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Optimization of Surface Roughness in Turning Operation using Al- 6063 and Effect of Dry Machining

Md Jafar Khan[1], Beena Rizvi[2]
[1]Department of Mechanical Engineering, Ambalika Institute of management & Technology, Lucknow
[2]Assistant Professor, Department of mechanical Engineering, Ambalika Institute of management & Technology, Lucknow

Abstract ALUMINIUM-6063 is a widely used alloy material in the production of aerospace, aircraft, gas turbine components. This investigation focuses on the influence of machining parameters, viz., spindle speed, depth of cut and feed rate on the surface roughness obtained in Lathe operation of Al 6063 alloy. In the present study, experiments are conducted for nine different Al 6063 work piece materials to see the effect of work piece material variation in this respect. This roughness parameters, viz., Centre line average roughness, root mean square roughness. The roughness models as well as the significance of the machining parameters have been validated with analysis of variance. In addition, a good agreement between the predicted and measured surface roughness was observed. Therefore, the developed model can be effectively used to predict the surface roughness on the machining of Al6063 within 95% confidence intervals ranges of parameters studied.
Keywords: Lathe Process, Aluminium-6063, Surface Roughness, Machining Parameters

I. INTRODUCTION

The most important function of a lathe machine is to be remove metal from the work- piece to requirement of a specified shape and size. This is skilled by holding the work securely and rigidly on the machine and then turning operation is started with the help of a cutting tool. The material is to be removed with the help of tool and removed metal from the work in the form of chips.
Lathe machine is a type of a machine and chuck is holding the work piece and tool is mounted on a tool post, the lathe machine is on and chuck is rotating the workpiece about an axis and the different type operations is to be performing such as turning, facing, chamfering, thread cutting, knurling, drilling, and more with tools that are applied to the workpiece to design an object with symmetry about that axis. The most important function of a lathe is to be eliminate the metal from a workpiece to elasticity a required size and shape. In a lathe machine, the tool is held and a workpiece is rotating about an axis rotation and different type of an operation is performing with the help of different type tool is to be used in a machining operation. Turning operation most impotent type machining operation in other words basic machining operation. This type machining operation is widely used in industries this operation is dealing with metal cutting. In turning operation is extremely used single point cutting tool is used. The turning operation is to be remove the metal from the workpiece in the form of the outer diameter of the rotating cylindrical work piece. Turning operation fundamentally reduced the diameter of the work piece usually into specified dimension and finally produced final product is in the form of finish product. The turning operation is most important type machining procedure and performing and producing the cylindrical type parts and this operation is basically defined as external surface is to be machined.

II. LITERATURE REVIEW

S.R. Daset al [1] this experiment conducted on the Tungsten AISI 4340 steel and using Coated Graphite tool inserts on tool post. Feed is most important factor in machining operation and feed is to be found and most significant parameter for the work piece surface roughness (Ra) with a percent contribution of 52.55%. Cutting speed contributed of 25.85% and considered significant parameter for Ra with Depth of cut had a negligible impact in case of Ra.
Jitendra. M. Varma et al [2] conducted experiments on AISI 4340 using solid lubricant with coated carbon tool inserts. It is start that the use of solid lubricant in dry machining has caused in a feasible alternative to cutting fluid, providing it is applied properly. There is enough improvement in surface roughness and quality of product produced.
Karanam Krishna et al [3] execute an investigation of material removal rate on Aluminum in turning by using ANN. This work researched the effect of the operating parameters like, depth of cut, feed rate, clamping length & spindle speed. Error in the dimensions of the machined component is studied by the operating parameters. Feed rate& depth of cut effected more on the accuracy than the other parameters. ANN predicted that before commencing the actual machining operation, the NC program could be corrected, hence accuracy of the components improved at less cost and time.

A.Sathyavathi et al [4]carried a study on different researches conducted. The most of researchers are interested in optimization of machining condition with corresponding surface roughness. In past reviewed found, none of researcher involved for TiBN coated cemented carbide tool. In this paper uncoated carbide tool and PVD (TiBN) coated carbide tool involved for performance of quality of surface and optimization of cutting parameter with aid of DOE and GA.

