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Research Article

Ovat Analysis for Surface Finish in CNC Contour Turning (G03) and Turning (G01) on Aluminum

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Abstract

CNC turning is one of the most important and widely used manufacturing processes in engineering industries. Today's manufacturing scenario, optimization of metal cutting process is essential for a manufacturing unit to respond effectively to competitiveness and increasing demand of quality which has to be achieved at minimal cost. Surface finish is one of the prime requirements of customers for CNC machined parts. The purpose of this project is primarily focused on the analysis of optimum cutting conditions to get good surface finish. This project presents an experimental study to investigate the effects of cutting parameters like Cutting speed, feed and depth of cut and cutting oil used on surface finish on Aluminium metal for contour turning and turning processes. The PATIL ENTERPRISES is an ISO 9001-2000 certified company established in 1985 with concentration in Manufacturing & Machining job works. Units expanding its manufacturing range to a wide variety of Gears, Pinions, Shafts and Valve Equipment's such as Ball, Stem for Ball Valve, Pinion for Actuator and Gate for Gate Valve. There are some problem related to surface finish of CNC turning components, OVAT Analysis is used for investigation of various CNC parameters which affects on surface Finish of components & CNC Programming modification according to required surface finish value.

Keywords: *Aluminum, Cut viewer turns 3.2, CNC Programming, One variable at a time analysis (OVAT Analysis), Surface Finish*

1. Introduction

Surface roughness often shortened to roughness, is a component of surface texture. If these deviations are large, the surface is rough; if they are small, the surface is smooth. Roughness is typically considered to be the high-frequency, short-wavelength component of a measured surface .However, in practice it is often necessary to know both the amplitude and frequency to ensure that a surface is fit for a purpose. Roughness plays an important role in determining how a real object will interact with its environment. Rough surfaces usually wear more quickly and have higher friction coefficients than smooth surfaces. Roughness is often a good predictor of the performance of a mechanical component, since irregularities in the surface may form nucleation sites for cracks or corrosion. On the other hand, roughness may promote adhesion.

Although a high roughness value is often undesirable, it can be difficult and expensive to control in manufacturing. Decreasing the roughness of a surface will usually increase its manufacturing costs. This often results in a trade-off between the manufacturing cost of a component and its performance in application.

Many factors contribute to the surface finish in manufacturing. Any given manufacturing process is usually optimized enough to ensure that the resulting texture is usable for the part's intended application. If necessary, an additional process will be added to modify the initial texture. The expense of this additional process must be justified by adding value in some way—principally better function or longer lifespan. Parts that have sliding contact with others may work better or last longer if the roughness is lower. Aesthetic improvement may add value if it improves the salability of the product.

The one-variable-at-a-time method (or OVAT) is a method of designing experiments involving the testing of factors, or causes, one at a time instead of all simultaneously. By performing OVAT (One Variable at a Time) analysis it is clear that speed, feed and depth of cut, are influencing CNC parameters on Surface finish. According to OVAT analysis following input parameters namely speeds, feed and depth of cut, are selected by keeping other process parameters constant which are less influencing on penetration

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The objective of present work is an attempt to find the optimum values of surface finish for given input parameters spindle speed, Feed rate, depth of cut and coolant used while performing turning operation and counter turning operation on the Aluminium work piece. The optimum value obtained for surface finishing using OVAT analysis technique in which one variable is studied while other variables are kept constant. In the last step of the process, we presented the results in the form of graphs by using MINITAB software.

2. Methodology

The One-Variable-At-Time method (or OVAT) is a method of designing involving the testing of variables, or causes, one at a time instead of all simultaneously. Prominent text books and academic papers currently favor factorial experimental designs, a method pioneered by Sir Ronald A. Fisher, where multiple factors are changed at once. Despite these criticisms, some researchers have articulated a role for OVAT and showed they can be more effective than fractional factorials under certain conditions (number of runs is limited, primary goal is to attain improvements in the system, and experimental error is not large compared to factor effects, which must be additive and independent of each other). Designed experiments remain nearly always preferred to OVAT with many types and methods available, in addition to fractional factorials which, though usually requiring more runs than OVAT, do address the three concerns above. One modern design over which OVAT has no advantage in number of runs is the Plackett-Burman which, by having all factors vary simultaneously (an important quality in experimental designs), gives generally greater precision in effect estimation. This technique has been used by us to evaluate the data from the observations to get the best optimum value for the surface finish.

