Experimental investigation and optimization of surface roughness on teflon (PTFE) cylindrical rods using ANOVA methodology

M. Subramanian[1], Dr. T. T. M. Kannan[2], I. Justin Antony raj[3]

[1,3] Assistant Professor, Department of Mechanical Engineering, Vandayar engineering college , Thanjavur-613501-TN- India.
[2] Associate Professor, Department of Mechanical Engineering, M.A.M. College of engineering , Tiruchirappalli. TN, India.

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Abstract: *Recently Teflon (PTFE) cylindrical round rods play an important role in manufacture of bushes, gears, sprockets and bearings due to their excellent properties of low coefficient of friction and thermal insulation. Optimization of turning parameters were achieved a set of quality attributes for productivity requirements with cost economic. Minimum surface roughness and good surface finish were the primary objectives of turning process on teflon (PTFE) cylindrical rounds. This paper presents the single response optimization of CNC turning parameters using TAGUCHI DESIGN and ANOVA method. An influent parameter was obtained by using signal to noise ratio values of 3 levels and 3 factors of machining process.*

Keywords: Turning, Teflon (PTFE), Machining parameters, surface roughness, S/N ratio, Anova.

1. INTRODUCTION

PTFE has emerged as an important class of material for manufacturing of bushes, gears, sprocket and bearing, which are increasingly being utilized in recent years. Application of these materials in many areas were due to light weight, corrosion resistant, etc. The term machinability referred to the case with which a material could be machined to an acceptable surface finish. In most cases, the strength and toughness of a material were the primary factors. In any machining process, product quality attributes represented satisfactory yield with surface finish, formed stability along with dimensional accuracy whereas productivity could be interpreted in terms of surface roughness (Ra). On the contrary, an improvement in quality resulted in increasing machining time thereby reducing productivity. it was essential to select a common base through which to correlate them. Effort had been made to study the influence of process parameters on performance of various aspects of machining like: tool wear, interaction of cutting forces, surface roughness, material removal rate (MRR), tool life, machine tool chatter and vibration etc. Mathematical models had also been developed to understand the functional relationship among process parameters with a foresaid process responses.

LITERATURE SURVEY:

M.sanjeev kumar, et al,(2014),Above researcher conducted the experiments on machining parameter optimization of poly tetra fluroe thylene (PTFE) used genetic algorithm. The optimum value of surface roughness was 61.92024µm,the corresponding speed was 158.064m/min, feed was 0.164433mm/rev & depth of cut was 1.719453mm.

Mohd.suhail,et al, (2014),Above researcher was conducted the experiments on study of cutting forces & surface roughness in turning of bronze filled poly tetra fluro ethylene .The surface roughness was increases with the increased of the feed rate, the cutting force was increases with the increased of feed rate & depth of cut respectively.

Mr.Tushar U.jagtap,et al,(2015),Above researcher was conducted the experiments on machining of plastics :A Review, Effects of machining parameters needed to be studied for different plastic materials separately.

Research Gap, Above researcher did not done the surface roughness with minimum value and did not researched over material removal rate ,chip formation ,heat generation.

2. EXPERIMENTAL DETAILS:

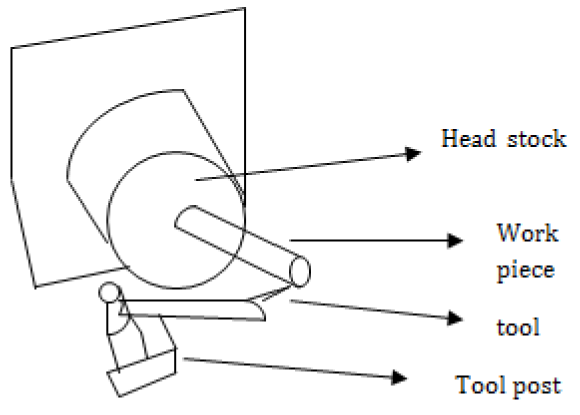

Fig .1. LATHE

Fig .2. DISCONTINUOUS BRITTLE CHIPS

Spindle speed -2000rpm,feed rate - 0.012mm/rev,discontinuous brittle chips.

