Electrochemical Honing (ECH)

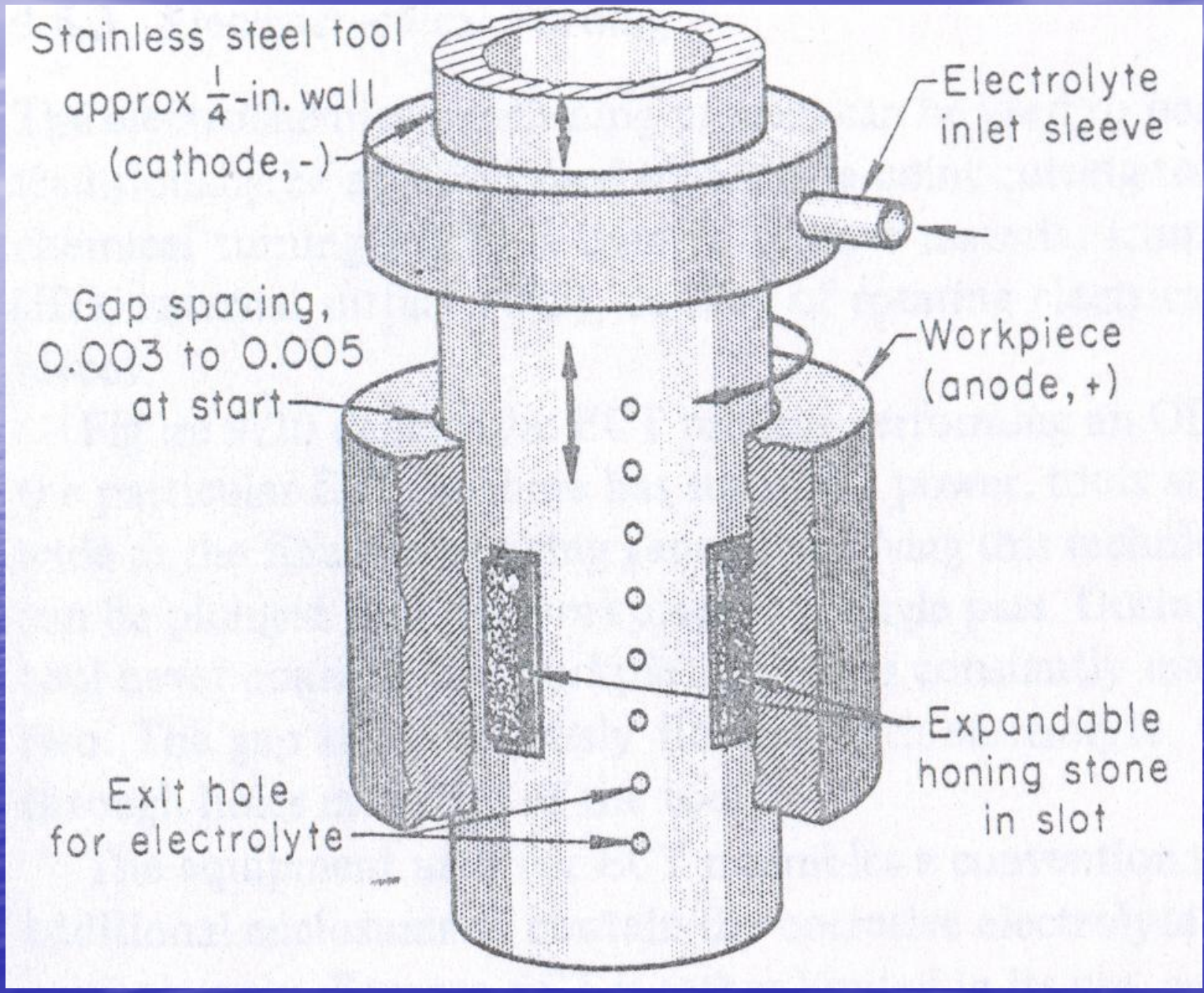
Synopsis

- Introduction
- Equipment
- Process parameters
- Advantages
- Limitations
- Applications

Introduction

- ECH is a process in which the metal removal capabilities of ECM are combined with the accuracy capabilities of honing. The process consists of a rotating and reciprocating tool inside a cylindrical component.
- Material is removed through anodic dissolution and mechanical abrasion – 8% or more, of the material removal occurs through electrolytic action
- As with conventional ECM, the workpiece is the anode and a stainless steel tool is the cathode

ECH tool construction



ECH tool construction

- Tool consists of a hollow stainless steel body that has expandable, nonconductive honing stones protruding from at least three locations around the circumference
- The honing stones are identical with those used in conventional honing operations, except that they must resist the corrosiveness of the electrolyte
- The honing stones are mounted on the tool body with a spring-loaded mechanism so that each of the stones exerts equal pressure against the workpiece
- The length of the stones is selected to be approximately one-half the length of the bore being processed

Working

- At the beginning of the ECH cycle, the stones protrude only 0.075-0.127mm from the stainless steel body, establishing the gap through which the electrolyte flows
- The electrolyte enters the tool body via a sliding inlet sleeve from which it exits into the tool-workpiece gap through small holes in the tool body
- After passing through the gap, the electrolyte flows from the workpiece through the gap at the top and bottom of the bore
- The mechanical action of the tool is the same as with conventional honing; the tool is rotated and reciprocated so that the stones abrade the entire length of the bore
- Electrolytes used in ECH are essentially the same as those used in ECM, although the control of pH, composition and sludge is less critical because the abrasive action of the stones tends to correct any resulting surface irregularities
- As in ECM, the electrolytes are recirculated and reused after passing through appropriate filtration, and the most commonly used electrolytes are sodium chloride and sodium nitrate

Process parameters

- Machines are available that deliver up to 6000 amp
- Current density at the workpiece can range from 12 to 47amp/cm2
- Working voltages are 6-30VDC
- The electrolyte is delivered to the work area at pressures of 0.5-1MPa
- ECH can remove materials at rates up to 100% faster than conventional honing, the gain being more pronounced as the material hardness increases
- Machine capacities are currently able to accommodate bore lengths up to 600mm and bore diameters from 9.5 to 150mm

Advantages

- Increased MRR particularly on hard materials
- Since most of the material is removed electrochemically, honing stone life is greatly extended
- Burr-free operation
- Unlike conventional honing, no micro-scratches are left on the work surface
- Less pressure required between stones and work
- Reduced noise and distortion when honing thin walled tubes
- Cooler action leading to increased accuracy with less material damage
- As with all ECM-based processes, ECH imparts no residual stresses in the workpiece
- Capable of achieving surface finishes of 0.05μ and dimensional accuracies of ±0.012mm
- By turning of the power to the tool before the end of the honing cycle, the stones can be used in the conventional manner to achieve tolerances of ±0.002mm and to impart a compressive residual stress in the work surface

Limitations

- High capital cost
- Corrosive environment
- High preventive maintenance cost
- Non-conductive materials cannot be machined
- Requires disposal and filtering of electrolytes

Applications

- Process is easily adaptable to cylindrical parts for trueing the inside surfaces
- Can duplicate over a number of components
- Example: 19mm dia bore of a carburized pinion gear made of 8620 steel and hardened to HRC 60-62 was hone by ECH; 0.05mm of material was removed from the bore in 4 sec with an accuracy of ±0.002mm; conventional honing required 18sec/part and consumed 300% more abrasive