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INCREASING THE SURFACE FINISH QUALITY AND MRR BY VARYING MILLING PARAMETERS FOR ALUMINIUM ALLOY

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ABSTRACT

The main objective of this project is to optimize the process parameters in milling to achieve better surface finish and higher material removal rates using different cutting tools.

Different experiments are conducted to optimize the process parameters to improve the surface finish quality and material removal rate while machining Aluminum alloy 8011A. A series of experiments are done by varying the milling parameters spindle speed, feed rate, depth of cut and tool material considering L9 orthogonal array by Taguchi method. The optimization is done for least surface roughness and high material removal rates.

The experiment has been done with process parameters feed rate 80mm/min, 100mm/min, 120mm/min, spindle speeds are 800rpm, 1000rpm, 1200rpm, and depth of cut 0.5mm, 1mm and 1.5mm.

INTRODUCTION

Metal cutting is one of the greatest important and extensively used manufacturing procedures in engineering trades and in today's engineering scenario, optimization of metal cutting process is critical high in a manufacturing industry to answer effectively to severe competitiveness and growing demand of quality which has to be attained at nominal cost.

OBJECTIVE OF THE PROJECT

The main objective of this project is to optimize the process parameters in milling to achieve better surface finish and higher material removal rates using different cutting tools.

Different experiments have been conducted to optimize the procedure limitations to develop the surface finish quality and material removal rate whereas machining of an Aluminum alloy 8011A. Here a series of experiments have been done by changing the milling parameters like spindle speed, feed rate and depth of cut, by considering L9 orthogonal array using Taguchi Method. The optimization is done for minimum surface roughness & for higher MRR.

The experiment has been done with process parameters feed rate 80mm/min, 100mm/min, 120mm/min, spindle speeds are 800rpm, 1000rpm, 1200rpm and depth of cut 0.5mm, 1mm and 1.5mm.

EXPERIMENTAL SETUP AND PROCEDURE

Experiments have been performed by machining Aluminum alloy 8011A in order to investigate the effects of one or more factors of the process parameters (spindle speed, feed rate and depth of cut) on the surface finish of the machined surface and material removal rate.

The main aim of the project is to determine the influence of Tungsten carbide tool in metal working. The cutting constraints considered here are feed rate and spindle speed and depth of cut.

MACHINE SPECIFICATIONS

Machine Model – Feeler
Control – Siemens 840d
Travel Size X – 1000mm, Y – 500mm, Z – 500mm

Fig – CNC Milling Machine

Fig – Machine Specifications

TAGUCHI PARAMETER DESIGN FOR MILLING PROCESS

Selection of process parameters as per Taguchi Technique

Factors	Units	Level 1	Level 2	Level 3
Cutting speed, N	**Rpm**	800	1000	1200
Feed Rate, f	**mm/min**	80	100	120
Depth of cut, d	**Mm**	0.5	1	1.5

Table – Process Parameters as per Taguchi Technique

Design of experiments for L9 orthogonal array

Job No.	Cutting speeds (RPM)	Feed Rate (mm/min)	Depth of cut (mm)
1	800	80	0.5
2	800	100	1
3	800	120	1.5
4	1000	80	1
5	1000	100	1.5
6	1000	120	0.5
7	1200	80	1.5
8	1200	100	0.5
9	1200	120	1