Fig 3. CONTINUOUS CHIPS

Spindle speed- 3000rpm,feed rate - 0,017mm/rev,continuous chips.

Fig 4. CONTINUOUS CHIPS

Spindle speed-4000rpm,feed rate 0.02mm/rev,continuous chips.

Table .1.CHEMICAL COMPOSITION

chromium	bcc	128	$Cr_{23}C_6$, Cr_3C, Cr_7C_3, Cr_3C_2

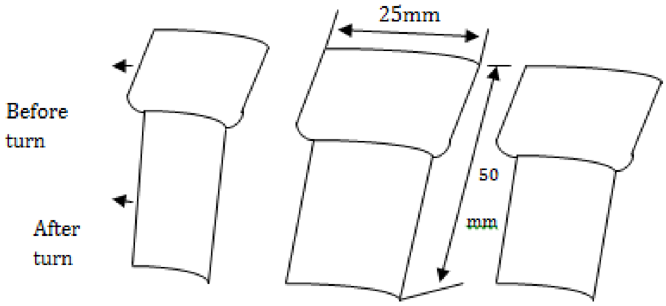

Fig. 5. After turning cylindrical rods

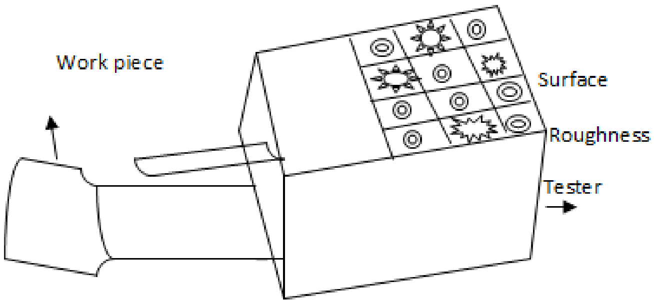

Fig .6.SURFACE ROUGHNESS TESTER WITH WORK PIECE

Surface roughness often shortened to roughness was a component of surface texture. It was quantified by the deviations in the direction of the normal vector of a real surface from its ideal form,If these deviations were large, the surface was rough, if they were small, the surface was smooth. Roughness was typically considered to be the high-frequency, short-wavelength component of a measured surface,However, in practice it was often necessary to know both the amplitude and frequency to ensure that a surface was fit for a purpose.Roughness played an important role in determining how a real object will interact with its environment. Rough surfaces weared more quickly and had higher friction coefficients than smooth surfaces. Roughness was often a good predictor of the performance of a mechanical component, irregularities in the surface may formed nucleation sites for cracks or corrosion. On the other hand, roughness may promoted the adhesion.

3. RESULTS AND DISCUSSION:

The following process results were getting for teflon material ,A taguchi design was a designed experiment that lets you choosen a product or process that functions were more consistently in the operating environment. Taguchi designs recognized that not all factors that caused variability could be controlled. These uncontrollable factors were called noise factors. Taguchi designs tried to identify controllable factors (control factors) that minimized the effect of the noise factors. During experimentation, you were manipulate noise factors to force variability to occur and then determined optimal control factor settings that made the process or product robust, or resistant to variation from the noise factors. A process designed with this goal will produce more consistent output. A product designed with this goal will deliver more consistent performance regardless of the environment in which it was used.

