ECM / PECM Technology
Polishing, Deburring,
3D Contouring
EMAG ECM GmbH
Complete solutions, design and development, contract manufacture, prototype manufacture, advisory service. Your contact for all questions on electro-chemical machining.
ELECTRO-CHEMICAL MACHINING
The process.

The electro-chemical machining process is based on the principle of electrolysis. An electrode connected to a D.C. source acts as cathode (the tool). The workpiece represents the other electrode and is poled as anode. In a watery electrolyte solution cathode and workpiece exchange a charge that machines the workpiece – without touching – at the selected point, generating contours, annular grooves, flutes or cavities – all of the highest precision. The material being removed separates from the electrolyte solution as metal hydroxide. Machining is accomplished irrespective of the metal’s microstructure and regardless of whether the material is soft or hard. The components are exposed to neither thermal nor mechanical stresses.
The different machining operations.

### ECM – Electro-Chemical Machining

<table>
<thead>
<tr>
<th>Operation</th>
<th>Technologies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stationary cathode</td>
<td></td>
</tr>
<tr>
<td>Deburring</td>
<td>DC (Direct Current) or pulsed ECM</td>
</tr>
<tr>
<td>Polishing</td>
<td>Pulsed ECM</td>
</tr>
<tr>
<td>Recessing the surface</td>
<td>Pulsed ECM</td>
</tr>
<tr>
<td>Cavity</td>
<td>DC or pulsed ECM</td>
</tr>
</tbody>
</table>

### PECM – Precise Electro-Chemical Machining

<table>
<thead>
<tr>
<th>Operation</th>
<th>Technologies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cathode with infeed and mechanical oscillation</td>
<td></td>
</tr>
<tr>
<td>Precision profile</td>
<td>Pulsed ECM</td>
</tr>
</tbody>
</table>

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<thead>
<tr>
<th>Operation</th>
<th>Technologies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cathode with infeed</td>
<td></td>
</tr>
<tr>
<td>Drilling</td>
<td>DC or pulsed ECM</td>
</tr>
<tr>
<td>2.5D countersinking</td>
<td>DC or pulsed ECM</td>
</tr>
</tbody>
</table>
Electro-chemical machining – Great precision and highly cost-effective.

ECM – Electro-Chemical Machining is the generic term for a variety of electro-chemical processes. ECM is used to machine workpieces by electrolytically dissolving the metal. The process is used in aerospace engineering and the automotive, medical equipment, microsystem and power supply industries. Almost all kinds of metal can be electro-chemically machined, even high-alloyed nickel- or titanium-based ones, and so can hardened materials. As it is a contactless procedure with no heat input, the process is not subject to any of the disadvantages experienced with conventional machining methods, e.g. tool wear, mechanical stresses, micro-fissures caused by heat transfer, surface oxidation or the need for subsequent deburring operations. All electro-chemical machining processes are characterised by stress-free stock removal, gentle transitions and smooth surfaces without burr formation.
The advantages of electro-chemical machining

- Low-level tool wear (cathode), an ideal precondition for batch production
- Surface finishes of up to Ra 0.05
- Precise machining
- No negative thermal and mechanical effects, thus no changes in the material’s microstructure
- The material properties are not affected
- Hardness, toughness and magnetic qualities of the material remain unchanged
- Possibility to machine diminutive and thin-walled contours
- A high degree of repeat accuracy in the machining of the surface structure
- Simple but highly efficient production process; no need for subsequent deburring or polishing
- Rough-machining, finish-machining and polishing in a single operation
- Possibility to machine superalloys
- Possibility to simultaneously machine macro and micro structures
Basic Standard / Basic Integrated.

On the ECM Standard Machining System "Basic Standard / Basic Integrated" the operator loads and removes the workpieces from the ECM unit by hand. A two-handed control button operation activates the ECM process that carries out the repeatable deburring operation.
A stainless-steel and plastic construction with a manual workstation of ergonomic design forms a solid basis, equipped – in its standard version – with:

- Operator-friendly Siemens control S7-300 with graphic panel
- Current relay and voltage monitor
- pH-value control and conductance monitor
- Temperature control
- Machining area: 1,150 x 950 mm
- Two-handed control button operation

Optional equipment on request
The Comfort Standard / Comfort Integrated represents the optimal introduction to the automation of ECM processes.

- Modular machine concept
- Intelligent software and hardware interfaces
- Starting with manual / semi-automatic operation, the system is quickly upgraded to full automation

The CS / CI contains as standard:

- Siemens touch-screen panel
- Scalable generator technology
- Conductance monitor
- Temperature control
- pH-value control with acid metering
- Quill clamping surface: 1,150 x 950 mm
- Quill stroke with safety interlock
- Two-handed control button operation
- Automation interfaces included
The Comfort stand-alone machine forms the basis of a modular automation concept. It saves on capital outlay, as further investment is only required when an increase in production calls for the link-up of a number of processes (e.g. pre-cleansing, ECM station 1, ECM station 2, secondary treatment).
PECM Premium.

