Volume-8, Issue-2, April 2018
International Journal of Engineering and Management Research
Page Number: 61-65

Performance Optimzation in Turning of Alluminium 8019 Alloy

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ABSTRACT

This paper presents reduction of surface roughness in dry turning of Aluminum 8019 alloy using TiN-TiCN-Al_2O_3-ZrCN multilayer coated cemented carbide & uncoated cryo-treated inserts. Effect of cutting velocity, feed rate, depth of cut and machining duration is studied on the surface roughness. Taguchi's design of experiment is used to find the optimum factor levels. From this experiment we came into a conclusion that the feed rate has much effect in producing lower surface roughness followed by speed. The depth of cut has lesser role on surface roughness. The result of Taguchi method shows that cutting speed of 2000 rpm, feed rate of 0.2 mm/rev and depth of cut of 0.75mm should be maintained as optimal parameter settings for both coated and uncoated tools.

***Keywords*—** Cryogenic, Dry Turing, Surface roughness, Taguchi Method

I. INTRODUCTION

Now-a-days, determination of optimum values of process parameters in manufacturing are the areas of great interest for researchers and manufacturing engineers. For modern machining, it is necessary to focus on the achievement of high quality in terms of product dimensional accuracy, surface quality, high production rate, less tool wear and economy of machining. Surface roughness is among the inevitable customer requirements as it is caused by the influence of the cutting tool during the machining process. Roughness is the dominant magnitude related to the machinability of the processed material, the tool form, the machining conditions, and the tolerance requirements. Therefore, attempt should be made to minimize surface roughness because higher unevenness leads to functional discrepancies.

CNC Turning is that the one among the foremost wide used machine for manufacturing rounded form work piece in shorter time at affordable prize with smart surface and metallic element is widely accustomed manufacture the elements of the vehicles by turning method due its light-weight weight. It is extremely desired that product having smart surface quality area unit factory-made in short time. The surface quality of product is usually determined in terms of the measured surface roughness. Surface roughness usually depend upon the cutting parameters such as: cutting speed, feed rate and depth of cut. Proper choice of the management factors for the experiment is very important so as to supply the parts with smart surface end and high tolerance in brief time. within the previous few decades, lots of labor has been dole out to boost the standard of the merchandise and potency in machining. Still varied aspects associated with this paper area unit however to be explored. Ravindra Thamma [1] has found completely different models to obtain optimal machining parameters for needed surface roughness for an aluminium 8019 work items. He complete that Spindle speed, feed rate, and nose radius have significant control factors for surface roughness. sander surfaces will be created once machined with a bigger spindle speed, smaller feed rate, and nose radius Depth of cut has a significant influence on surface roughness. H. M.Somashekaraet. al. [2] used management factors e.g. cutting speed, feed rate and depth of move optimize Surface Roughness. while machining Al 6351-T6 alloy with uncoated Carbide tool. They used Taguchi Technique to optimize the process parameters and confirmation take a look at were additionally performed for locating main factors influencing Surface Roughness. They complete that Speed includes a larger influence on the Surface Roughness. Gaurav Vohraet. al. [3] have optimized the machining parameters for boring of aluminium material on CNC turning centre e.g. cutting speed, feed rate and depth of cut, to get optimum material removal rate and minimum surface roughness by exploitation the Taguchi - method.

1.1 Surface roughness

R value, the arithmetic average roughness (center line average), determined from deviations about the center line within the evaluation length is the most popular parameter for a machining process and product quality control. This parameter is easy to define, easy to measure even in the least suitable profile-meters and gives a general description of surface amplitude. Though it lacks physical significance, it is established in almost every national standard for measuring roughness. The average surface roughness is given by

$$Ra = \frac{1}{l} \int_0^l |y(x)|\, dx \quad (1)$$

Here, Ra is the arithmetic average deviation from the mean line; l is the sampling length, y coordinate of the profile curve.