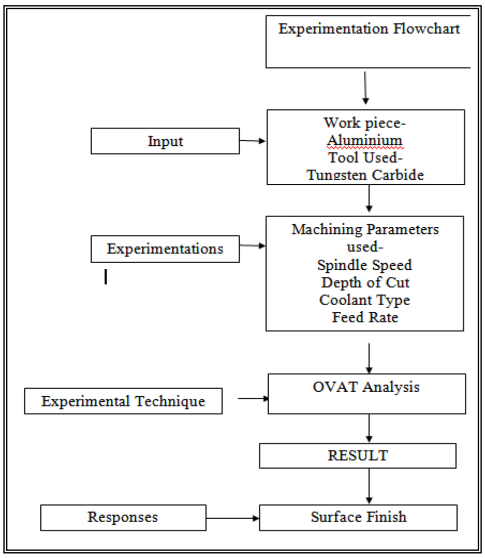


Fig.1 Methodology

3. Experimental work

For this Experiment, whole work is done by the CNC CLT 100 machine, tool used was tungsten carbide, and work piece used is aluminum material. The coolant is varied in order to obtain different results so as to compare and obtain in the optimum result. Experiment was conducted by varying different input parameters to obtain better surface finish.

Fig.2 CNC Machine (CLT 100)

3.1 Work piece Material

The work material used in the project is Aluminum job. The work piece has the dimensions of 40mm*25mm. The Aluminum job is selected because the company deals with manufacturing of aluminum jobs and work pieces. Also aluminum is the most used material in industries. The aluminum material is selected so that it is fitted in the chuck of CNC and proper operations can be performed on it. This aluminum material has been machined by turning and contour turning operations.

Fig.3 Work piece material (Aluminium)

3.2 Measuring of Surface Roughness

The surface roughness is measured using device named Hommelwerke T800.Wavesystem, a system which offers perfect configuration options for roughness, contour and topography measurement for all application areas. It has simple operation, rapid and precise measurement and functional and ergonomic design. And the best of all: more comfort at higher accuracy.

Fig 4 Surface roughness tester

3.3 Experimental Setup

Experimental setup consists of –CNC Machine, aluminum material and surface tester. First we studied all parameters of CNC machine that affect the surface finish of material, then we selected the material aluminum as it was required by the company requirement. working on CNC Machine with different feed rate, depth of cut and all parameters .we studied for 18 work piece (sample).we produce the different CNC Program required for the process of 18 samples, we used it for the machining process of turning and contour turning on our 18 samples with different parameters and calculate the surface roughness by using surface roughness tester. We used Cut viewer software on the CNC machine to check simulation of operation.

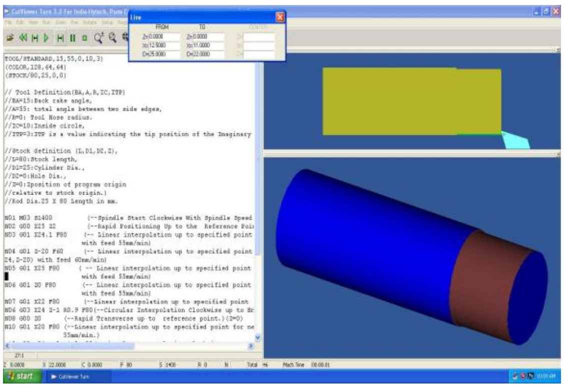


Fig .5 Cutviewer turning simulation (raw material)

