Experimental Investigation of Electromechanical Machiing and Optimization of Process Parameters Using Aluminium Alloy 7075 Electrode

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Abstract –

Electrochemical Machining Is Often Used For Shaping Intricate Or Non-Metallic Forms But Complex To Machine Processes. EC Is Commonly Relevant In The Aeronautics, The Security Business. It Is A Common Commodity For Aerospace Owing To The Excellent Combination Of Properties And Low Density In The Aluminum Alloys. The Ultimate Goal Of The Experimentation Is To Discover The Highest MRR And The Optimal Surface End. In This Investigation, Parametric Analysis Of ECM Was Performed To Congregate The Criteria Of Proficient Micromachining. Most Relevant Process Parameters In ECM Are Machining Voltage, Electrolyte Concentration, And Time-Pulse. Micro Machining Was Observed Under Material Removal Rate (MR) And Machining Conditions Where The Cut Diameter Was Decreased. The Final Results Of This Study Showed That Processing Voltage And Electrolyte Concentrations Are Very Significant.

The Optimal Parameter Obtain Is Voltage 15V, Feed Rate 0.9 Mm/Min, Electrolyte Concentration 20 Percent. Aluminium Alloy 70 Underwent The Electrochemical Machining Validation Inspection.

Key Words: MRR, SR, Taguchi, ECM, Grey Relational Analysis.

1. INTRODUCTION:

An Unconventional Production Process Uses Only Mechanical, Electrical, Thermal, Or Chemical Assembly Techniques To Achieve Its Goal. Manufacturing Or Non-Traditional Methods Prevent The Use Of Sharp Cutting Tools

The Reverse Phase Of Electrochemical Plating Is The Electro-Chemical Machining, Which Is A Regulated Anodic Electrochemical Atomic Level Dissolution Process. The Steel Component Is Made Conductive By Employing A Shape-Generating Method, Where The Electrical Current Flows Utilizing An Electrolyte (Acidic Or Basic). The Anodic Dissolution Within Electrolyte Cell Is Used To Dissolve The Work-Piece Metal (Anode) In A Regulated Manner Utilizing A Method (Cathode) (Cathode). The Cell Passes The Current, While The Electrolyte Is Pumped Between The Tool Across The Crack, And Dissolves The Work-Piece Wire. Electrochemical Plating Is Commonly Used In Manufacturing Operations On Metals, Both Hard And Soft.

Emmold Is Widely Used For Heavy Metal Parts These Days, Hard Surfaces Such As Ceramics And Strong Alloy Steels Have Also Seen Greater Use In Metallurgy Micro-Machining Neither The Cutting Tips Nor The Workpiece Are Negatively Impacted By Electrochemical Machining (EDM). Of Late, Multiple R&D Activities Have Disclosed That EMM Is A Possible Technique With Flexibilities In Micro Electromechanical Systems (MEMS) And In Some Advanced Manufacturing Domain. There Are Several Contending Innovations, Such As Micro EDM, Ion Beam, And Laser Beam Machining, With

Good Removal, Cost Effectiveness, But The Latter Has The Clear Advantage That It Doesn't Need Any Specialised Equip. EMM Is One Of Among The Most Widely Followed Manufacturing Techniques In Electronics Industry, Aircraft Industry, Automotive Industry And In Medical Sector As Well For A Variety Of Applications That Involve Production Of Metallic Components, Pcbs, Semiconductor Chips, Cooling Holes In Jet Turbine Blades And In Surgical Implants.

2. Materials And Methods

2.1. Selection Of Work Piece Material

The Workpiece Is Drawn From The Most Genuine Of The ALUMINIUM 7075 Material And The Measuring Piece Is AL The Percentage Of Composition Of ALUMINIUM ALLOY 7075 Is Seen In Table 1. ALUMINIUM ALLOY 7075 Dissolved In Purified Water Is Chosen As Electrolyte Put In A Still Bath And Therefore During Machining Phase, Electrolyte Flow Is Not Calculated. The Drill Tool Is Copper Metal. Approximately 0.5 Mm Of Wire Was Wound And Fixed In A Copper Toolholder When It Was Being Machined

Table 1: Summary Of Mechanical Properties For 7075 Aluminum Alloy.

Mechanical Properties	Metric	English
Ultimate Tensile Strength	572 Mpa	83000 Psi
Tensile Yield Strength	503 Mpa	73000 Psi
Shear Strength	331 Mpa	48000 Psi
Fatigue Strength	159 Mpa	23000 Psi
Modulus Of Elasticity	71.7 Gpa	10400 Ksi
Shear Modulus	26.9 Gpa	3900 Ksi

The Electrochemical Machining Is Carried Out In The Following Setup With Three Subsystems, Namely, Electrolytic Bath And Circulation System, Tool Feed System And Inter Electrode Gap Control System, Shown In Fig. 1.

Fig. 1. Electrochemical Machine Setup.

2.2 Applications Of 7075 Aluminum

Kind 7075 Aluminum Is An Aluminum Alloy Of Exceptional Strength. The Material Has A High Tensile Strength (Above 500 Mpa) And Low Density, Which Is An Asset For Aerospace Uses, Such As Aircraft Components. Although Alloys (Like

5052 Aluminum Alloy) Are Much Less Corrosion Resistant, The Amount Of Strength That They Retain More Than Makes Up For That. Are Used For Airplanes, Jets, Piston Aircraft Engines, Turbopropropressors, And Turboshafts
If The Helicopter Blades Rotate At 200 Feet A Minute In A Headwind Of Just 5 Miles Per Hour, The Net Speed Is 320 Miles Per Hour.