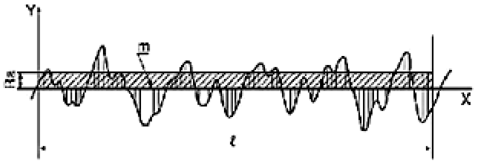


Figure 1 Evaluation of surface roughness

1.2 Taguchi DOE

Taguchi's design of experiment methodology is a convenient tool to optimize the cutting parameters with less experimental runs [2]. Taguchi primarily recommends experimental design as a tool to make products more robust – to make them less sensitive to noise factors. The experimental design procedure is suitable tool for reducing the effect of variation on product and process quality characteristics [3]. Analysis of Variance (ANOVA) can be employed to identify the most significant

Variables and interaction effects [4] In turning, many researchers have modeled surface roughness. Davim [5] has presented a study of the influence of cutting parameters on the surface roughness obtained in turning of free machining steel using Taguchi design and shown that the cutting velocity has a greater influence on the roughness followed by the feed rate. Lin et al. [6] have shown that feed rate is the critical parameter in turning to affect the surface roughness as increase of feed rate increases the surface roughness. Suresh et al. [7] have shown that surface roughness decreases with an increase in cutting speed in turning of mild steel. Arbizu and Perez [8] have developed models to determine surface quality of parts obtained through turning processes and shown that surface roughness increases with increase in depth of cut and feed rate. Sahin and Motorcu[9] have developed a surface roughness model for turning of mild steel with coated carbide tools and shown that feed rate is the main influencing factor on surface roughness. Surface roughness increases with increase in feed rate but decreases with increase in cutting speed and depth of cut. The literature survey shows that mainly three cutting parameters viz. cuttings peed, feed rate and depth of cut are the common parameters considered for most of the studies. The present research has two purposes. The first is to demonstrate the use of Taguchi's parameter design in order to identify the optimum parametric combination to minimize surface roughness. The second is to propose a predictive methodology for estimating surface roughness using data obtained during experimentation conducted as per Taguchi design.

II. EXPERIMENTAL DETAILS

2.1 Work piece material

Al (% of Wt.)= 87.5
Fe (% of Wt.)=8.3
Ge (% of Wt.)=4.0
O (% of Wt.)=0.2

Job material (step turned Al)

2.2 Cutting tool material

The cutting tool is P30 cemented carbide inserts (Make: Widia) having Insert designation as CNMG 12 04 08 and tool geometry -60, -60, 60, 60, 150, 750, 0.8 mm. P 30 grade of cemented carbide has excellent hardness, wear resistance and toughness [10]. The composition of P30 carbide inserts WC74.25%, TiC 8.25%, Ta +NbC 8.80%, and Co 8.70%.

Cutting tool (carbide tipped tool CNMG120408TM-T9125)

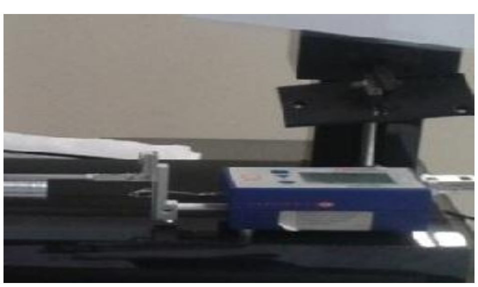
2.3 Machine tool

The turning operations were carried out in a rigid CNC turning machine AMS India, Bangalore. The tool holder used for machining is MCLNR 2525 M12.

Machining Set Up(Super Jobber CNC Turning)

2.4 Surface roughness Measurement

Surface roughness was measured using a portable stylus-type profilometer, Talysurf (Taylor Hobson, Surtronic 3+, UK)



Shows the Talysruf surface roughness testing device for measurement of surface roughness(Ra)

2.5 Cryo-treatment

In the present investigation, PVD coated carbide inserts were subjected to deep cryogenic treatment (-190°C). Cryotreatment (CT) is a secondary process to conventional heat treatment that involves deep freezing of materials at cryogenic temperatures to enhance the mechanical and physical properties.