M.M.A. Khan et al [5] carried out on study to analyze the effects of minimum quantity lubrication liquid is used in machining operation on turning AISI 9310 alloy steel using vegetable oil-based cutting fluid. They decided that the chips produced under both dry and wet condition are of ribbon type continuous chips at lower feed rates and more or less tubular type continuous chips at higher feed rates. The prime contribution of MQL jet is to reduce the flank wear by machining the low alloy steel and by the carbide insert, which improves the tool life Oenanthe productivity (MRR)provide higher cutting velocity and feed. The Surface finishes also improved mainly due to reduction of wear and damage at the tool-tip by the application of MQL.

M. Venkata Ramana et al [6]carried experiments to study the effect of process parameters on tool wear in Turning of Titanium Alloy under different machining conditions It was concluded that the advantages of MQL machining is that it reduces tool wear as well as environmental issues, which reduces the friction between the tool-chip interaction .In ANOVA ,role of cutting speed is more followed by tool material, depth of cut, feed rate and then coolant condition which help in minimizing the wear of tool.

VikasB. Magdumetal [7] carried out investigation to evaluate and enhance/optimize the machining parameters for turning of EN 8 steel using, Carbide, HSS M2 and Cermet tools.

N.Zeelan Basha et al [8]optimized turning process parameters on Aluminum 6061 using Genetic Algorithm. Optimum surface finish was obtained at maximum cutting speed, minimum feed and minimum depth of cut.

Y.B. Kumbhar et al [9] investigated tool life and surface finish optimization of PVD TiAlN/TiN multi-layer coated Carbide tool inserts in semi hard turning of hardened EN-31 alloy steel under dry cutting conditions. Maximum tool life is obtained at low cutting speed, moderate feed and depth of cut. Feed rate was found to be the most significant factor for tool life. Feed rate was also the most significant factor for surface roughness.

Gopal Krishna, P. V et al [10]studied the effect of cryogenic processing and carried out experiments on cryogenic treated tools in turning. Significant influence is seen on tool life which gets improved up to 90%. It has been concluded that the tool life enhanced by cryogenic treatment while machining both soft and hard materials. The most productive at high speeds and feeds are carried by cryogenic treated tools.

Hemant B. Patil et al [11] study of the effects of cryogenic on steel tool is to be used. It was concluded that cryogenic induces wear confrontation as the soft austenite is converted into hard martensite. The sample dimensional accuracy and surface appearance also get better-quality. They also concluded that the use of cryogenic increases the cutting strength which can be reduced by the practice of secondary liquid nitrogen.

Lakhwinder Pal Singhet al [13] study of this paper is compared cryogenic treated and un-treated high speed steel tool is used in turning operation. It was determined that after cryogenic treatment of high-speed steel the routine of the tool was enhanced. Less power consumption can be experiential work.

M.Dhananchezian et al [14] Investigated the effects of cryogenic cooling by liquid nitrogen in orthogonal turning of Ti-6Al-4V. The cryogenic decreases the cutting temperature. The cutting force is found to be increased. The chip thickness was compact by 25% as compared to dry turning.

S. Thamizhmanii et al [15] in their study of lowermost surface roughness in turning SCM 440 alloy steel found that depth of cut was the most significant factor for surface roughness. Feed rate was the second most influencing factor for surface roughness.

C R Bariket al [16] Studied roughness characteristics of surface roughness using in CNC turning of EN 31 alloy steel and optimization of machining parameters based on Genetic Algorithm. The experimental study is concluded that the surface roughness gets decrease with decreasing feed rate but it is constant with rate of the cutting speed. The surface roughness also decreases with decrease in depth of cut.

Ajeet Kumar Rai et al [17] investigated the effect of cutting parameters (cutting speed, feed rate, and depth of cut) on surface roughness in a turning operation of cast iron. The results show that cutting speed, feed rate and depth of cut affects the surface roughness. The cutting speed was the most significant factor for the surface roughness while there was no significant effect of depth of cut on surface roughness.

