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Optimization of MRR on ECM Using Taguchi Method

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Abstract: Non-conventional machining has grown out as the need to machine different engineering materials, composites and ceramics having good mechanical properties and thermal properties as well as better electrical conductivity. The work has been carried out on mild steel specimen having good thermal and electrical conductive properties. The work on output parameters like as Material Removal Rate (MRR) and Surface Roughness (SR) of stainless steel as a work piece material. Respect on the selection of input parameters of ECM such as Voltage, Electrolyte Concentration and feed rate are suitable for improving the productivity and other output parameters. This work formulates the relationship between input and output variables for improving the ECM operation. The Regression analysis is used for making the relationship between independent and dependent variables. Our main objective is to determine the optimal value of the process parameter commonly used in the ECM process which is Voltage, Electrolyte Concentration and Feed Rate so as to improve the output parameter such as Material Removal Rate and Surface Roughness by Minitab Taguchi optimization technique method.
Keywords: ECM, MRR, SR, Regression analysis, Taguchi optimization technique.

I. INTRODUCTION

Electro-chemical Machining (ECM) is one of the most potential unconventional machining processes. This process generally belongs to a category called as electro-chemical category. ECM process may be considered as the antonym or opposite of electro-chemical process or electro-chemical displacement process. Thus a guided anodic dissolution at very molecular level of the work piece that is electrically conductive in nature by any tool respective of flow of high current at closely low potential difference with the flow of an electrolyte which is generally conductive neutral brine or NaCl salt solution is referred as Electro-chemical process.

II. EXPERIMENTAL WORK

For this experimental analysis, the total work is done out by Electrochemical Machining set up at SunMax Auto Engineering Private Ltd. , Manesar, Gurgaon, which is having Supply of - 425 v +/- 11%, 3 φ AC, 51 Hz.

III. PROCEDURE OF THE EXPERIMENT

Before starting the experiment the initial weight of the work piece is taken to calculate the MRR. Precaution has been taken so that end tip of the electrode should not come in contact with the surface of the work piece. The time of machining of the work-piece at fixed feed and voltage V is noted down during the through process.

A. Observation tables: Experiment No.1: - Taguchi design (mild steel)

S.no.	Voltage (V)	Feed F (mm/min)	Concentration (C)	MRR (mm3/min)	SR (µm)
1	8	0.2	12	0.0129000	5.20
2	8	0.4	14	0.0345700	6.91
3	8	0.6	16	0.0856000	9.20
4	10	0.2	14	0.0166500	7.20
5	10	0.4	16	0.0540600	7.00
6	10	0.6	12	0.0852000	9.60
7	12	0.2	16	0.0132243	6.60
8	12	0.4	12	0.0232400	10.25
9	12	0.6	14	0.0515180	11.23

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B. Calculation of Material Removal Rate (MRR)-

MRR is calculated by the following formula:-

$$MRR = \frac{(W_0 - W_1) \times 10^3}{\rho_w \times \text{time}} \ mm^3/\text{min} \qquad (4.7)$$

MRR = Material removal rate
W_0= initial weight
W_1 = final weight
ρ_w = density of the workpiece

C. Calculation of Surface roughness (SR)-

Surface roughness is measured by Handysurf E35B tracing driver profilometer.

IV. RESULTS & DISCUSSIONS

A. Effects on the value of MRR by S/N ratio

Electrolyte concentration, feed rate and voltage are the dominant factor on the value of MRR. Effects of different input machining parameters on MRR (and means of MRR) are shown in fig.1. When increasing the feed rate, The MRR value is increasing slightly. After that the factor which affects the MRR value the most is feed rate. But MRR increases with increases in concentration then increases furthermore with a faster rate with further increase in electrolyte concentration.