2.6 Experimentation

Three cutting parameters with their levels are shown in Table1. A L_{27} orthogonal array was chosen for conducting experiments [11, 12]. The complete experimental plan along with response (surface roughness) for Coated and Cryotreated uncoated tools is shown in Table 2. The responses are converted into signal-to-noise ratio (S/N ratio) for lower-the-better quality characteristic. Analysis of responses is carried out by MINITAB 14 software. S/N ratio for 'lower the better' type response is given by

$$S/N\ ratio= -10\log [(1/n\ (y_1^2+y_2^2+\ldots\ldots+y_n^2)] \quad (2)$$

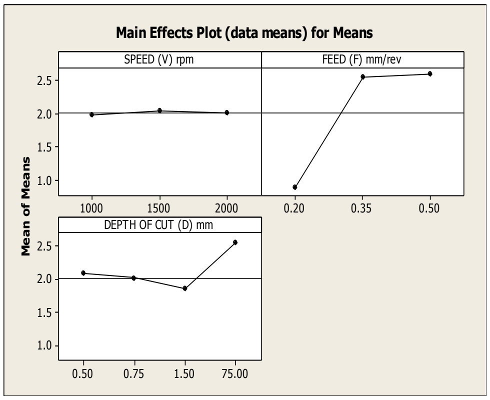
Where y_1, y_n are the responses of values of quality characteristic for the trial condition repeated 'n' times. Experimental conditions are shown in Table.1.

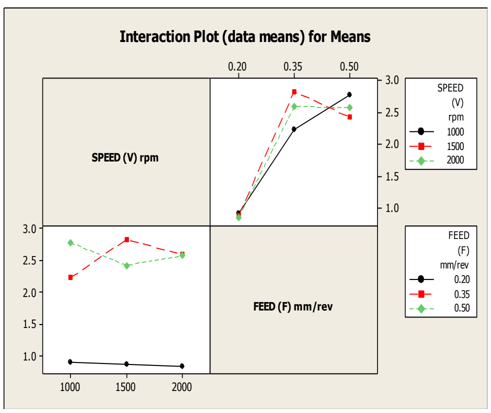
Table -1: Name of the Table

Exp No.	SPEED (V) rpm	FEED (F) mm/rev	DEPTH OF CUT (D) mm	SURFACE ROUGHNESS OF COATED (Ra) µm	SURFACE ROUGHNESS OF CRYOTREATED
1	1000	0.2	0.5	0.823	0.81
2	1000	0.2	0.75	0.957	0.932
3	1000	0.2	1.5	0.965	0.925
4	1500	0.2	0.5	0.952	0.932
5	1500	0.2	0.75	0.795	0.783
6	1500	0.2	1.5	0.882	0.835
7	2000	0.2	0.5	0.809	0.802
8	2000	0.2	0.75	0.668	0.656
9	2000	0.2	1.5	1.06	0.969
10	1000	0.5	0.5	3.03	2.792
11	1000	0.5	0.75	3.12	2.885
12	1000	0.5	1.5	2.18	1.98
13	1500	0.5	0.5	1.87	1.53
14	1500	0.5	0.75	2.78	2.328
15	1500	0.5	1.5	2.62	2.255
16	2000	0.5	0.5	3.10	2.82
17	2000	0.5	0.75	2.74	2.454
18	2000	0.5	1.5	1.88	1.456
19	1000	0.35	0.5	2.10	1.865
20	1000	0.35	0.75	2.15	1.869
21	1000	0.35	1.5	2.44	2.14
22	1500	0.35	0.5	2.85	2.35
23	1500	0.35	0.75	2.92	2.57

24	1500	0.35	1.5	2.71	2.54
25	2000	0.35	0.5	3.25	2.965
26	2000	0.35	075	2.54	2.168
27	2000	0.35	1.5	1.99	1.64

Chart -1:





