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INVESTIGATING THE EFFECT OF MATERIAL'S INITIAL TEMPERATURE ON SURFACE ROUGHNESS FOR MILLING OF AL 6061 ALLOY USING FULL FACTORIAL APPROACH

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ABSTRACT

The Al 6061 alloy has a wide variety of applications in automobile industries as well as aerospace industries due to its light weight to strength ratio, high corrosion resistance, heat treatable and easily weldable property. Quality and productivity are two important aspects for manufacturing industries for that purpose milling is the best option for machining of Al 6061. Milling is a process having wide variety of applications in the industry. While machining on the milling machine Surface Roughness (Ra) and Material Removal Rate are two output parameters comes into the picture. Surface roughness is influencing on allowance and external appearance of the final product. In this investigation, we are going to analyse process parameters are temperature, speed, feed and depth of cut. The research papers which are studied by us, we found that three basic parameters have been mostly studied are speed, feed and DOC. We are going to take a one parameter material's initial temperature which is not studied much more as that of first three parameters. For investigation, full factorial approach has been used, by taking L16 array. This approach has been applied to investigate the maximize values of the cutting process in end milling for Al 6061 alloy in order to provide better surface finish. With the help of full factorial approach, by performing experiments it

has been found that surface finish has gets affected by material's initial temperature. Graphs and response table were used to find the effect of parameters in end milling process. Also, we are getting the mathematical model for Ra value with the help of regression analysis. The Ra value is getting 14% affected by reducing Material's initial temperature.

KEYWORDS: End Milling, Full Factorial method, Al 6061, Ra value,Material's initial temperature.

INTRODUCTION

Al 6061 is most widely used raw material in various manufacturing firms like automobile industry, utensils, structural applications and so on due to its properties of light weight, corrosion resistance, weld ability, machinability. Al 6061 are used for production of cylinders and pistons, hence very close allowances is required for good fittings and mounting. As we reduce the weight by 10%, fuel efficiency will be increased by 5% and hence the aim of this analysis is to select parameters for maximise higher Ra value. Milling is the one of the machining process generally used in manufacturing industry as it is able to producing high variety of product shapes with good surface finish with high Material Removal Rate. Ra value has significant importance in manufacturing as which is depend on various parameters like Depth Of Cut (DOC), Feed Rate, Spindle Speed, Tool Material, Tool Geometry, Material Properties. A good surface finish is required as the selection of Al alloy is done for good external appearance and for close tolerances. For the purpose of analysis, we are going to use full factorial approach with L16 orthogonal array.

From literature study so far it found that spindle speed, DOC, Feed and coolant are the major parameter which has mainly affect the Ra value. Also, we found that the initial temperature of material is the one parameter which is not much studied yet. So we decided to start our study around this parameter. The basic concept behind this is to reduce initial temperature of Al alloy work piece, so that when actual machining operation is done the temperature generated during operation do not reach. Another effect of initial cooling is the brittleness of work piece increases, therefore the machining characteristic and chip formation properties improves.

We are going to take milling parameters such as spindle speed, feed rate, DOC, along with material's initial temperature. Objective of present work is to investigate the effect of Material's initial temperature on the Ra value.

LITERATURE REVIEW

Milling is the most extensively used metal machining operation. Most of the finished products undergo milling processes at some stage of fabrication. The widespread use of end milling for machining parts is attributed to its ability to give a faster rate of metal removal as well as a reasonably good surface texture. End milling operating are highly adaptable for both the roughing finishing operation for different product that can be produce with high level of accuracy and surface finish.

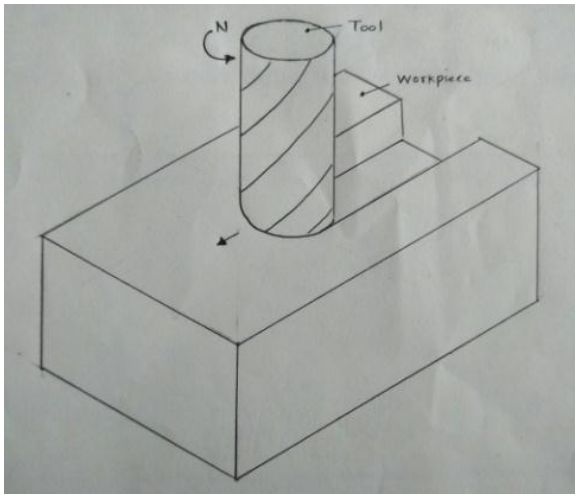

Fig 1: Schematic diagram of End Milling Process.