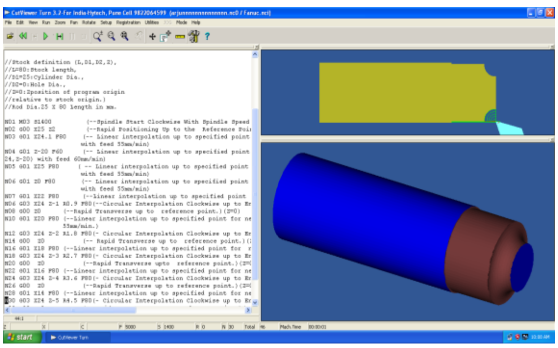
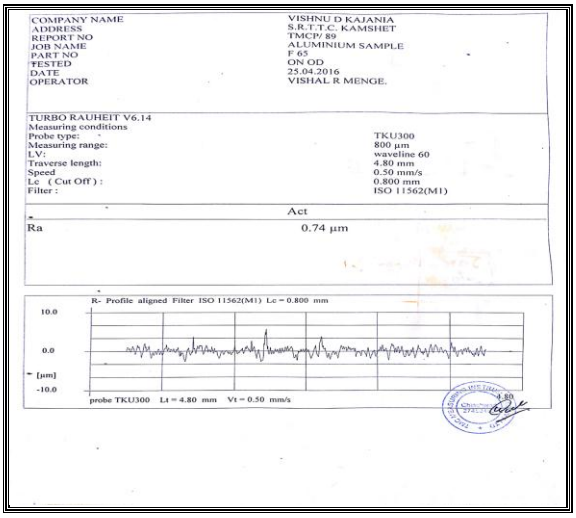


Fig .6 Cut viewer turning simulation (Final Stage)

Fig.7 Work piece material (Sample)

4. **Observation & Results**



COMPANY NAME	VISHNU D KAJANIA
ADDRESS	S.R.T.T.C. KAMSHET
REPORT NO	TMCP/ 89
JOB NAME	ALUMINIUM SAMPLE
PART NO	F 65
TESTED	ON OD
DATE	25.04.2016
OPERATOR	VISHAL R MENGE.

TURBO RAUHEIT V6.14

Measuring conditions	
Probe type:	TKU300
Measuring range:	800 µm
LV:	waveline 60
Traverse length:	4.80 mm
Speed	0.50 mm/s
Lc (Cut Off):	0.800 mm
Filter:	ISO 11562(M1)

	Act
Ra	0.74 µm

Fig.8 Report (Sample)

OVAT Analysis of Cutting for Turning Process (G01): Cutting Speed (G01)

Table 1 Effect of cutting speed For Turning (G01) Operation

Job No.	Cutting speed (rpm)	Surface finish (µm)			Average Surface Finish
		1	2	3	
1	1400	0.78	0.76	0.77	0.76
2	1200	0.62	0.62	0.62	0.62
3	1000	0.84	0.84	0.84	0.84
4	800	0.76	0.76	0.76	0.76
5	600	1.31	1.31	1.31	1.31

Feed Rate (G01)

Table 2 Effect of feed rate For Turning (G01) Operation

Job No.	Feed Rate	Surface finish (µm)			Average Surface Finish
		1	2	3	
1	85	0.82	0.82	0.82	0.82
2	75	1.70	1.75	1.80	1.75
3	65	0.74	0.74	0.74	0.74
4	55	0.76	0.76	0.76	0.76
5	45	0.79	0.80	0.81	0.8

Depth of Cut (G01)

Table 3 Effect of depth of cut For Turning (G01) Operation

Job No.	Depth of Cut (mm)	Surface finish (µm)			Average Surface Finish
		1	2	3	
1	0.9	0.86	0.86	0.86	0.86
2	0.8	0.87	0.85	0.86	0.86
3	0.7	0.85	0.86	0.84	0.85
4	0.6	0.85	0.85	0.85	0.85
5	0.5	0.85	0.85	0.85	0.86

Coolant Used (G01)

