NEW TRENDS IN ELECTRO CHEMICAL MACHINING AND FEATURES OF HYBRID ECM

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Abstract: Electro chemical machining process consists of an identical features which offer a better performance in producing complex shaped macro and micro features. Electrochemical Machining (ECM) gives a conservative and powerful technique for machining high quality, heat safe materials into complex shapes. ECM is performed without physical contact between the instrument and the workpiece rather than the mechanical machining. This paper describes about the features of ECM process such as electro chemical machining process, process modelling, process control and monitoring, electrolytes, tools and hybrid ECM.

Keywords: ECM, electrolytes, tools.

Introduction

Electrochemical machining (ECM) is a machining procedure in which electrochemical process is utilized to expel materials from the workpiece. All the while, workpiece is taken as anode and tool is taken as cathode. The two anodes workpiece and device is inundated with an electrolyte, (for example, NaCl). At the point, when the voltage is connected with the two anodes, the material expulsion from the workpiece begins. The workpiece and device is set near each other without touching each other. In ECM, the material evacuation happens to nuclear level so it delivers a mirror complete surface. The ECM is mainly used in Die-sinking operations, Drilling jet engine turbine blades, Multiple hole drilling, Machining steam turbine blades of close limits. Electrochemical machining (ECM) is a viable strategy for handling hard to-cut materials. There are many variables which impact the expulsion rate and the machining exactness, and the component has not been uncovered well on account of the multifaceted nature of machining process [1- 2].

Electro chemical machining

Electrochemical machining (ECM) is a nontraditional machining process in which material is evacuated by the component of anodic disintegration during an electrolysis procedure [3-4]. A D.C. voltage (10-25 volts) is applied for pre-molded cathode device and an anode workpiece. The electrolyte (e.g. NaCl watery arrangement) streams at high speed (10-60 m/s) through the inter electrode gap (0.1- 0.6 mm) between cathode and anode. The present thickness are typically 20 to 200 Amperes per cm square. The anodic disintegration rate, which is administered by Faraday's laws of electrolysis, relies upon the electrochemical properties of the metal, electrolyte properties and electric current/voltage provided. ECM creates an estimated identical representation of the instrument on the workpiece [5]. Pulse electrochemical machining (PECM) is a variety of ECM where a pulsed control is utilized rather than DC current. PECM prompts higher machining exactness, better process steadiness and reasonableness for control. These focal points are because of the enhanced electrolyte stream conditions , improved limitation of anodic disintegration, little and stable holes found in PECM[6-7] ECM processed component has been utilized as a part of building up a pulse/pulse reverse approach to deal with electro-cleaning and intensive cover electro-drawing applications such as fluid control valves, radio frequency cavities[8].

ECM process modelling

In ECM and its variation forms, it is fundamental to assess the anode material evacuation thickness at guaranteed time increased. The material expulsion thickness is a capacity of current density of the hole by varying the electrical conductivity of the electrolyte. The electrolyte properties rely upon the temperature, gas bubble arrangement, the speed and pressure fields other than current thickness [9]. Numerical modeling on the ECM process considering the hydrodynamics engaged with the process was contemplated [10]. The end anode shapes in ECM utilizing a triangular molded cathode was demonstrated for this examination. A comparative model for bend cathode considering electrolyte condition over bend surfaces was demonstrated [11]. Recreation of the heat and utilization of the electrolytic stream was studied [12]. It was discovered that an empty cathode and pulse voltages offer to heat. Numerical process of the ECM procedure considering the temperature impacts was studied [13-14].

Process control and monitoring

The cathode hole is a basic parameter that should be controlled during the machining procedure in ECM. Setting and keeping up a little yet stable hole estimate for ECM is critical to accomplish better dimensional exactness and control [15]. Current and voltage signals are the reason for the gap checking in a few of the control methods utilized for ECM [16-19].ECM parameters mainly depend on the human experience and focuses the process automation which includes the artificial neural networks [20-22].Metals, semiconductor are machined using ECM [23].The gap width of ECM process is mainly depending on charging time constant and pulse duration which is estimated as 20nm [24]. An investigation into ECM, produced surface attributes to titanium uncovered that higher rates of electrolyte stream brought about enhanced material evacuation rate and better surface finish [25].

Electrolytes

The electrolytes in ECM, rely upon the sort of material to be machined. Acidic, essential and unbiased watery arrangements have been utilized as electrolyte in ECM [26]. The NaNO3 aqueous solution is used an electrolyte for the solubility of the metal debris [27]. The ecological concerns emerging from the utilization of toxic electrolytes are one of the constraining components of ECM in the business. Earth well disposed ECM uses nontoxic electrolytes like water [28]. Tungsten carbide composites are machined using basic and impartial arrangements due to the development of passive oxide layer in acidic arrangements [29].

Tools

Shaped and unshaped tools are the two varieties mainly used. The primary variety of ECM sinking are steady state process. In this procedure the device profile is a 3-D negative picture of the required surface profile. The device is permitted to soak in to the work piece at a steady state rate until the point when the required shape is acquired on the work piece. Another variety is the ECM molding process. In this procedure all-inclusive straightforward formed device (e.g. barrel shaped or round) is moved along a predetermined way to get the required state of the work piece. ECM had a property of high electrical, thermal conductivity, corrosion resistance. Titanium, tungsten carbide and copper are some of the tool materials used [30]. In order to avoid electrode deformation in machining process, tungsten is used as a tool electrode so that high electrical and thermal property is achieved [31]. One of the significant preferences for ECM is the adaptability of the procedure with the utilization of various cathodes on the same machining setup. ECM performing different anodes machined to machine varieties of smaller scale openings was examined [32]. Stream electrochemical machining (JECM) is a variety of ECM where the electrolyte is pumped through a nozzle. DC control is provided for the nozzle and the workpiece with the current being exchanged by the stream electrolyte. Convoluted shapes were machined in the movement towards the nozzle [33].

Hybrid ECM

ECM has been joined with a few others machining procedures to empower enhanced machining qualities. The hybrid machine comprising of electro release machining (EDM), electrochemical machining (ECM) and mechanical processing was created [34]. The blend of EDM and ECM forms on the same setup is fit for producing complex and exact 3 dimensional structures [35]. In Laser helped ECM a laser bar is centered on a region presented to the electrolyte jet, which breaks for a particular district enhancing exactness and surface harshness. This procedure additionally reports a higher material expulsion rate because of temperature increment in the area directed by the laser beam [36]. In rough ECM, abrasives like silicon carbide are suspended openly in the electrolyte in the region of the work piece. These abrasives alongside a wire cathode are in charge of cutting silicon wafers with better generation rate, less cost and great surface integrity [37]. Ultrasonic electrochemical machining includes vibrating the device cathode to disturb the abrasives suspended in the electrolyte for a good surface finish. An investigation into the geometry and kind of the cathode which gives a much cleaned surface is accounted and the impact on ultrasonic vitality is recognized [38].

Summary

The recent progressions in different areas of electrochemical that reflect the cutting edge in the process are exhibited in this paper. ECM innovations have been effectively used to create large scale, smaller scale parts with complex highlights and high viewpoint proportions for biomedical and different applications.

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