Table .2.Taguchi Design

Taguchi orthogonal array Design	L9
Factors	3
Runs	9

The surface roughness test was conducted for teflon (PTFE)material through surface roughness tester ,ninth job was getting minimum surface roughness value,minimum surface roughness value was better for turning process

Table. 3.Surface roughness values

JOB NO	VALUES(μm)
1	3.65
2	3.34
3	3.21
4	3.16
5	2.77
6	2.70
7	2.66
8	2.58
9	1.85

In taguchi designs ,a measure robustness used to identify control factors that reduced variability in a product or process by minimizing the effects of uncontrollable factors (noise factors). process parameters that could be controlled. Noise factors could not be controlled during production or product use, but could be controlled during experimentation. In a Taguchi designed experiment, you manipulated the noise factors to force variability to occur and from the results, identify optimal control factor settings that made the process or product robust, or resistant to variation from the noise factors. Higher values of the signal-to-noise ratio (S/N) was identify control factor settings that minimized the effects of the noise factors.

Table .4.ANOVA table

Response Table for Signal to Noise Ratios Smaller is better			
Level	Spindle speed	Feed rate	Depth of cut
1	-10.600	-9.725	-9.339
2	-9.125	-9.175	-8.588
3	-7.163	-7.987	-8.960
Delta	3.437	1.738	0.751
Rank	1	2	3

Spindle speed got more influence on teflon material ,so spindle speed got first rank, spindle speed increased surface roughness decreased. Here smaller is better concept taken for surface roughness.

Table .5.Analysis of Variance for Surface roughness, using Adjusted SS for Tests S = 0.203415 R-Sq = 96.46% R-Sq(adj) = 85.82%

Source	DF	Seq SS	Adj SS	Adj MS	F
Spindle speed	2	1.77182	1.77182	0.88591	21.41
Feed rate	2	0.42249	0.42249	0.21124	5.11
Depth of cut	2	0.05796	0.05796	0.02898	0.70
Error	2	0.08276	0.08276	0.04138	-
Total	8	2.33502	-	-	-

Through by ANOVA methodology ,Accuracy was 96.46%.

Main Effects Plot (data means) for SN ratios

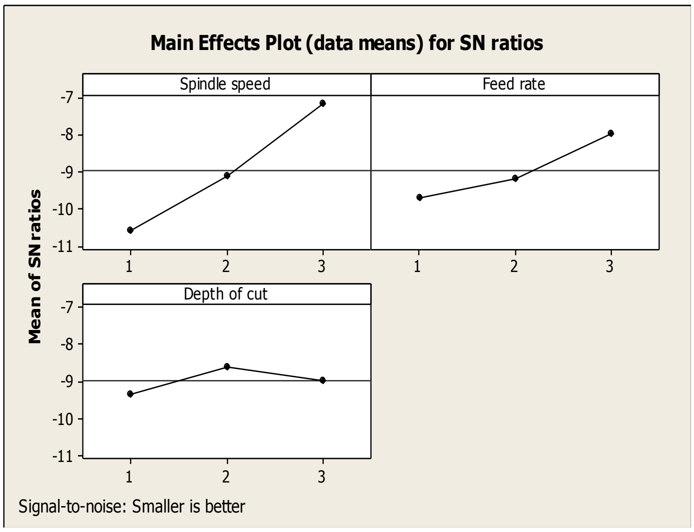

Fig .7.S/N ratio of turning parameters

Through by main effects plot (data means) for SN ratios curve spindle speed increased correspondingly surface roughness decreased.

Question: What was an independent variable?

Answer: An independent variable was exactly what it sounded like. It was a variable that stood alone and wasn't changed by the other variables you were trying to measure. For example, someone's age might be an independent variable. Other factors (such as what they ate, how much they gone to school, how much television they watched) weren't going to change a person's age. In fact, when you were looking for some kind of relationship between variables you were trying to see if the independent variable caused some kind of change in the other variables, or dependent variables.

Question: What was a dependent variable?