Table 4 Effect of coolant used For Turning (G01) Operation

Job No.	Type of coolant Conditions	Surface finish (µm)			Average Surface Finish
		1	2	3	
1	Dry Condition	0.76	0.77	0.75	0.76
2	Wet Condition	0.75	0.73	0.74	0.74

OVAT Analysis of cutting speed for contour Turning (G03)

Cutting Speed (G03)

Table 5 Effect of cutting speed For (G03) Contour Turning

Job No.	Cutting speed rate (rpm)	Surface finish (µm)			Average Surface Finish
		1	2	3	
1	1400	1.9	1.9	1.9	1.9
2	1200	0.24	2.24	2.24	2.24
3	1000	1.60	1.62	1.61	1.61
4	800	1.96	1.96	1.96	1.96
5	600	2.13	2.55	2.51	2.54

Feed Rate (G03)

Table 6 Effect of Feed rate For (G03) Contour Turning

Job No.	Feed rate (mm/min)	Surface finish (µm)			Average Surface Finish
		1	2	3	
1	85	1.97	1.97	1.97	1.97
2	75	1.49	1.49	1.49	1.49
3	65	1.60	1.62	1.61	1.61
4	55	1.57	1.57	1.57	1.57
5	45	2.22	2.22	2.22	2.22

Depth of cut (G03)

Table 7 Effect of depth of cut For (G03) contour turning

Job No.	Depth of Cut (mm)	Surface finish (µm)			Average Surface Finish
		1	2	3	
1	0.9	2.10	2.10	2.10	2.10
2	0.8	2.34	2.35	2.36	2.35
3	0.7	1.18	1.18	1.18	1.18-
4	0.6	1.19	1.19	1.19	1.19
5	0.5	1.22	1.22	1.22	1.22

Type of Coolant used

Table 8 Effect of coolant used For (G03) contour Turning

Job No.	Type of Coolant used	Surface finish (µm)			Average Surface Finish
		1	2	3	
1	Dry Condition	1.9	2.0	1.8	1.9
2	Wet Condition	1.9	1.8	1.7	1.7

5. Result and Discussion

The graphs and results obtained are as follows:

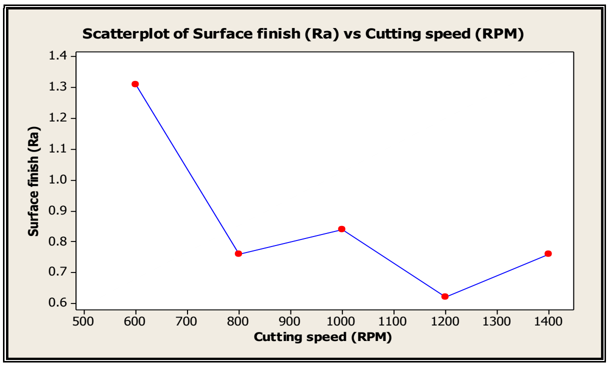


Fig.9 cutting speed vs. Surface finish

Table 9 cutting speed for G01 (turning)

Job No.	Cutting speed (rpm)	Surface finish (µm)			Average Surface Finish
		1	2	3	
1	1400	0.78	0.76	0.77	0.76
2	1200	0.62	0.62	0.62	0.62
3	1000	0.84	0.84	0.84	0.84
4	800	0.76	0.76	0.76	0.76
5	600	1.31	1.31	1.31	1.31

