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# An Experimental Investigation of Wet and Dry Turning Machinh Process with use of Minitab Software

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***Abstract:*** **The main objective of today's manufacturing industries is to produce low cost high quality products in shorts time. The selection of optimal cutting parameters is very important issue for every machining process in order to enhance the quality of machining product and reduce the machining cost. Surface inspection is carried out by manually inspecting the machine surface. As it is the post-process operation, it becomes both time consuming and laborious. In addition , a number of defected parts can be found during the period of surface inspection, which leads to additional production cost. In the present work cutting parameters ( cutting speed, depth of cut, feed rate, cutting fluids) have been optimized in turning of AISI 1045 of in turning operation on and AISI 1045 as a result of that combination of the optimal level of the factor was obtained to get the lowest surface roughness.**

**Keywords:** ***Anova, depth of cut, feed rate, spindle speed, AISI 1045, turning operation***

## I. INTRODUCTION

Turning is a type of machining, a material expulsion process, which is utilized to make rotational parts by removing undesirable material as appeared in figure1.1. The turning procedure requires a turning machine or machine, work piece, apparatus, and cutting device. The work piece is a bit of pre-formed material that is verified to the installation, which itself is connected to the turning machine, and permitted to pivot at high speeds. The shaper is regularly a solitary point cutting apparatus that is additionally verified in the machine, albeit a few activities utilize multi-point instruments. The cutting instrument sustains into the turning work piece and removes material as little chips to make the ideal shape.

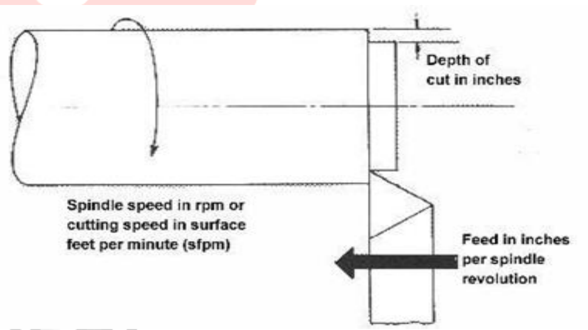


Figure 1.1: Turning Process

### 1.2 ADJUSTABLE CUTTING FACTORS IN TURNING

So as to distinguish the procedure parameter that may influence the machining qualities of turned parts an Ishikawa cause impact chart was developed and is appeared in figure 1.2. The procedure parameters influencing the qualities of turned parts are: cutting device parameters-instrument geometry and device material; work piece related parameters-metallography, hardness and so forth.; cutting parameters-cutting rate, feed, profundity of cut, dry cutting and wet cutting. The three essential factors in any fundamental turning activity are speed, feed, and profundity of cut. Different factors, for example, sort of material and kind of hardware have an enormous impact, obviously, however these three are the ones the administrator can change by altering the controls, directly at the machine.