Answer: Just like an independent variable, a dependent variable was exactly what it sounded like. It was something that depended on other factors. For example, a test score could be a dependent variable because it could change depending on several factors such as how much you studied, how much sleep you got the night before you took the test, or even how hungry you were when you took it. when you were looking for a relationship between two things, you were trying to find out what made the dependent variable change the way it did. Many people had trouble remembering which was the independent variable and which was the dependent variable. An easy way to remember was to insert the names of the two variables you were using in this sentence in the way that made the most sense. Then you could figure out which was the independent variable and which was the dependent variable:

(Independent variable) caused a change in (Dependent Variable) and it wasn't possible that (Dependent Variable) could cause a change in (Independent Variable)

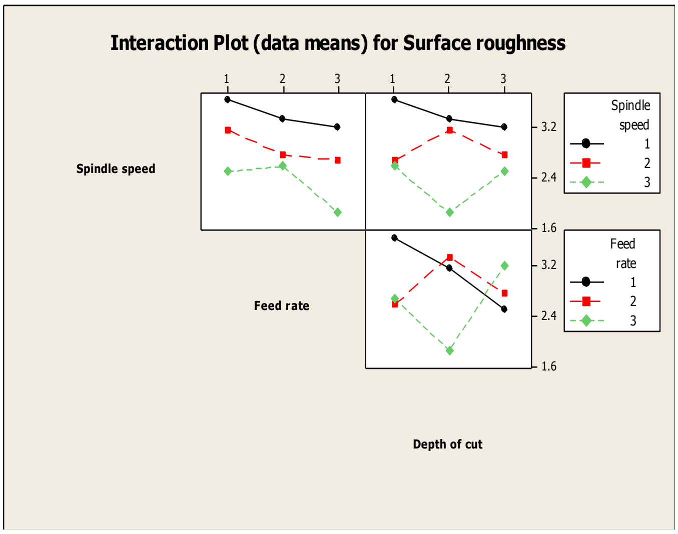

Fig .8. Interaction plot for turning parameters

From the above Interaction plot for turning parameters graph, spindle speed was independent parameter, other feed and depth of cut was dependent each other,so it was called as a dependent variable

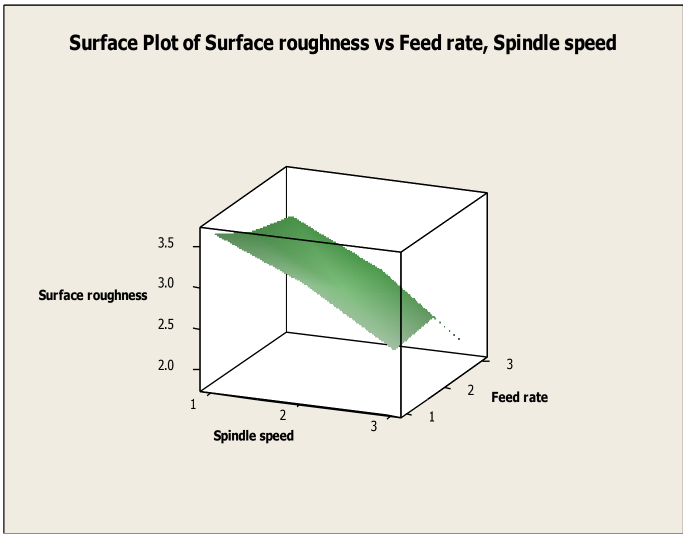

Fig .9. surface plot of surface roughness v_s feed rate, spindle speed

From the above surface plot of surface roughness v_s feed rate ,spindle speed gave the third level of spindle speed and first level of feed rate gave minimum surface roughness value.

4.CONCULSION

- The spindle speed was comparatively got more influence on surface roughness in turning process of teflon rods .
- L9 orthogonal array was accuracy about 96.46%.spindle speed showed optimum value in S/N curves.
- Each and every parameters were dependent and spindle speed showed optimum value comparatively with others.
- If spindle speed increased correspondingly surface roughness decreased.
- Spindle speed 4000 rpm, feed 0.012mm/rev, depth of cut 0.4mm showed minimum surface roughness value.
- Minimum heat transfer 879.2J,For spindle speed 2000 rpm ,feed .017mm/rev, depth of cut 0.4 mm.

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