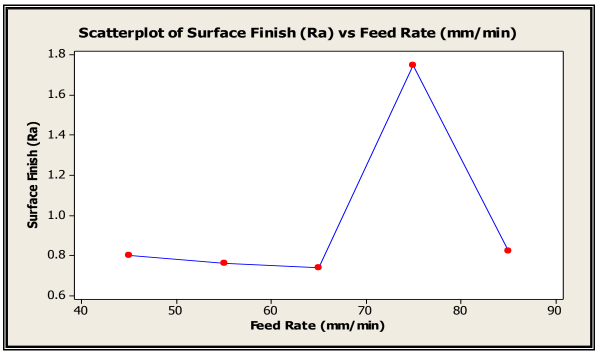


Fig.10 Feed rate vs. Surface Finish

Table 10 Feed rates for turning

Job No.	Feed Rate	Surface finish (µm)			Average Surface Finish
		1	2	3	
1	85	0.82	0.82	0.82	0.82
2	75	1.70	1.75	1.80	1.75
3	65	0.74	0.74	0.74	0.74
4	55	0.76	0.76	0.76	0.76
5	45	0.79	0.80	0.81	0.8

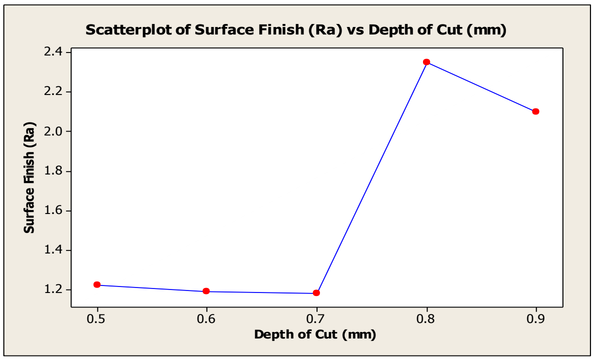


Fig.11 Depth of Cut vs. Surface Finish

Table 11 Depth of Cut for turning

Job No.	Depth of Cut (mm)	Surface finish (µm)			Average Surface Finish
		1	2	3	
1	0.9	0.86	0.86	0.86	0.86
2	0.8	0.87	0.85	0.86	0.86
3	0.7	0.85	0.86	0.84	0.85
4	0.6	0.85	0.85	0.85	0.85
5	0.5	0.85	0.85	0.85	0.86

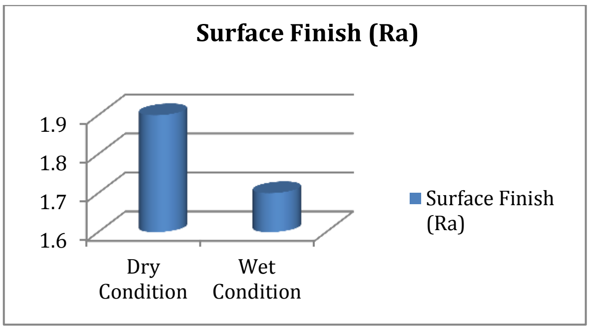


Fig.12 Coolant Variation vs. Surface Finish

Table 12 Coolant Variation for Turning

Job No.	Type of coolant Conditions	Surface finish (µm)			Average Surface Finish
		1	2	3	
1	Dry Condition	0.76	0.77	0.75	0.76
2	Wet Condition	0.75	0.73	0.74	0.74

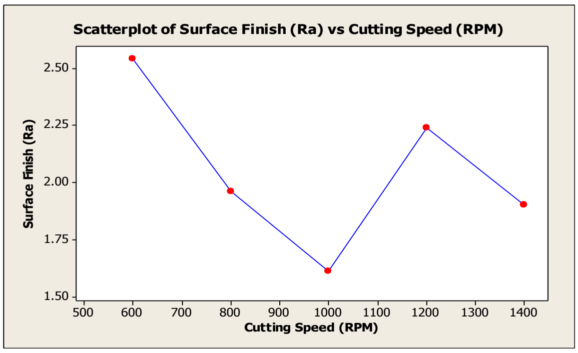


Fig.13 Cutting speed vs Surface Finish for Contour Turning

Table 13 cutting speed for Contour Turning

Job No.	Cutting speed rate (rpm)	Surface finish (µm)			Average Surface Finish
		1	2	3	
1	1400	1.9	1.9	1.9	1.9
2	1200	0.24	2.24	2.24	2.24
3	1000	1.60	1.62	1.61	1.61
4	800	1.96	1.96	1.96	1.96
5	600	2.13	2.55	2.51	2.54