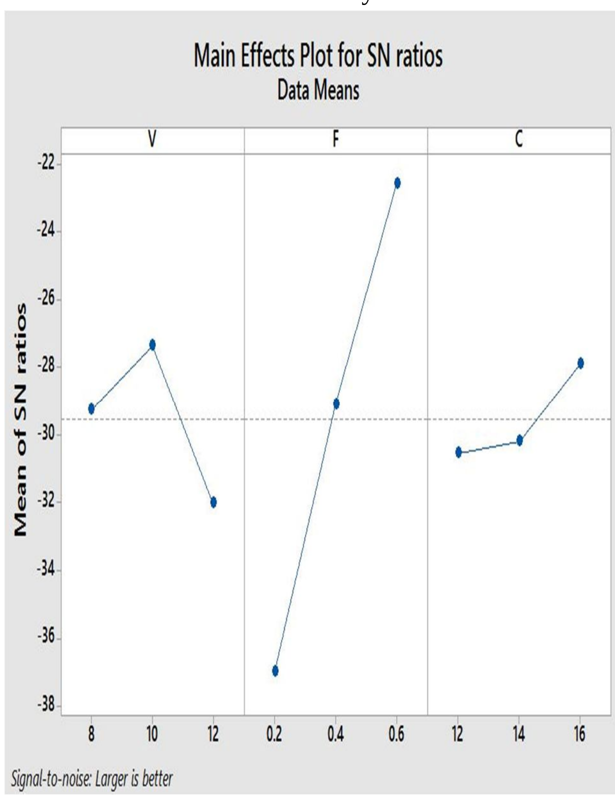

Figure - 1

In fig. 1 the most effective parameter and their level is feed (F=0.6mm/min)and that is why the maximum S/N ratio value is for feed, which indicates that a larger value of MRR is produced at such level of machining performance. Furthermore, one other parameters and their level is feed (F=0.6mm/min) has shown the optimum mean value. Now, the third parameter level is one of the concentration of electrolyte and the level 1 of the voltage (V=10volts) is also indicating the optimum condition of S/N ratio and mean value. Therefore the optimal values for the larger MRR is Voltage (V=10 volts), Feed (F=0.6mm/min) and electrolyte concentration (C=16g/l) as shown in figures.

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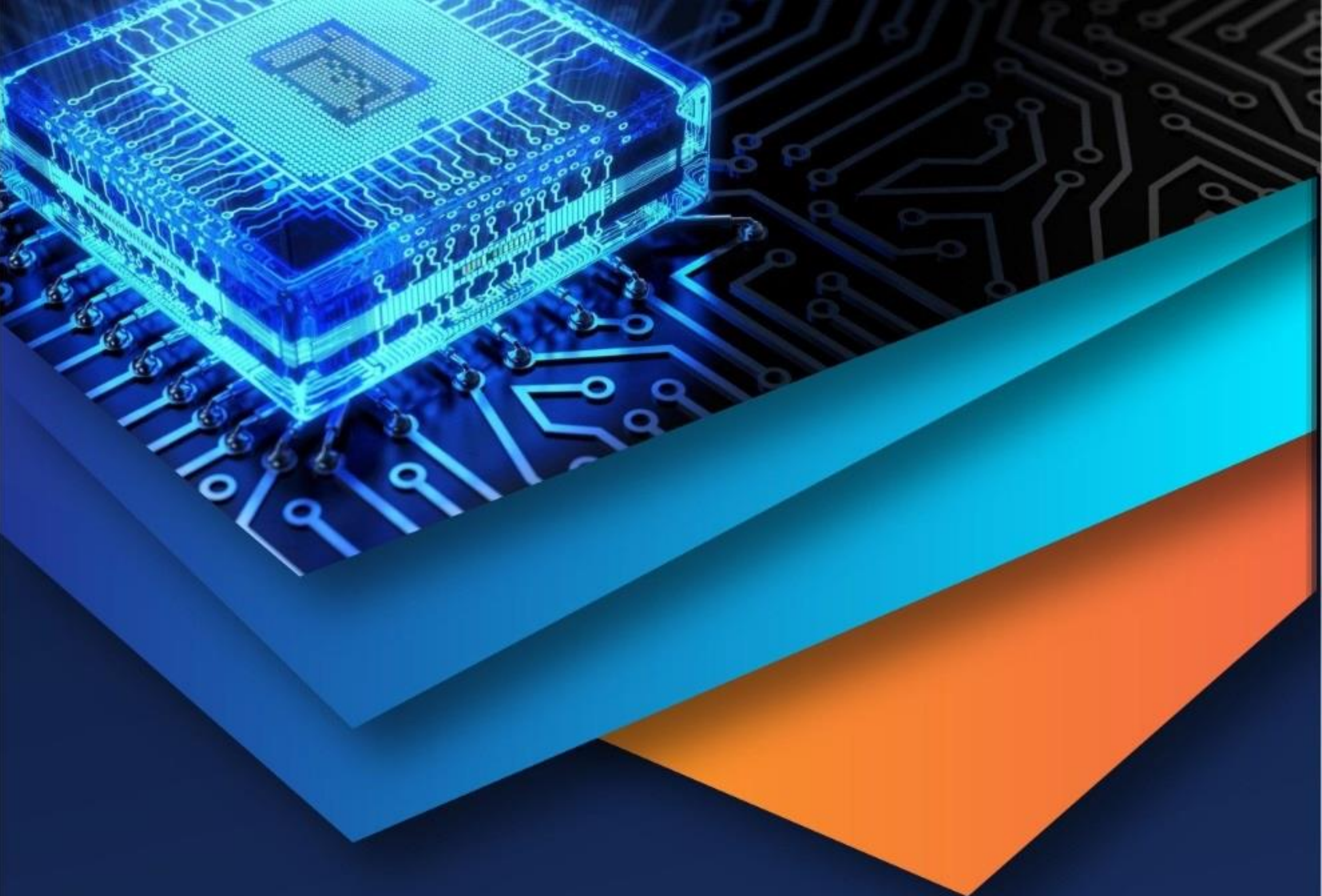

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