PECM system based on a modularly upgradeable machine tool concept.

- High degree of positioning accuracy
- Precision oscillator
- Graphic visualisation with ergonomic operator interface

The PECM Premium shortens the process stream and provides viable solutions for difficult metalworking applications.

Highlights:
- Precision imaging in 2.5D
- Great repeatability of lowering speeds
- Surface finishes up to Ra 0.05

The excellent repeatability of the PECM process on the Premium series is a result of the intelligent machine concept and the patented process control.
ECM / PECM subcontracting service.

In the course of the continuing expansion of their business activities EMAG ECM offers subcontracting services in ECM / PECM technology, covering anything from specials to batch production, including automation.

PECM laboratory.

The PECM laboratory is equipped to optimise the process to suit individual customer requirements. Trials determine how a variety of component geometries can be machined at an advantageous cost-benefit ratio.

Range of services:

- Design and development of fixtures
- Material testing
- Development of and support in developing new products
- Process optimisation
- Process and cycle time analyses
Technical Data.

<table>
<thead>
<tr>
<th>Capacity</th>
<th>BS</th>
<th>BI</th>
<th>CS</th>
<th>CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machining area</td>
<td>1,150 x 950</td>
<td>1,150 x 950</td>
<td>1,150 x 950</td>
<td>1,150 x 950</td>
</tr>
<tr>
<td>Vertical travel</td>
<td>–</td>
<td>–</td>
<td>300</td>
<td>300</td>
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</table>

Power rating / equipment specification

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<tr>
<th></th>
<th>DC</th>
<th>30–60 V / 200–5,000 A</th>
<th>30–60 V / 200–5,000 A</th>
<th>30–60 V / 200–5,000 A</th>
<th>30–60 V / 200–5,000 A</th>
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<tbody>
<tr>
<td>Pulsed</td>
<td>max. 20,000 A</td>
<td>max. 20,000 A</td>
<td>max. 20,000 A</td>
<td>max. 20,000 A</td>
<td>max. 20,000 A</td>
</tr>
<tr>
<td>Electrolyte</td>
<td>NaNO3 / NaCl</td>
<td>NaNO3 / NaCl</td>
<td>NaNO3 / NaCl</td>
<td>NaNO3 / NaCl</td>
<td>NaNO3 / NaCl</td>
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<tr>
<td>Operating pressure</td>
<td>10 bar</td>
<td>10 bar</td>
<td>10 bar</td>
<td>10 bar</td>
<td>10 bar</td>
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<tr>
<td>Automation</td>
<td>possible</td>
<td>possible</td>
<td>possible</td>
<td>possible</td>
<td>possible</td>
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<tr>
<td>NC drive</td>
<td>option</td>
<td>option</td>
<td>option</td>
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<td>option</td>
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<tr>
<td>Retraction unit</td>
<td>–</td>
<td>–</td>
<td>option</td>
<td>option</td>
<td>option</td>
</tr>
<tr>
<td>Extraction system</td>
<td>–</td>
<td>–</td>
<td>option</td>
<td>option</td>
<td>option</td>
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</table>

Measurements

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<tr>
<th></th>
<th>–*</th>
<th>3,400</th>
<th>–*</th>
<th>3,400</th>
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<tbody>
<tr>
<td>Length</td>
<td>3,400</td>
<td>2,000</td>
<td>2,700</td>
<td>2,700</td>
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<tr>
<td>Width</td>
<td>2,000</td>
<td>2,700</td>
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</table>

Electrolyte supply

<table>
<thead>
<tr>
<th></th>
<th>1,000–2,700</th>
<th>1,000</th>
<th>1,000–2,700</th>
<th>1,000</th>
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<tbody>
<tr>
<td>Temperature measure</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
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<tr>
<td>pH-value measure</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Conductance measure</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
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<tr>
<td>Acid replenishment</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
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<tr>
<td>Cooling system</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Filtration</td>
<td>Chamber filter-press / microfiltration / filter cartridge **</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

* dependent on installation
** dependent on application

<table>
<thead>
<tr>
<th>Measurements</th>
<th>Tank capacity</th>
<th>Side A</th>
<th>Side B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1,000 litre</td>
<td>2,100 mm</td>
<td>1,150 mm</td>
</tr>
<tr>
<td>2</td>
<td>1,600 litre</td>
<td>3,100 mm</td>
<td>1,150 mm</td>
</tr>
<tr>
<td>3</td>
<td>2,700 litre</td>
<td>3,500 mm</td>
<td>1,750 mm</td>
</tr>
</tbody>
</table>
Manual machining

Loading by robot

Loading with linear handling system

I - ECM machine
II - Electrical cabinet
III - Machining area
IV - Secondary cleaning
V - Secondary preservation
VI - Preliminary purification
VII - Robot
VIII - Linear handling system
Technical Data.

Floor plan BI

Measurements in mm

Floor plan BS

Measurements in mm

Subject to technical changes
Floor plan CI
Measurements in mm

Floor plan CS
Measurements in mm

Subject to technical changes
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