Determination of Surface Roughness in AA6063 Using Response Surface Methodology

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Abstract - *The study aims at analysis of surface roughness of AA6063 in CNC turning operation. In this paper an effective approach is made for the optimization of surface roughness using input parameters. The optimization process is done using RSM (Response surface methodology). This paper discusses the use of response surface methodology for minimizing the required surface roughness. Experiments were conducted based on the established RSM technique. The three machining parameters that are chosen as process parameters are: Cutting speed, feed rate and depth of cut. Using design of experiments the Box-Behnken method is used in Response surface methodology to determine surface roughness.*

Key Words: **Machining, Surface roughness, ANOVA, Response surface methodology**

1. INTRODUCTION

Turning is the most widely used among all the cutting processes. Surface finish is the method of measuring the quality of a product and it is an important parameter in machining process. It is also considered as one of the basic requirement of a customer for machined parts. Productivity is also important to fulfil customers demand and henceforth the quality of the product should be high. In order to perform all these desired measures in any machining operation proper selection of machining parameter is essential. AA6063 is an alloy of primarily alloyed with Magnesium and Silicon. Aluminium alloys are the most widely used non ferrous materials in engineering applications owing to their attracting properties such as excellent corrosion resistance, good ductility and high strength to weight ratio. However their applications are Architectural, Extrusions and used in extreme support equipments. And also in missile parts, keys, bike frames and all terrain vehicle sprockets because aluminium alloys are soft and high strength material. B.Radha Krishnan, P.Ramakrishnan, S.Sarankumar. S.Tharun Kumar, P.Sankarlal [1] Parameter optimization for surface roughness and wall thickness on AA5052 Aluminium alloy using RSM and ANOVA technique with input parameters such as Spindle speed, Tool feed, Steps size and the Output parameters were surface roughness and wall thickness. Radhakrishnan B, Sathish T, Siva Subramanian T.B, Tamizharasan N , Varun Karthik E [2] Optimization of cutting parameters for minimizing energy consumption and maximizing cutting quality on AL 6063 T6 Aluminium using RSM. The input parameters are Depth of cut, Feed rate. The output results obtained is feed rate and depth of cut is the most significant factors for minimizing total specific energy consumption.

2. RESPONSE SURFACE METHODOLOGY

Response surface methodology is a collection of statistical and mathematical methods that are useful for modelling and analysing engineering problems. The main objective of this technique is to optimize the response surface that is influenced by various process parameters. RSM also determines the relationship between the controllable input parameters and the obtained response surfaces. The data obtained from the experiments is used to build a mathematical surface model using response surface methodology. It is a collection of mathematical and statistical techniques used for modelling and analyzing problems.

The main objective of this paper is to obtain optimal settings and study the effect of process parameters such as cutting speed, feed rate and depth of cut resulting in an optimal value of surface roughness using response surface methodology.

3. EXPERIMENTAL DETAILS

Experimental Setup:

a) Work piece Material:

We have selected ALUMINIUM 6063for our experiment. It has the following Chemical composition and heat treatment specification respectively.

Table -1: Chemical Composition of AA6063

Chemical	Composition (%)
Magnesium	0.45-0.9
Chromium	0.1
Titanium	0.1
Manganese	0.1
Iron	0.35
Silicon	0.2-0.6
Copper	0.1
Zinc	0.1
Remainder	Aluminum

AA6063 has good thermal conductivity which has used in many construction and automobile industries.