- Rocket-Engine Parts
- Valve Management
- Thrithing
- Applications In Aerospace And Security

As Shown In Figure 2, The Technique For This Inquiry Would Be Used

Additional Input Parameters Include Power Supply For ECCM And Inter Electrode Diameter Difference Varying From 15 To 20 Micrometers

• Response Parameters Include Conicity, MRR And Overcut, Where
- Conicity = $((D_{ENTRY} - D_{EXIT})/2H) \times 100$
  Where D_{ENTRY} Is The Hole Entry Diameter (Mm), D_{EXIT} Is The Hole Exit Diameter (Mm) And H Is The Workpiece Thickness.
- MRR = $(W_B - W_A)/T$
  Where W_B Is The Weight Before Work Piece Machining, W_A Is The Weight After Work Piece Machining And T Is The Machining Time.
- Overcut Is The Difference Between Mean Diameter Of Hole At Entry Point And The Diameter Of Tool.
- Duty Ratio = $T_{ON}/(T_{ON} + T_{OFF})$

• Set 1: Duty Ratio = 0.6

Set 2: Duty Ratio = 0.7
Set 3: Duty Ratio = 0.8

2. Experimental Procedure

2.1 Experimental Setup:

Several Experiments On The ECMAC (METEC) Electrochemical Machining Equipment Are Shown In The Accompanying Figure. Machining Device, Electrolysis Chamber, Control Panel, And Electrolyte Circulation Are Important Components Of The ECM. The Task Is Pre-Machined And Hermetically Sealed To Ensure That No Liquid Will Get Into The Work Area, Providing A Gap That Allows Inspection Of Machining Work Progress. The Machine Should Be Set Up Such That Press Buttons Are Brought Close The Work, And Specific Gaps Can Be Maintained As The Control And Table Are Lifted. The Tool Advancement Is Operated By A Servo And Can Be Controlled By A Micro-Programmable DC Motor. Then, The Parameters Such As The Tool Feed Rate, Voltage, And Timer Are Defined For The Operation. The Electrolysis Mechanism Begins With The Use Of A Specialized Filling Device, Called An An An Anode Cathode Pump, Which Simultaneously Introducing A Potential Difference Between The Anode And Cathode. To Change The Electrolyte Flow, Use The Flow Control Valve.

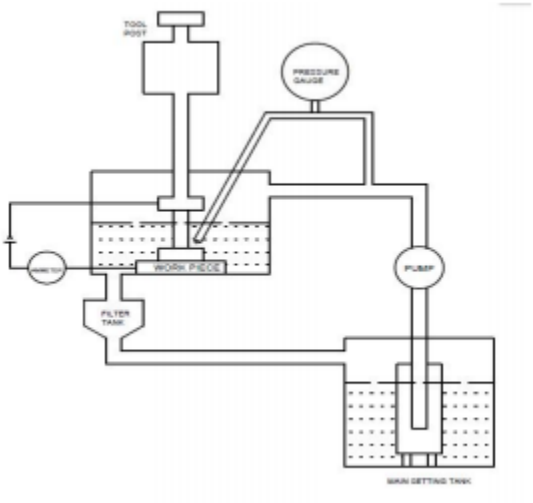

Figure-2. Electrochemical Micro Machine.

2.2 Work Piece Material, Tool Material And Electrolyte:

An Aluminium Alloy Block 50×40×11 Mm In Size Is Chosen For The Electrochemical Machining Because Of Its Excellent Corrosion Resistance And Strength. The Thermal Conductivity Of 7075 Aluminum Alloy Is Approximately 130-180 W/M-Cm And Density Is Approximately 2.81 G/Cm3 KCI Serves As An Electrolyte And Copper Is Used As A Weapon.

2.3 Selection Of Machining Parameters And Their Level:

In This Experiment, The Variables Under Experiment Regulation Are The Voltage, The Feed Intensity, And The Electrolyte Concentration. The Taguchi Orthogonal Array Is Used, Which Has Nine Tests In Nine Orders. Parameters That Describe The Process And Their Order

	Process parameter	Level 1	Level 2	Level 3
A	Voltage	15	18	21
B	Tool Feed	0.3	0.6	0.9
C	Electrolyte concentration	10	15	20

Table 2 Experimental Observation

Sr No.	Voltage	Feed rate	Electrolyte conc(%)	MRR gm/min	Roughness (Ra)
1	15	0.3	10	0.1	1.838
2	15	0.6	15	0.188	4.8
3	15	0.9	20	0.286	3.023
4	18	0.3	15	0.101	2.564
5	18	0.6	20	0.134	3.986
6	18	0.9	10	0.169	5.7
7	21	0.3	20	0.16	1.93
8	21	0.6	10	0.146	4.614
9	21	0.9	15	0.298	4.3

6. Conclusion:

An Experiment Was Conducted To Determine The Dominant Parameters And Their Function In MRR And SR Of Aluminium 7075 Alloy. The Optimum Values Were Calculated According To The Gray-Tag Procedure. Biotransfer Device Voltage, Electrolyte Concentration, And Feed Rate Have Been Referred To As Machining Parameters, And Roughness Has Been Selected As The Result Of The ECM Process. The Best Possible Parameters Have Been Discovered Alternating Current: 15 V 0.9 Mm/Min Electrolyte Concentration: Measurement Of The Quantity Of An Electrolyte, Such As Sodium Or Potassium, Which Contains 20% Of The Total.

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