Table– L9 Orthogonal Array

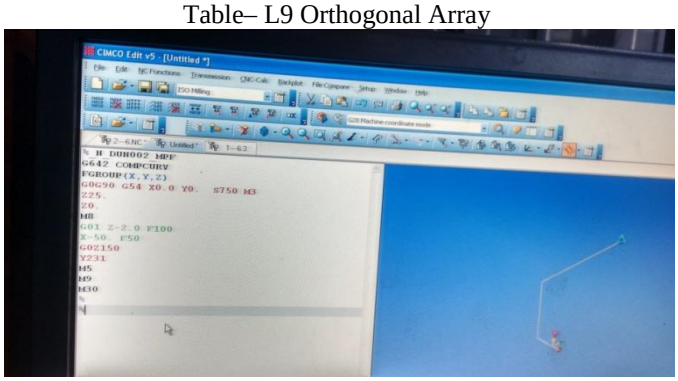


Fig – Machining Program

Fig – HSS tool in machine

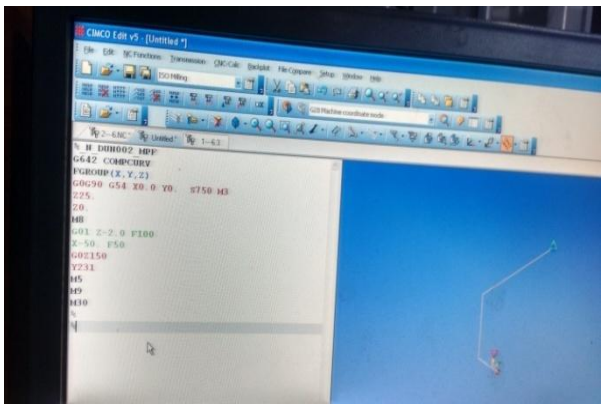
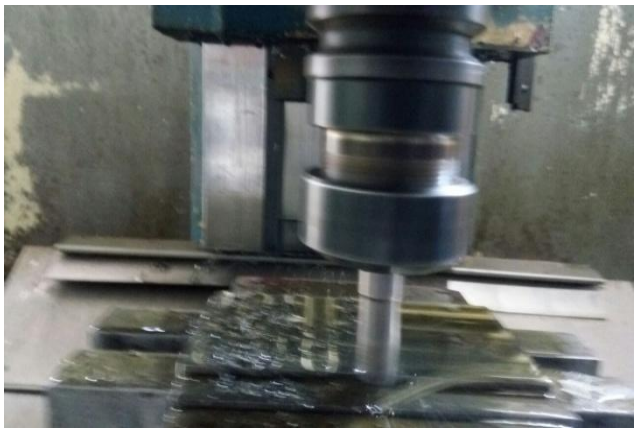


Fig – Machining Program

Fig – Machining of work piece by applying parameters – Spindle Speed 1000rpm, Feed Rate – 80mm/min and Depth of Cut – 1mm



Fig– Machining of work piece by applying parameters – Spindle Speed 1200rpm, Feed Rate – 120mm/min and Depth of Cut – 0.5mm,

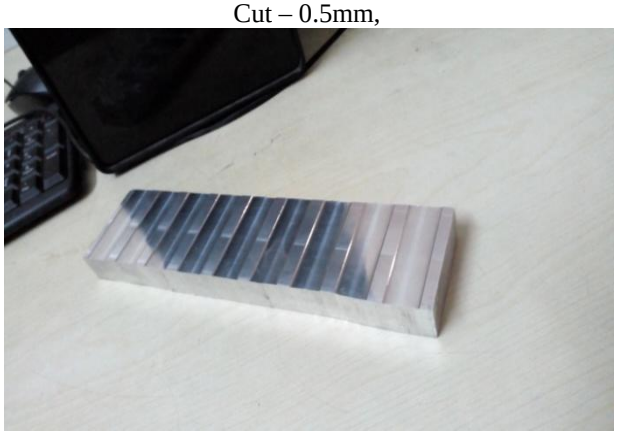
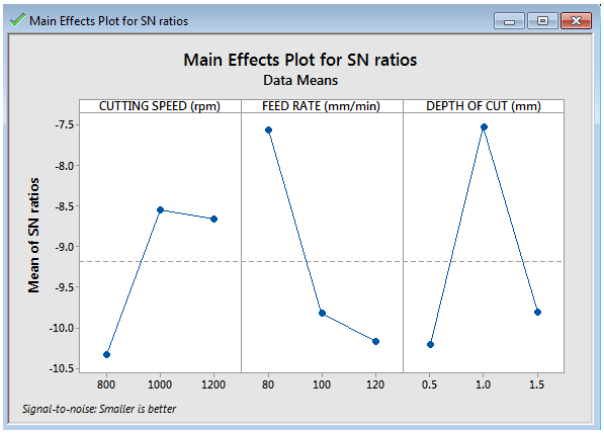
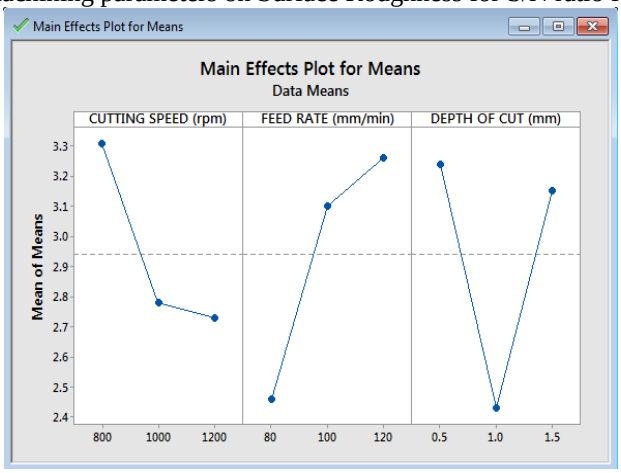