Table -2: Thermal Properties

Melting Temperature	615^{0}C
Thermal Conductivity	201-218W/m*K

b) Equipment

CNC Lathe Machine has been used to carry out our experiment. It has the following specifications: (All dimensions are in mm)

Table -3: CNC Specification

Model	Flex Turn
Processor	With Siemens 802D SI control with Standard Equipments.
Spindle speed range	1500-2000rpm
Axis Travel	Length X axis-190,Z axis-210
Power required	3 Phase,415 V AC,12 KVA

Fig -1: CNC Lathe Setup for turning process

c) Camera:

For image capturing and processing, we have selected a Canon EOS 600DWith the following specification:

- 18-megapixel CMOS sensor
- Scene Intelligent Auto mode
- Full-HD EOS Movie
- On-screen Feature Guide
- Up to 3.7fps continuous shooting
- Wide-area 9-point AF
- 1,040k-dot vary-angle 7.7cm (3.0”) screen
- Basic+ and Creative Filters
- Built-in wireless flash control

4. RESULTS AND DISCUSSION

Set the level of Input values which speed, depth of cut feed rate given to the RSM. Generate the trial run values and give the output values to the respective input parameters. Based on that ANOVA results generate the Final equation.

Table -4: Experimental input and output values

RUN	SPEED (rpm)	DEPTH OF CUT (m/rev)	FEED RATE (m)	SURFACE ROUGHNESS (uM)
1	1200	0.50	0.05	0.33
2	1200	0.60	0.10	0.52
3	1200	0.70	0.15	0.58
4	1200.	0.90	0.05	0.58
5	1200	1.00	0.10	0.66
6	1200	0.80	0.05	0.56
7	1300	0.50	0.05	0.33
8	1300	0.60	0.15	0.54
9	1300	0.70	0.10	0.66
10	1300	0.80	0.05	0.6
11	1300	0.90	0.10	0.77
12	1300	1.00	0.05	0.65
13	1400	1.00	0.15	0.68
14	1400	0.90	0.10	0.61
15	1400	0.80	0.05	0.5
16	1400	0.70	0.05	0.61
17	1400	0.60	0.10	0.52
18	1400	0.50	0.15	0.42

a) ANOVA for Response Surface Quadratic Model

Source	Sum of Squares	df	Mean Square	F Value	p-value Prob > F
Model	0.20	9	0.023	7.97	0.0038
A-speed	*7.373E-005*	*1*	*7.373E-005*	*0.026*	*0.8760*
B-doc	*0.13*	*1*	*0.13*	*46.49*	*0.0001*
C-feed rate	*0.016*	*1*	*0.016*	*5.68*	*0.0443*
AB	*9.013E-004*	*1*	*9.013E-004*	*0.32*	*0.5888*
AC	*5.006E-005*	*1*	*5.006E-005*	*0.018*	*0.8977*
BC	*4.209E-004*	*1*	*4.209E-004*	*0.15*	*0.7104*
A^2	*0.011*	*1*	*0.011*	*3.74*	*0.0891*
B^2	*0.017*	*1*	*0.017*	*5.95*	*0.0406*
C^2	*5.780E-003*	*1*	*5.780E-003*	*2.03*	*0.1917*
Residual	0.023	8	2.842E-003		
Cor Total	0.23	17			

b) Final Equation in Terms of Actual Factors

$$\text{SURFACE ROUGHNESS} = -10.36754 + 0.014324 * \text{speed} + 3.58818 * \text{doc} + 2.65797 * \text{feed rate} - 6.58356\text{E-}004 * \text{speed} * \text{doc} + 6.11946\text{E-}004 * \text{speed} * \text{feed rate} + 0.94474 * \text{doc} * \text{feed rate} - 5.33275\text{E-}006 * \text{speed}^2 - 1.53086 * \text{doc}^2 - 16.56449 * \text{feed rate2}$$

Predicted and actual value showed the impact of the surface roughness by the depth of cut. Remaining parameters affect the surface roughness level as very minimum compare with the depth of cut