Literature study is required to understand the correct objective of the project work. Past research work gives the better idea for cognition. The goal is to find "Effect of initial temperature on surface roughness for aluminium 6061 alloy"

Rajesh Kumar and et.al. Investigated the optimised value for milling process parameters by using GRA based Taguchi method, and helps us to secure the objective of our project. Seemikeri and et.al. Investigated surface integrity of AISI 1045 using LPB tool. With the study we get the idea regarding full factorial method. U. D. Gulhane and et.at. estimated that the feed is most influencing parameter corresponding the quality characteristic. They applied Taguchi of experimental design for optimizing multi response process parameter for turning 316LLS optimized with L9 orthogonal array. Results obtained from Taguchi method closely matches with ANOVA. According to Mahadev Naik and et.al. MRR and Ra value heavily affects the productivity. By studying all these papers we found that we can investigate the effect of initial temperature on Ra value.

Experimentation

The specimen used for experimentation was Al 6061 alloy. The composition and metallic properties of Al 6061 alloy are as shown in table 1.

Table 1: Composition of Al 6061 alloy in %

Element	Percentage
Al	97%
Mg	1.2%
Si	0.8%
Fe	0.6%
Cu	0.4%

The specimen were subjected to end milling operation which was carried out on universal milling machine. End mill cutter used was HSS which is mostly used and economical one. A rectangular specimen of 80X30 mm^2 and thickness 20 mm was hold in vice. As the specimen is of less in thickness it was needed to provide a packing while machining. Without such arrangement of holding and packing the specimen may not machine properly.

Fig. 2: Experimental setup (Universal milling machine).

As L16 array is selected 16 specimens were used for experimentation. The specimen was initially adjusted such a way that its axis should be exactly perpendicular to the tool axis. The specimen was positioned in such manner that there leaves zero clearance between tool and specimen. The cutting speed, feed, DOC and temperature were adjusted according to levels.

Table 2: End Milling Parameters and levels.

Factors	Level 1	Level 2
Initial Temperature	6	32
DOC (mm)	0.5	1
Spindle Speed (RPM)	58	220
Feed (mm/min)	7.56	19.55

RESULTS AND DISCUSSION

The results of Ra value for machining of Al 6061 alloy with different milling parameters are shown in table.

Table 3: Results for Ra values.

Sr.No.	Int. Temp	DOC (mm)	Speed (RPM)	Feed (mm/min)	MRR (mm^3/min)	Ra (micro m)
1	6	0.5	58	19.55	90.55	3.88
2	6	0.5	58	7.56	105.119	2.72
3	6	0.5	220	19.55	90.55	6.79
4	6	0.5	220	7.56	35.039	1.82
5	6	1	58	19.55	362.222	4.01
6	6	1	58	7.56	105.119	3.97
7	6	1	220	19.55	181.11	4.42
8	6	1	220	7.56	105.119	7.02
9	32	0.5	58	19.55	271.66	10.70
10	32	0.5	58	7.56	70.07	5.60
11	32	0.5	220	19.55	181.11	3.47
12	32	0.5	220	7.56	140.15	2.98
13	32	1	58	19.55	362.22	6.40
14	32	1	58	7.56	140.11	6.68
15	32	1	220	19.55	181.11	7.02
16	32	1	220	7.56	105.119	4.83

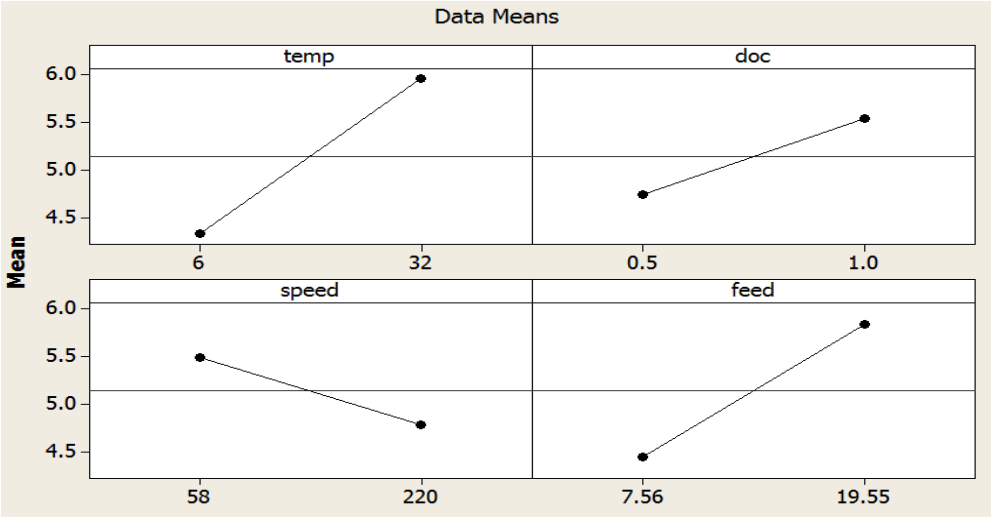

Fig 3: Main Effect Plot for Ra.