Fig – Final Machined Pieces

OPTIMIZATION OF MACHINING PARAMETERS USING MINITAB SOFTWARE
OPTIMIZATION OF MRR USING TAGUCHI METHOD



Graph - Effect of machining parameters on Surface Roughness for S/N ratio for Smaller is better



Graph - Effect of machining parameters on Surface Roughness for Means.

Response Table for Signal to Noise Ratios
Smaller is better
Taguchi Analysis: Surface Roug versus CUTTING SPEE, FEED RATE (m, DEPTH OF CUT
Response Table for Signal to Noise Ratios
Smaller is better

Level	CUTTING SPEED (rpm)	FEED RATE (mm/min)	DEPTH OF CUT (mm)
1	-10.336	-7.557	-10.211
2	-8.550	-9.818	-7.528
3	-8.661	-10.172	-9.808
Delta	1.786	2.615	2.683
Rank	3	2	1

Response Table for Means

Level	CUTTING SPEED (rpm)	FEED RATE (mm/min)	DEPTH OF CUT (mm)
1	3.311	2.461	3.240
2	2.783	3.102	2.429
3	2.731	3.261	3.155
Delta	0.580	0.800	0.811
Rank	3	2	1

Analysis with Discussions

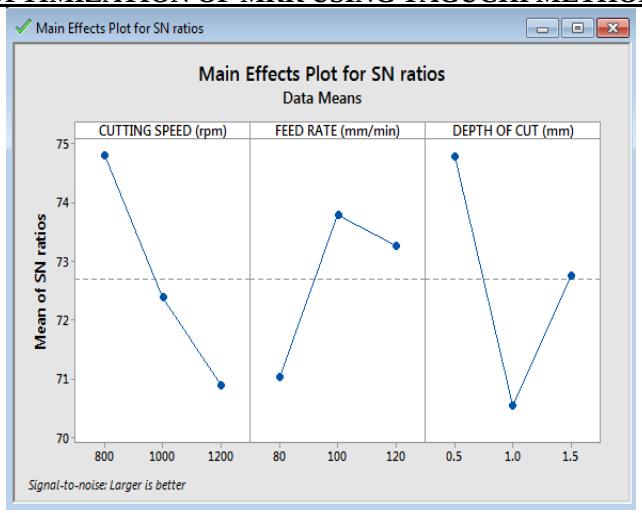
Irrespective of the category of the presentation features, a higher S/N value resembles to a better performance. Therefore, the optimum level of the machining constraints is the level with the highest value.

Cutting Speed:-The effect of parameters cutting speed on the stress is shown above figure for S/N ratio. The optimum cutting speed is 1000rpm.

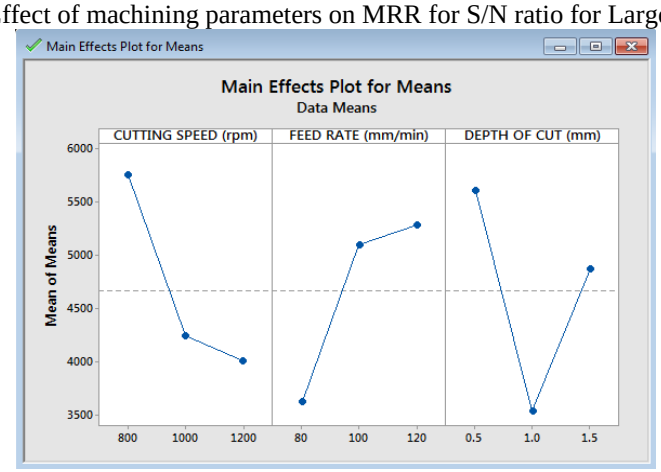
Feed:-The effect of parameter Feed on the stress is shown above figure S/N ratio. The optimum Feed Rate is 80mm/min

Depth of Cut:-The effect of parameters Depth of Cut on the stress is shown above figure S/N ratio. The optimum Depth of Cut is 1mm.