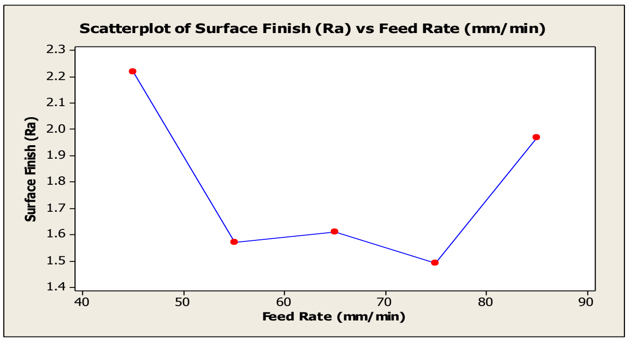


Fig.14 Feed Rate v surface Finish

Table 14 Feed Rate for Contour Turning

Job No.	Feed rate (mm/min)	Surface finish (µm)			Average Surface Finish
		1	2	3	
1	85	1.97	1.97	1.97	1.97
2	75	1.49	1.49	1.49	1.49
3	65	1.60	1.62	1.61	1.61
4	55	1.57	1.57	1.57	1.57
5	45	2.22	2.22	2.22	2.22

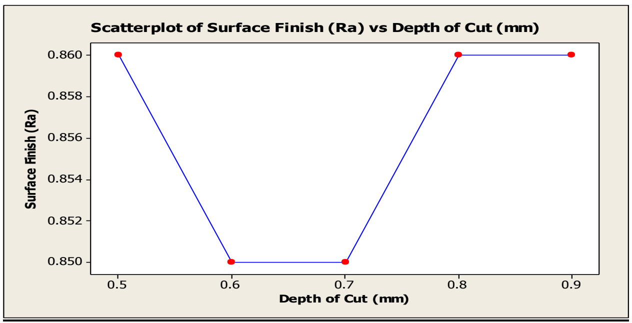


Fig .15 Depth of Cut vs Surface Finish

Table 15 Depth of cut for contour turning

Job No.	Depth of Cut (mm)	Surface finish (µm)			Average Surface Finish
		1	2	3	
1	0.9	2.10	2.10	2.10	2.10
2	0.8	2.34	2.35	2.36	2.35
3	0.7	1.18	1.18	1.18	1.18
4	0.6	1.19	1.19	1.19	1.19
5	0.5	1.22	1.22	1.22	1.22

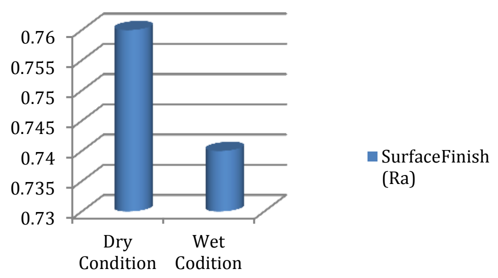


Fig.16 Coolant Varied vs Surface Finish

Table 16 Type of Coolant used for contour turning

Job No.	Type of Coolant used	Surface finish (µm)			Average Surface Finish
		1	2	3	
1	Dry Condition	1.9	2.0	1.8	1.9
2	Wet Condition	1.9	1.8	1.7	1.7

Conclusions

The optimum values obtained For (G01) Turning process for each parameters are :cutting speed is 1200rpm, feed rate is 65mm/min, depth of cut is 0.7mm, and surface roughness are 0.62, 0.74, 0.85 respectively and for coolant is 0.74.

(G03) Contour turning process, optimum value are: cutting speed is 1000rpm, for feed rate is 75mm/min, for depth of cut is 0.7mm, and surface roughness are 1.61, 1.49, 1.18 respectively and for effect of coolant is 1.7.

Thus the optimum values are obtained for the surface finish, and modified settings of the CNC program with the optimum value for cutting speed, Feed rate, Depth of Cut and Coolant is used to obtain the optimum surface finish for the job.

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