Feng and Wang [18] The considered for the experimental data and estimation of surface roughness in finish turning operation by developing an experimental data through considering machining work and using the machining parameters: work piece hardness (material), feed, cutting tool point angle, depth of cut, spindle speed, and cutting time is most important type parameter. To develop the empirical model to predict the surface roughness, techniques like Data mining, nonlinear regression analysis with logarithmic and most efficient type data transformation were employed.

Suresh et al. [19] Intensive of the machining work in this type materials secondhand such as mild steel by TiN-coated tungsten carbide (CNMG) cutting tools used for developing a surface roughness prediction of the model and using this technique such as Response Surface Methodology (RSM). Genetic Algorithms works as an optimizer of the objective function and an it compares with RSM results. It was experimental data that GA program provided minimum and maximum values of surface roughness in this experimental work and their separate optimal machining circumstances.

III. WORK MATERIALS

Aluminum alloy is used this experimental work. This aluminum alloy is 6063 material is used and materials was obtained in the form of cylindrical type work piece. Find most widely used around the world become very popular in Asian. This aluminum alloy 6063 can be made into plates and coils and finds used in the field of architectural application and windows and door frames, pipe and tubing and also used in the field of aluminum furniture.

Table 3.1 of chemical composition

S NO	Elements	% wt
1	Aluminum	97.25
2	Chromium	0.05
3	Copper	0.05
4	ferrite	0.30
5	Magnesium	0.85
6	Manganese	0.05
7	Silicon	0.50
8	Tin	0.05
9	Zinc	0.05

Figure 3.2 Mechanical Properties of Al-6063

S. NO	Property	Value
1	Density	2.7 g/cm
2	Yield strength	195 Mpa
3	Ultimate strength	240 Mpa
4	Hardness	75 BHN
5	Shear strength	150 Mpa
6	Fatigue strength	65 Mpa
7	Poisson’s ratio	0.33

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IV. SURFACE ROUGHNESS

Surface roughness shows the quality of the machining or a job. It is desirable to decrease the surface roughness of the work-piece, as much as we lower the surface roughness the surface finish of the work piece will increase and the quality of the machining will improve. Surface roughness measurements are made using Stylus type profilometer TALYSURF surface roughness tester. Figure shows the TALYSURF surface roughness tester.

V. ANALYSIS OF VARIANCE (ANOVA)

This method was developed by Sir Ronald Fisher in the 1930's as a way to interpret the results from agricultural experiments. ANOVA is not a complicated method and has a lot of mathematical beauty associated with it. ANOVA is a statistically based, objective decision-making tool for detecting and differences in average performance of groups of items tested. The decision rather than using pure judgment, takes variation into account.

Table 5.1: L9 Orthogonal Array

Exp. No	Speed (Rpm)	Feed Rate	Depth of cut
1	150	0.1	0.5
2	150	0.2	0.7
3	150	0.3	0.9
4	250	0.1	0.7
5	250	0.2	0.9
6	250	0.3	0.5
7	350	0.1	0.9
8	350	0.2	0.5
9	350	0.3	0.7

VI. CALCULATIONS FOR SURFACE ROUGHNESS

A. General Linear Model: surface Roughness (Ra)

Table 6.1 Calculations For Surface Roughness

Exp. No	Speed (Rpm)	Feed Rate	Depth of cut	Surface roughness (Ra)
1	150	0.1	0.5	1.492
2	150	0.2	0.7	2.461
3	150	0.3	0.9	3.468
4	250	0.1	0.7	2.241
5	250	0.2	0.9	2.751
6	250	0.3	0.5	1.541
7	350	0.1	0.9	1.962
8	350	0.2	0.5	1.017
9	350	0.3	0.7	2.925

Table 6.2 ANOVA of Surface Roughness

Source	DOF	SS	Adj MS	F Value	P value	Contribution
Speed (Rpm)	2	0.3873	0.1936	1.57	0.390	7.906%
Feed Rate	2	0.9117	0.4559	3.69	0.213	18.612%
Depth od cut	2	3.3519	1.6759	13.55	0.069	68.431%
Error	2	0.2473	0.1236	-	-	5.4%
Total	8	4.8982	-	-	-	100%