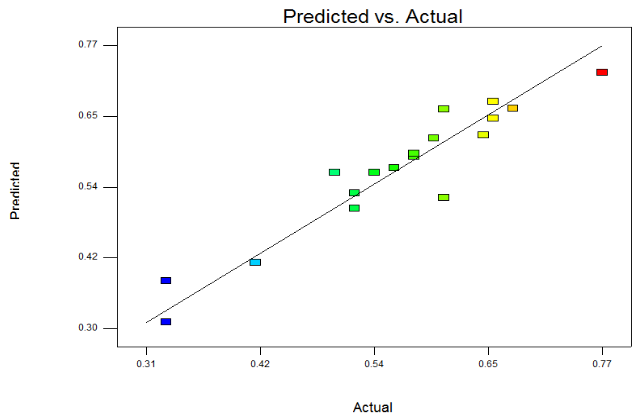

Chart -1: Graph for Actual value and predicted value

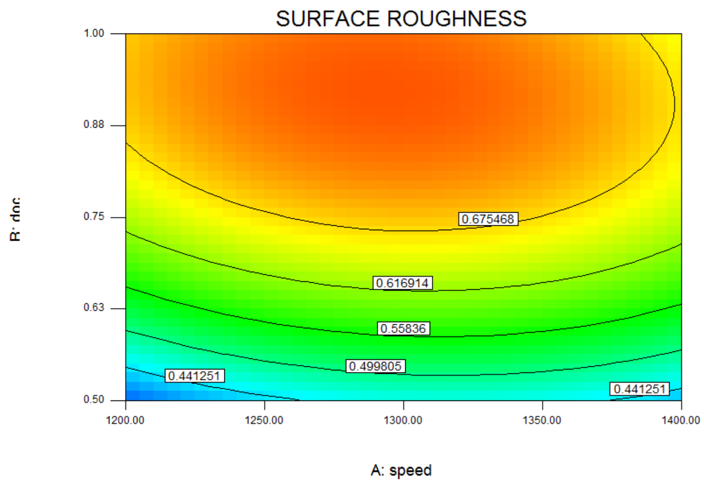

Chart -2: Impact of speed and Depth of cut

5. CONCLUSIONS

Most of the aluminium alloy materials used in the automobile and construction industries. Here the thermal and strength as play the major role. In this paper has used to optimize the parameter for achieving the good surface roughness. Final equation has used to predict the optimal roughness value. The paper clearly shows the impact of depth of cut whether the depth of cut is maximum it was reduced the quality of surface roughness, other parameters like speed, and feed rate influence the minimum over the roughness.

REFERENCES

[1] B.Radhakrishnan, P.Ramakrishnan. S.Sarankumar. S.Tharun Kumar, P.Sankarlal "Optimization of CNC Machining Parameters For Surface Roughness in Turning of Aluminium 6063 T6 With Response Surface Methodology" SSRG International Journal of Mechanical Engineering - (ICCREST'17) - Special Issue - March 2017 (23-31).

[2] Radhakrishnan B, Sathish T, Siva Subramanian T.B, Tamizharasan N , Varun Karthik E "Optimisation of Surface Roughness in CNC Milling Process Using RSM" , SSRG International Journal of Mechanical Engineering - (ICRTECITA-2017) -Special issue- March 2017 (5-12)

[3] C.a. Conceicao antonio, andj.p. Davim, optimal machining parameters based on surface roughness experimental data and genetic search, industrial lubrication and tribology 57/6 (2005) 249–254

[4] B.Radha Krishnan, R.Giridharan, S.Rajaram, R.Sanjeevi, and M.Ramesh, "Prediction of Surface Roughness in turning process by using artificial neural network model", TAGA journal of Graphic Technology 14 (2018) 2823-2829.

[5] K. Elissa, "Title of paper if known," unpublished. Chandra shekar, n b d pattar, y vijaya kumar, optimization of machining parameters in turning of al6063t6 through design of experiments , international journal of mechanical engineering and technology (IJMET) volume 7, issue 6, November–December 2016, pp.96–104, article id: IJMET_07_06_010

[6] P. Jayaraman, l. Mahesh kumar, multi-response optimization of machining parameters of turning aa6063 t6 aluminium alloy using grey relational analysis in taguchi method, procedia engineering 97 (2014) 197 –204.