In End Milling operation Surface Roughness is important criteria, so the main purpose of analysis of variance (ANOVA) is to find out which design parameters significantly affect the Ra value.

Table 4: ANOVA for Ra varience.

Source	DF	Seq SS	Adj SS	F	P
Temp	1	10.64	10.64	0.93	0.511
DOC	1	2.55	2.55	0.22	0.719
Speed	1	1.97	1.97	0.17	0.750
Feed	1	7.66	7.66	0.67	0.563
Temp*DOC	1	0.26	0.26	0.02	0.905
Temp*Speed	1	17.12	17.12	1.50	0.436
Temp*Feed	1	0.97	0.97	0.08	0.820
DOC*Speed	1	6.34	6.34	0.55	0.593
DOC*Feed	1	9.56	9.56	0.84	0.528
Speed*Feed	1	0.06	0.06	0.01	0.954
Temp*DOC*Speed	1	3.21	3.21	0.28	0.690
Temp*DOC*Feed	1	1.57	1.57	0.14	0.774
Temp*Speed*Feed	1	0.68	0.68	0.06	0.847
DOC*Speed*Feed	1	0.02	0.02	0.00	0.970
Error	1	11.44	11.44		
Total	15	74.06			

Table 4 shows the experimental results of Ra, in which the combination of parameters for Ra are obtained by the Full Factorial orthogonal array design method. Table 4 shows the experimental results of Ra, in which interaction of temperature and speed is the mainly influencing the Ra value. After that the parameter which affects the Ra value is temperature.

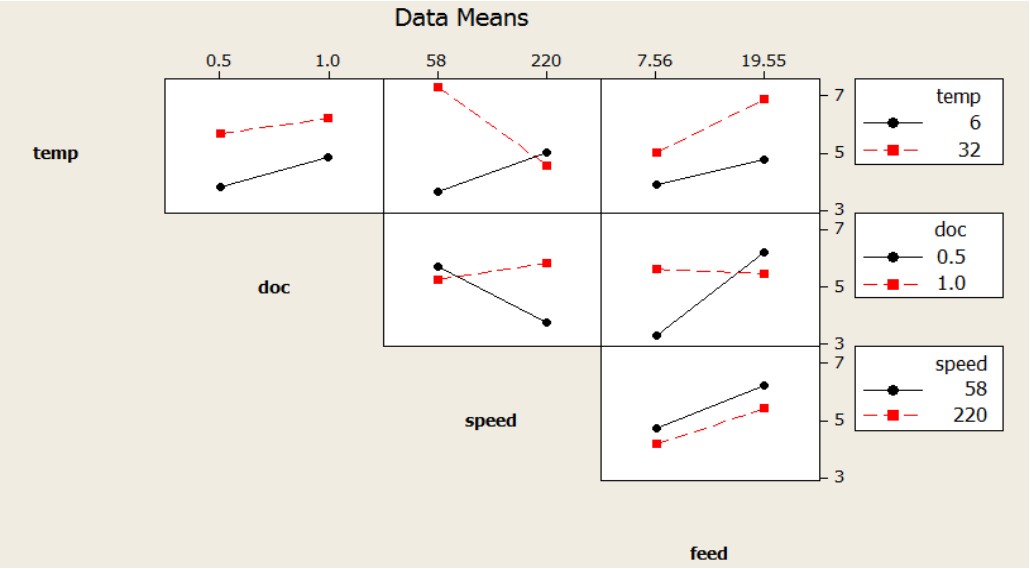

Fig 4: Interaction plots for Ra value.

The Regression equation for Ra value

Ra = 1.79 + 0.115 Feed + 0.00433 Speed + 1.60 DOC + 0.0627 Temperature

Confirmation Test

The graph Plotted for Main Effect Plot is better fig .2 and it gives combination of optimize parameter that is temperature = 6^0c, DOC = 0.5 mm, Speed 220 rpm and Feed 7.58 mm/min.

Table 5: Confirmation results for Ra value.

Sr. No.	End Milling Parameters				Ra value
	Temperature	DOC	Speed	Feed	
1	6	0.5	220	7.58	1.82

Fig 5: Confirmation Test specimen.

CONCLUSION

Temperature influences the Ra value. When taking the interaction of the temp. and speed, it having dominating influence on the Ra value. The optimized value for Ra are found, for Ra lower is better (temperature 6^0c, DOC 0.5mm, speed 220r.p.m. and feed 7.58mm/min.) are optimized value. While considering effect of temperature on Ra value, Temperature influence about 15% to Ra value. But the interaction of temperature and speed influence Ra value about 2.

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