B. At Least 95% Confidence

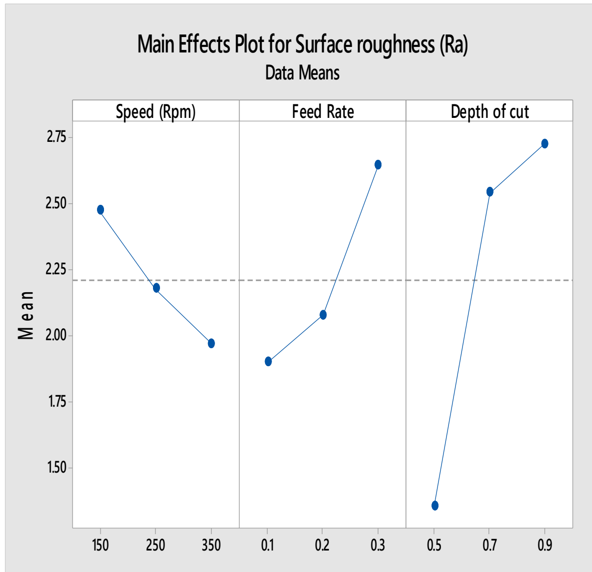

Figure 5.6 Main Effect Plot for Surface Roughness

Main effect plots for surface roughness square measure shown within the figure . Main impact plot shows the variation of surface roughness with regard to Spindle speed, feed rate and depth of cut. X -axis represents amendment in a level of the variable and y-axis represents the amendment within the resultant response.

The above graph presents the main effect plot for surface roughness. From all the three graphs it is observed that the surface finish degrades with increase in the level of machining parameters. Feed rate is the major influencing parameter for surface roughness with a contribution of 18.612%. The graph elucidates that surface roughness increases with increase in feed rate. The surface degrades with the increase in feed rate as thicker layer of material is removed which will roughness the new exposed machined surface. By increasing the cutting speed, the surface roughness increases. Very rough surface is generated at higher level of cutting speed. In case of depth of cut, it also affects the surface roughness in similar fashion but has a lower influence. Depth of cut is the least influencing parameter for surface roughness.

The graph in the Figure 5.7 presents the relation and interaction between surface roughness produced and plain turning parameters. In this case, the surface roughness increases with cutting speed at lower level of feed rate. But at higher levels of feed rate (0.2 and 0.3 mm/rev), the surface roughness plot is almost flat and has almost negligible influence with cutting speed

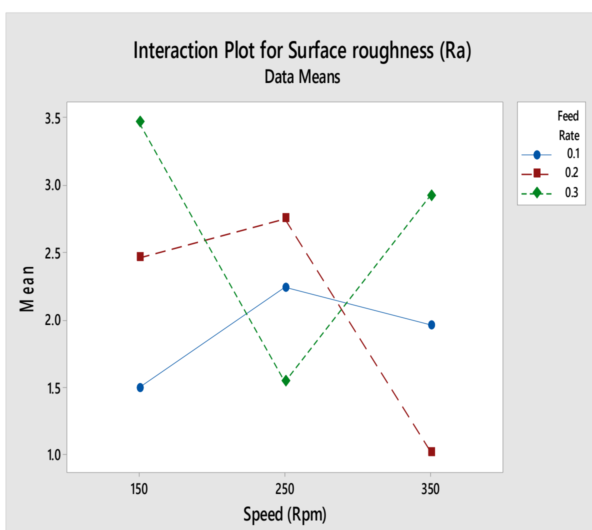

Figure 5.7: Interaction Plot between Surface Roughness and plain turning parameters

VII. CONCLUSIONS

The Surface roughness is principally plagued by feed rate, depth of cut and spindle speed. With the rise in feed rate the surface roughness conjointly will increase, because the depth of cut will increase the surface roughness initial increase and reduce and because the spindle speed increase surface roughness decreases. From multivariate analysis parameters making very important result on surface roughness area unit feed rate and depth of cut. The parameters taken within the experiments area unit optimized to get the minimum surface roughness potential. The optimum setting of cutting parameters for prime quality turned elements is as: -

1. Spindle speed = 350 rpm
2. Feed rate = 0.1 mm/ rev
3. Depth of cut = 0.5 mm

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