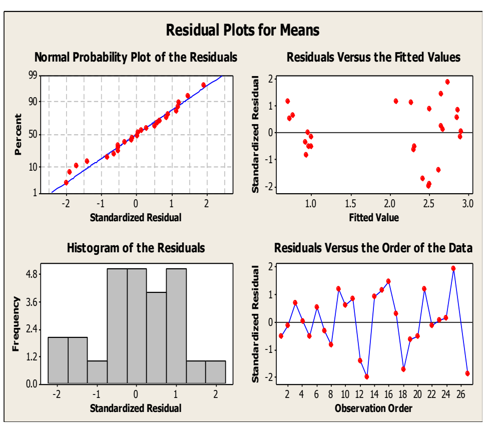
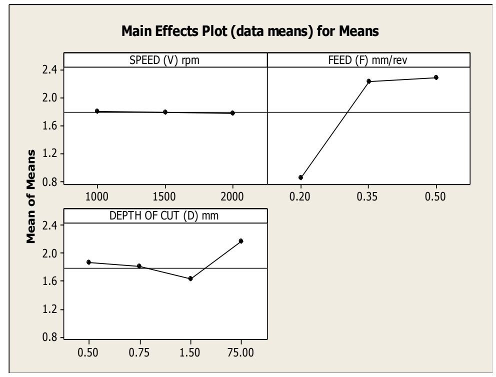
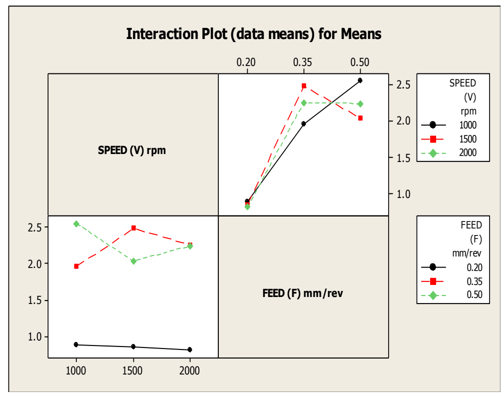
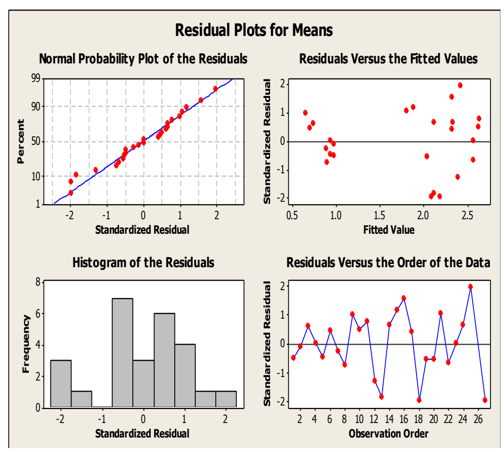


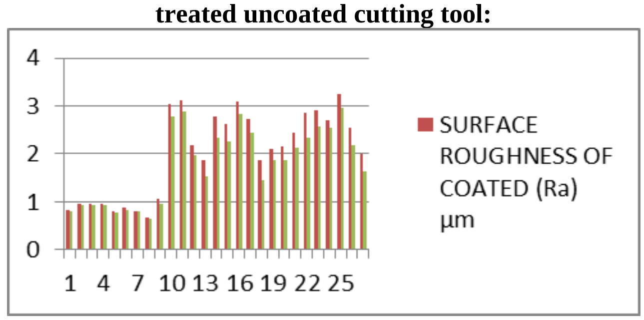
Chart -2:







The comparison graph between coated and cryo treated uncoated cutting tool:



III. CONCLUSION

In this paper, the effects of the machining parameters were evaluated on surface roughness ,when step turning of Al Alloy under dry cutting condition were performed by using Taguchi methodology. The following specific conclusions are achieved based on the results:

- For machining Aluminium alloy feed rate is the most significant control factor.
- Average surface roughness decreased with increasing cutting speed during machining using carbide tipped tool inserts.
- For obtaining better surface finish for machining of material, the control parametric combinations are 3rd level spindle speed (2000 rpm), 1st level feed rate(0.2 mm/rev) and 1st level depth of cut(0.75 mm).

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