OPTIMIZATION OF MRR USING TAGUCHI METHOD



Graph - Effect of machining parameters on MRR for S/N ratio for Larger is better



Graph 4- Effect of machining parameters on MRR for Means

Response Table for Signal to Noise Ratios
Larger is better
Taguchi Analysis: MRR (cm3/sec) versus CUTTING SPEED (r, FEED RATE (mm/mi, DEPTH OF CUT (mm

Response Table for Signal to Noise Ratios
Larger is better

Level	CUTTING SPEED (rpm)	FEED RATE (mm/min)	DEPTH OF CUT (mm)
1	74.82	71.03	74.80
2	72.40	73.80	70.55
3	70.88	73.27	72.75
Delta	3.94	2.77	4.25
Rank	2	3	1

Response Table for Means

Level	CUTTING SPEED (rpm)	FEED RATE (mm/min)	DEPTH OF CUT (mm)
1	5752	3621	5604
2	4243	5098	3532
3	4009	5285	4868
Delta	1743	1664	2072
Rank	2	3	1

Analysis with Discussions

Irrespective of the category of the presentation features, a higher S/N value resembles to a better performance. Therefore, the optimum level of the machining constraints is the level with the highest value.

Cutting Speed:-The effect of parameters cutting speed on the stress is shown above figure for S/N ratio. The optimum cutting speed is 800rpm.

Feed:-The effect of parameter Feed on the stress is shown above figure S/N ratio. The optimum Feed Rate is 120mm/min

Depth of Cut:-The effect of parameters Depth of Cut on the stress is shown above figure S/N ratio. The optimum Depth of Cut is 0.5mm.

RESPONSE SURFACE METHODOLOGY

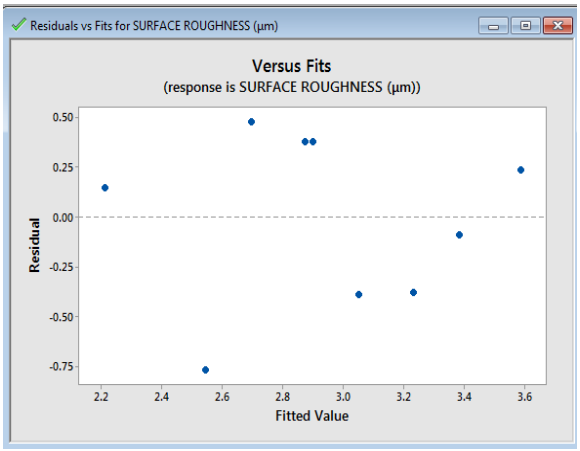
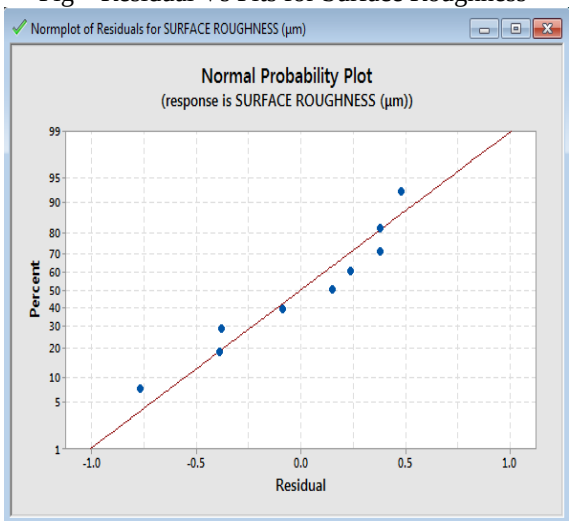
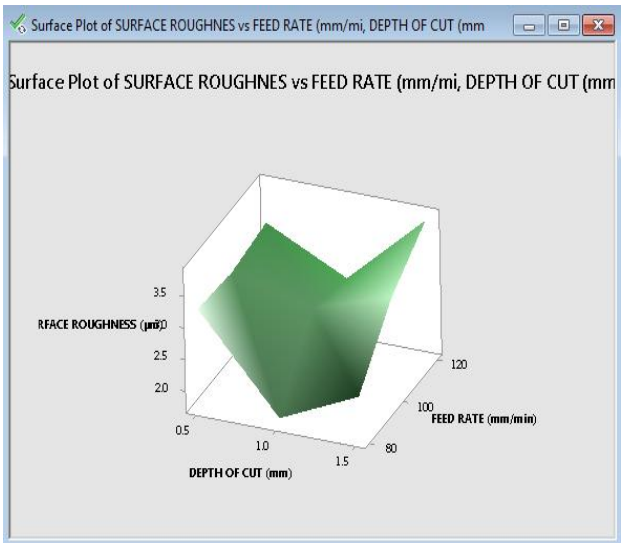


