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Electro Chemical Machining

Chris Ivana*

Department of Industrial Engineering and Management, Centre for Management Studies, Spain

Description

The term machining refers to the removal of any substance, whereas the term electrochemical refers to the energy source. Electrochemical machining is the result of the combination of these two terms. Electrochemical machining is a technique for removing metal using an electrolysis process. Because metal is deposited on the surface of the workpiece in electroplating, whereas metal is removed from the workpiece in electrochemical machining, the electrochemical process is sometimes known as the reverse of electroplating. This method is used to mass-produce machined items on a huge scale. Electrochemical machining is a modified but distinct technology that can be traced back to Russian chemist E. Shpitalsky's invention of electrolytic polishing in 1911. In the year 1929, W. Gusset experimented with ECM. An engineering firm popularized the use of electrolysis for the removal of metals in 1959. With the passage of time, the ECM technology improved even more. Faraday's law of electrolysis underpins the electrochemical machining process. When two electrodes, anode (+ve) and cathode (-ve), are positioned in an electrolyte, the mass of the metal deposited on the cathode from the anode is precisely proportional to the potential difference applied across the electrodes, according to Faraday's equation of electrolysis. The electrolyte is NaCl, the workpiece is the anode, the tool (desired shape) is the cathode, and a voltage difference is applied.

An electrolyte is a salt solution used to keep the workpiece and tool cool throughout the machining process. Between the workpiece and the tool, it serves as a current-carrying medium. It also works as a coolant, protecting the tool and the workpiece from overheating by removing waste products from internal crevices. Sodium chloride (NaCl), sodium nitrate ($NaNO_3$), hydrochloric acid (HCl), and other electrolytes are utilized in ECM. One of the electrodes in ECM is the tool or cathode. It's also the shape that the workpiece should be cut into. In ECM, the tool should always have precise dimensions. The mechanical system is one of the most significant aspects of ECM. It's used to move a tool that's perpendicular to the workpiece and moving at a steady speed. The electrolyte, tool, and workpiece are all kept in the tank. This is where all of the reactions take place. The pressure of electrolytes delivered to the tool is measured using a pressure gauge. The flow of electrolyte delivered to the tool is controlled by a flow control valve. The pressure relief valve opens when the electrolyte flow pressure exceeds a particular limit, and the electrolyte is returned to the tank. Hard materials are machined using the electrochemical machining method. Electrochemical machining is used to machine materials that are difficult to machine using traditional methods [1-3].

Electrochemical machining, unlike any other machining method, produces no tensions since there is no contact between the tool and the workpiece. Electrochemical machining produces very little heat because there is no friction involved. If a little quantity of heat is generated by ion movement, the heat is absorbed by the electrolyte in which the workpiece is immersed. Because electrochemical machining involves no friction and produces no heat, the tool is not subjected to any pressures, resulting in no tool material wear and tear. When electrochemical machining is used, the surface finish is outstanding. This machining method can produce surfaces with a mirror-like polish. This is due to the atomic level removal of material. In most industries, accuracy is crucial. Because the electrochemical process involved in ECM works on atomic levels, we can achieve precise dimensions with the use of ECM. When compared to other machining methods, electrochemical machining equipment is substantially more expensive. In the case of ECM, the cost of maintenance is likewise considerable. Metals are usually the parts that are machined with ECM. Metals are electropositive and corrode when they come into touch with a liquid, as we all know. As a result, the electrolyte has the potential to corrode the metal workpiece. An ECM system is made up of a number of different components. An ECM system necessitates a wide area due to the numerous intricate operating parts. As a result, installing the system in a compact space is tough. Electrolytes can be reused for a limited number of cycles. After a given period of time, the electrolyte and slug created in the process must be disposed of. The waste materials generated during the ECM process are extremely hazardous to dispose of. A method based on electrical discharges in electrolytes has been created, allowing metal erosion as well as ECM in that medium. Electrochemical arc machining is the name given to this method because it relies on the initiation of arcs rather than sparks (ECAM). An arc is a stable thermionic phenomenon, while a spark is a brief and loud discharge between two electrodes. Sparks are defined as discharges with a period of 1 second to 1 millisecond, whilst arcs are defined as discharges with a duration of less than 0.1 second [4,5].

Conflict of Interest

None.

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***Address for Correspondence:** Ivana Chris, Department of Industrial Engineering and Management, Centre for Management Studies, Spain; E-mail: IvanaC@im.edu*

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