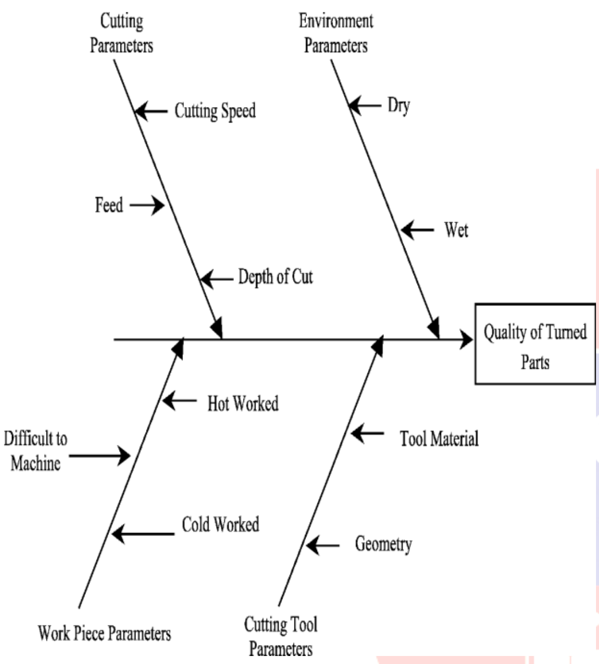


Figure1.3: Ishikawa cause-Effect outline of a Turning procedure

## 1.3 SURFACE STRUCTURE AND PROPERTIES

Harshness is a proportion of the surface of a surface. It is evaluated by the vertical deviations of a genuine surface from its optimal structure. In the event that these deviations are enormous, the surface is harsh; in the event that they are little the surface is smooth. Unpleasantness is ordinarily viewed as the high recurrence, short wavelength segment of a deliberate surface. Surface unpleasantness is a significant proportion of item quality since it incredibly impacts the exhibition of mechanical parts just as generation cost. Surface unpleasantness affects the mechanical properties like weariness conduct, erosion obstruction, creep life, and so on. Prior to surface unpleasantness, it is additionally important to talk about surface structure and properties, as they are firmly related.

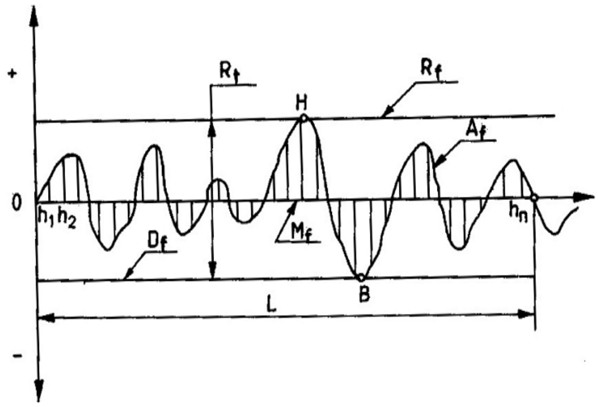


Figure 1.4: Surface Undulations

## 1.3 FACTORS AFFECTING THE SURFACE FINISH

At whatever point two machined surfaces interact with each other the nature of the mating parts assumes a significant job in the presentation and wear of the mating parts. The stature, shape, course of action and heading of these surface anomalies on the work piece rely on various factors, for example,

I. Machining factors which include:

a) Cutting speed

b) Feed, and

c) Depth of cut

II. Apparatus geometry

Some geometric variables which influence accomplished surface completion include:

a) Nose span

b) Rake point

c) Side bleeding edge point, and

d) Cutting edge

## 1.4 ADVANTAGES AND ADVANTAGES OF TAGUCHI METHOD

A favorable position of the Taguchi technique is that it underscores a mean exhibition attributes worth near the objective worth as opposed to an incentive inside certain detail limits, along these lines improving the item quality. Moreover, Taguchi's strategy for test configuration is clear and simple to apply to many designing circumstances, making it an incredible yet straightforward apparatus. It very well may be utilized to rapidly limit the extent of an examination venture or to recognize issues in an assembling procedure from information as of now in presence. Likewise, the Taguchi strategy takes into account the examination of a wide range of parameters without a restrictively high measure of experimentation. For instance, a procedure with 8 factors, each with 3 states, would require 6561 (38) trials to test all factors. Anyway utilizing Taguchi's symmetrical clusters, just 18 investigations are essential, or under 3 % of the first number of trials. Along these lines, it takes into account the ID of key parameters that have the most impact on the exhibition qualities esteem with the goal that further experimentation on these parameters can be performed and the parameters that have little impact can be disregarded.

### 1.5 MINITAB SOFTWARE

Minitab is a measurements bundle. It was created at the Pennsylvania State University by analysts Barbara F. Ryan, Thomas A. Ryan, Jr., and Brian L. Joiner in 1972. Minitab offers a gathering of programming, bolster materials and administrations that empower you to deal with your quality and procedure improvement forms. This product is utilized for Data and File Management-spreadsheet for better information examination; Analysis of Variance; Regression Analysis; Power and Sample Size; Tables and Graphs; Multivariate Analysis - incorporates factor investigation; group investigation; correspondence investigation; and so forth., Nonparametric tests including sing test, runs test, friedman test, and so on., Time Series and Forecasting apparatuses that help show inclines in information just as foreseeing future qualities. In this work, the Minitab 19 programming is utilized for acquiring ANOVA

## II. METHODOLOGY AND EXPERIMENTATION

The objectives of the present work have already been mentioned in the forgoing chapter. Accordingly the present study has been done through the following plan of experiment.