Fig – Residual Vs Fits for Surface Roughness



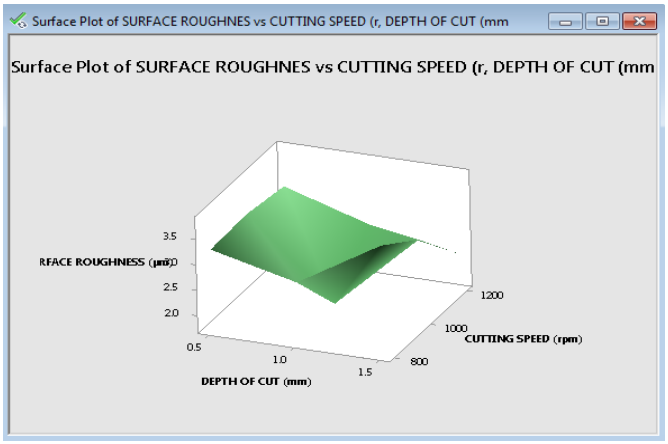
Fig– Normal Plot of Residuals for Surface Roughness

An 3D surface response plot is represented in a graphical form for the regression analysis. Here in the plotting we can understand the interactions of the different variables and can locate the better level for all the variables for maximum response.



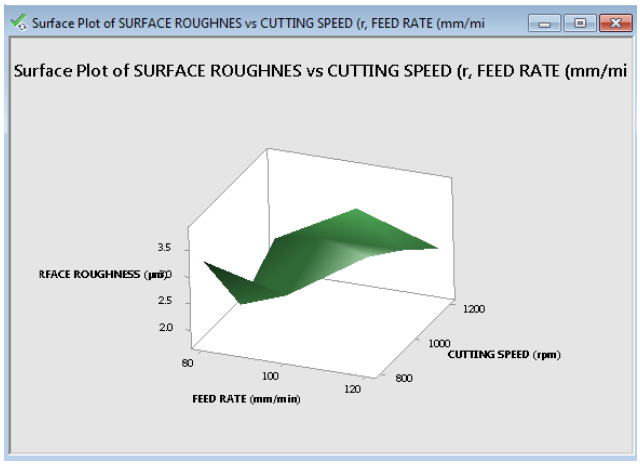
Graph – Surface Plot of Surface Roughness Vs Depth of cut and feed rate

By observing above graph, to minimize surface roughness, the depth of cut should be set at 1mm and Feed Rate at 120 mm/min.



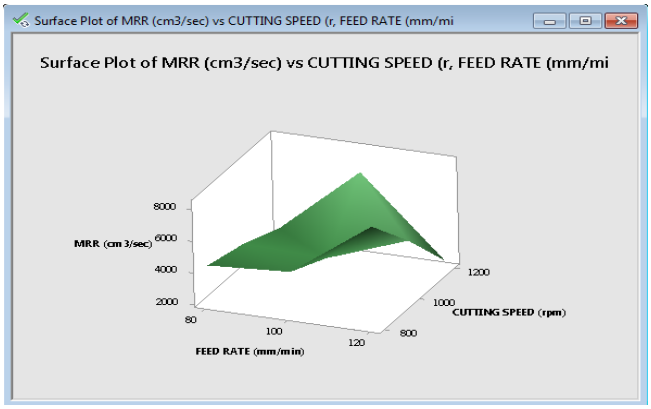
Graph – Surface Plot of Surface Roughness Vs Depth of Cut and Cutting Speed

By observing above graph, to minimize surface roughness, the Depth of cut should be set at 1mm and Cutting Speed at 1000rpm.



