid finishing process combining advantages of ECM and mechanical grinding processes to produce burr-free, stress-free and super finished components.
- Figure depicts the schematic of a simple ECG setup in which the abrasive grinding wheel is made as cathode and while the workpiece is made anode using appropriate DC power supply.
- ECG grinding wheel is similar to a conventional grinding wheel except that its bonding material is electrically conductive. Commonly used bonding materials are copper, brass, nickel, or copper impregnated resin.
- Abrasive particles protruding outside from the bonding material of the wheel maintain a constant lEG between the grinding wheel and workpiece.
- Alumina is the most commonly used abrasive with mesh size in the range of 60-80. Grinding is performed in as usual but Instead of coolant a spray of electrolyte is supplied by a nozzle.
- Both mechanical grinding and ECM take place simultaneously and the grinding wheel is sharpened easily and quickly. The electrolyte takes away the heat and the electrochemical reaction products from the machining zone.
- Mainly sodium chloride and sodium nitrate is used as electrolyte in ECG.

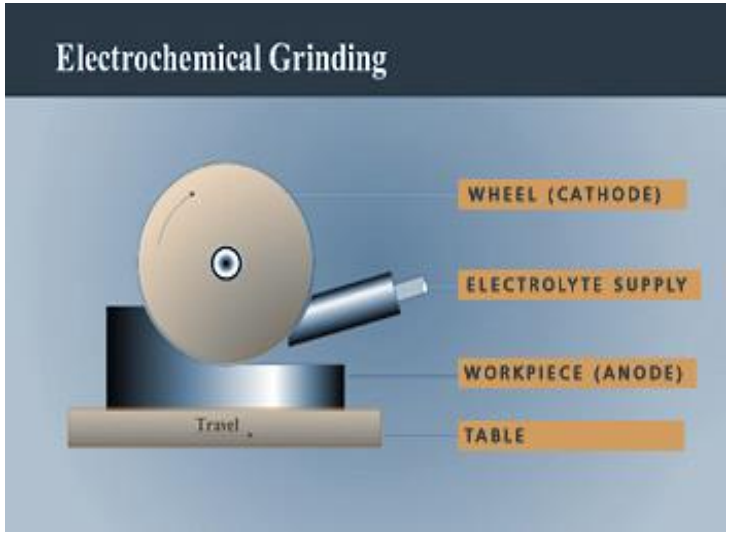


ELECTROCHEMICAL GRINDING (ECG)

Started in USA in early 1950's

1955 – first machine

Also known as electrolytic grinding



Grinding wheel spindle:

– conductors (eg: bronze, copper, graphite)

Abrasive grains:

– non-conductors (eg: diamond, aluminium oxide)

– provide gap of about 0.025 mm (25 μm)

– prevents short circuiting.

Electrolyte – applied through non-conducting nozzle

Electrolyte flow rate and pressure – low in ECG, higher in ECM

Advantages

- MRR achieved during ECG may be high as 10 times as compared to conventional grinding on hard materials having hardness up to 65 HRC.
- Excellent surface finish under controlled process parameters. Surface finish obtained by ECG ranges from 0.12 and 0.8 µm. Surface finish produced on non-homogeneous materials during ECG is better than that produced during conventional grinding.
- Minimum inside corner radius of 0.25 mm and outside corner radius of 0.025 mm can be produced by this process.
- No thermal and mechanical damage to workpiece
- Absence of work hardening
- No grinding burrs or grind lines over workpiece surface
- Absence of distortion in thin/fragile/thermo sensitive parts
- Narrow tolerances can be achieved
- Longer life of the grinding wheel
- Relatively small environmental impact because of the reuse of the electrolyte economically viable machining of high grade aerospace components made possible.

Limitations

- Process is limited to only electrically conductive materials
- Not suitable for soft materials
- Requires dressing tool preparation for the grinding wheel
- Higher power consumption
- Higher initial investment cost due to specially design and manufacture the grinding wheel
- Corrosion problem due to use of electrolyte

ELECTROCHEMICAL GRINDING (ECG)

EXAMPLES OF ECG APPLICATIONS

1. CARBIDE CUTTING TOOLS

Main **advantages**: no grinding cracks and high machining rate

Example: Cemented Carbide

- Binder is dissolved (electrolysis)
- Tough carbide is abraded

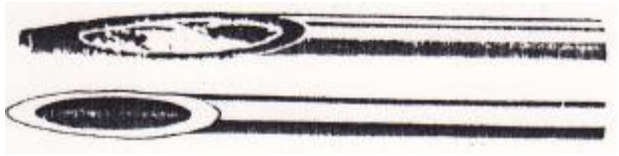
2. STEEL COMPONENTS - Especially for fragile components

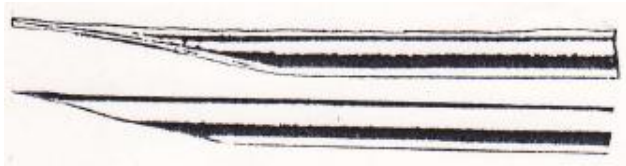
Examples:

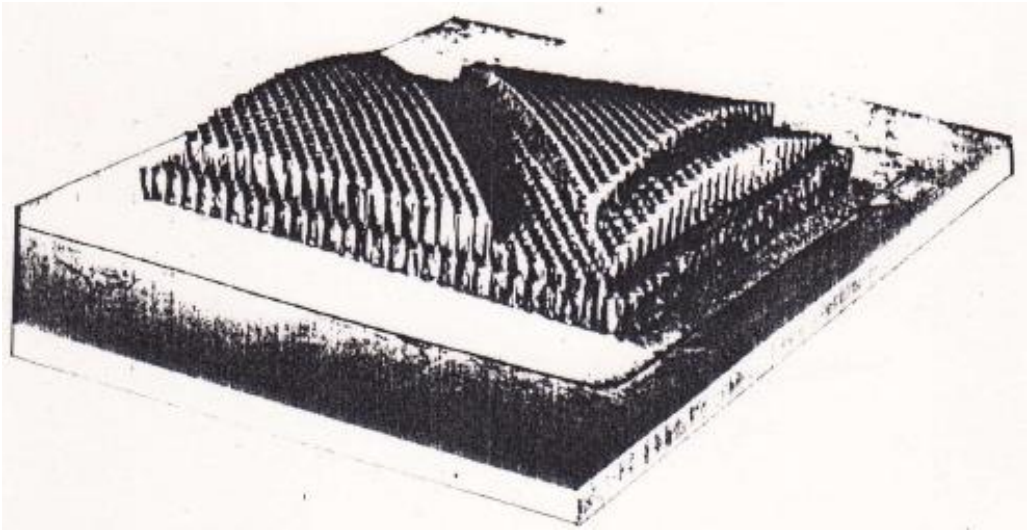
Thin-walled tube
Hypodermic needle
Medical implants
Honeycomb structure

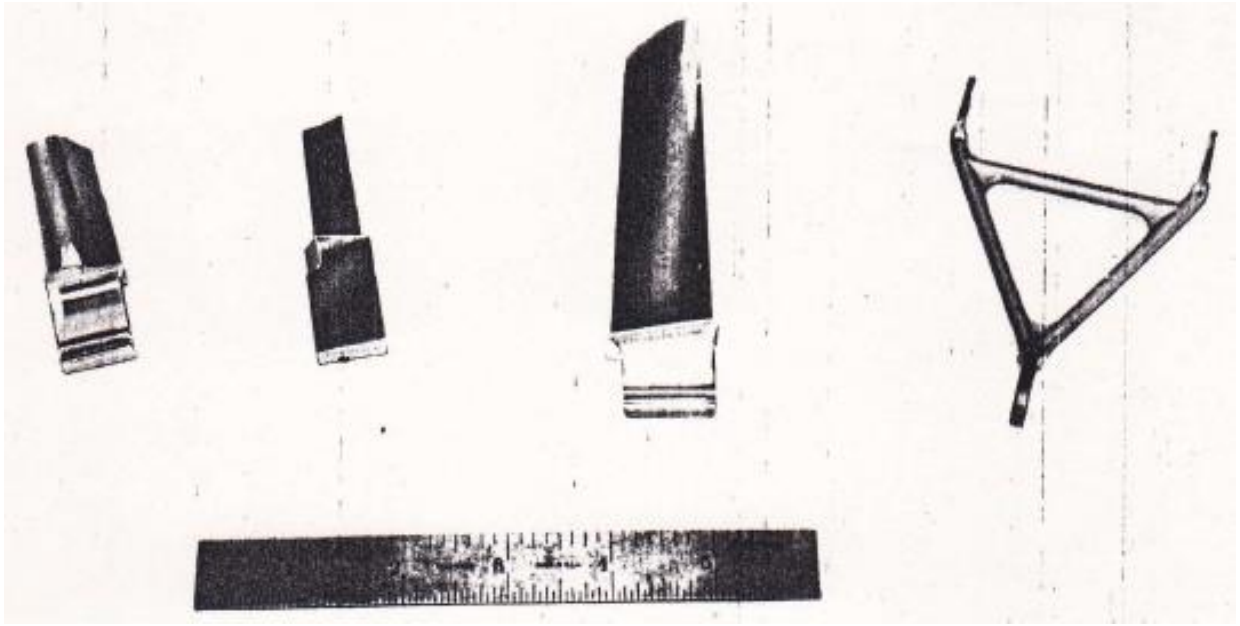
} by medical device manufacturers such as Sherwood Medical, Becton-Dickinson, and Tyco Kendall

ECG Parts









ELECTROCHEMICAL GRINDING (ECG)

EXAMPLES OF ECG APPLICATIONS

3. MARINE INDUSTRY

To remove fatigue cracks from undersea steel structures

Seawater is used as electrolyte (3.5% NaCl solution)
Specific conductivity ≈ 1/5 of typical ECM electrolyte

4. AIRCRAFT ENGINE BLADES AND VANES

Example: Form-grinding of refurbished aircraft engine blades and vanes by General Electric and Pratt & Whitney

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