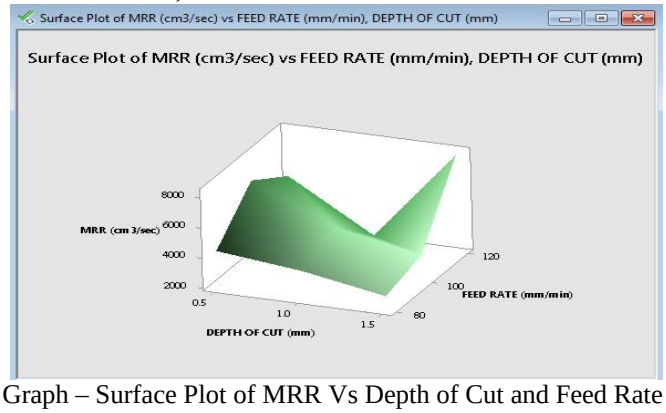
Graph – Surface Plot of Surface Roughness Vs Feed Rate and Cutting Speed

By observing above graph, to minimize surface roughness, the Feed Rate should be set at 120 mm/min and Cutting Speed at 1000rpm.



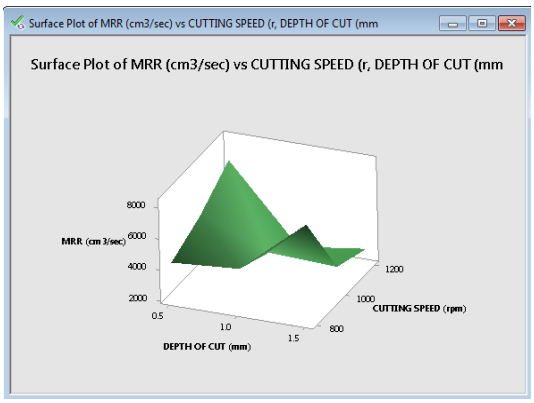
Graph – Surface Plot of MRR Vs Feed Rate and Cutting Speed

By observing above graph, to maximize MRR, the Feed Rate should be set at 120mm/min and Cutting Speed at 800rpm



Graph – Surface Plot of MRR Vs Depth of Cut and Feed Rate

By observing above graph, to maximize MRR, the Depth of Cut should be set at 0.5mm and Feed Rate at 120mm/min.



Graph – Surface Plot of MRR Vs Depth of Cut and Cutting Speed

By observing above graph, to maximize MRR, the Depth of Cut should be set at 0.5mm and Cutting Speed at 800rpm.

CONCLUSION

Different experiments are conducted to optimize the process parameters to improve the surface finish quality and material removal rate of Aluminum alloy 8011A. A series of experiments are done by varying the milling parameters cutting speed, feed rate and depth of cut considering L9 orthogonal array by Taguchi Method. The optimization is done for least surface roughness and high material removal rates.

The experiment has been done with process parameters feed rate 80mm/min, 100mm/min, 120mm/min, spindle speeds are 800rpm, 1000rpm, 1200rpm and depth of cut 0.5mm, 1mm, 1.5mm.

Optimization is done by taguchi method using Minitab 17 software. By observing the experimental results and by optimizing the parameters, the following conclusions can be made:

- To get better surface finish the optimized parameters are Cutting Speed – 1000rpm, Feed Rate – 80mm/min, Depth of Cut – 1mm.
- To get high MRR the optimized parameters are Cutting Speed – 800rpm, Feed Rate – 120mm/min, Depth of Cut – 0.5mm.

From the Response Surface method, the following results can be obtained:

- For Minimum Surface Roughness, the optimum Cutting Speed is 1000rpm, Feed Rate is 120mm/min and Depth of Cut is 1mm.
- For Maximum MRR, the optimum Cutting Speed is 800rpm, Feed Rate is 120mm/min and Depth of Cut is 0.5mm.

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