1.Checking and preparing the Lathe ready for performing the machining operation.

2.Cutting steel bars by power saw and performing initial turning operation in Lathe to get desired dimension (of diameter 50mm and length 140 mm) of the work pieces.

3.Performing straight turning operation under dry and wet conditions on specimens in various combinations of process control parameters like: spindle speed, feed and depth of cut.

4.Length of cut was kept constant at 50 mm for both dry and wet turning.

5.Measuring surface roughness and surface profile with the help of a portable stylus- type profilometer, Talysurf(Taylor Hobson, Surtronic 3+, UK).

### 2.2 PROCESS VARIABLES AND THEIR LIMITS

The working ranges of the parameters for subsequent design of experiment, based on Taguchi's L9 Orthogonal Array (OA) design have been selected using MINITAB 15 software. In the present experimental study, spindle speed, feed rate and depth of cut have been considered as process variables.

The process variables with their units (and notations) are listed in Table 3.1.

**Table 2.1: Process variables and their limits**

| **Parameters/Factors** | | **level** | | |
|---|---|---|---|---|
| | | **1** | **2** | **3** |
| **A** | **Spindle speed (rpm)** | 160 | 320 | 620 |
| **B** | **Feed rate (mm/rev)** | 0.3 | 0.4 | 0.5 |
| **C** | **Depth of cut (mm)** | 0.7 | 0.8 | 0.9 |

### 2.3 DESIGN OF EXPERIMENT

Experiments have been carried out using Taguchi's L9 Orthogonal Array (OA) experimental design which consists of 9 combinations of spindle speed, longitudinal feed rate and depth of cut. According to the design catalogue prepared by Taguchi, L9 Orthogonal Array design of experiment has been found suitable in the present work. It considers three process parameters (without interaction) to be varied in three discrete levels. The experimental design has been shown in Table 3.2.

**Table 2.2: Cutting Parameters and Levels for Dry and Wet Turning**

| Experiment no. | Spindle speed (rpm), N | Feed rate (mm/rev), f | Depth of cut (mm), a |
|---|---|---|---|
| 1 | 160 | 0.3 | 0.7 |
| 2 | 160 | 0.4 | 0.8 |
| 3 | 160 | 0.5 | 0.9 |
| 4 | 320 | 0.3 | 0.8 |
| 5 | 320 | 0.4 | 0.9 |
| 6 | 320 | 0.5 | 0.7 |
| 7 | 620 | 0.3 | 0.9 |
| 8 | 620 | 0.4 | 0.7 |
| 9 | 620 | 0.5 | 0.8 |

## 2.4 MATERIAL USED

The material chose was AISI 1045 MS bars (of breadth 50 mm and length 140 mm) on the premise that it was reasonable for most designing and development applications.

## 2.5 WORK PIECE DIMENSION

The width of bar is 50 mm and of length 140 mm. The size was estimated with the assistance of computerized verniercaliper. The analysis was done on a piece multiple times of AISI 1045 steel bars having same sythesis to quantify the estimation of surface harshness and to figure out which benefit of slicing parameters will be ideal to limit it. The work piece has been appeared in figure 2.1.

Figure 2.1: Picture of work piece before machining


Figure 2.2: Picture of work piece in the wake of machining

### 2.5.1. CUTTING SPEED CALCULATION

In the wake of choosing the axle speed the cutting rate were determined as needs be. The equation utilized for computing the cutting pace was

$$V = \frac{\pi D N}{1000}$$

v-Cutting speed in m/min

d-Diameter of the pole in mm

N-Rotations every moment

For a pole having 50 mm breadth the cutting pace esteems are as determined in the Table 3.4.

### 2.5.2. MACHINE USED

Side Base CNC Lathe machine with covered solidified carbide cutting instrument was utilized in the trials. Cutting velocity, feed rate and profundity of cut were chosen as the machining parameters to dissect their impact on surface unpleasantness.

Figure 2.3: Side Base CNC machine (H.M.T)

## 2.6 SURFACE ROUGHNESS MEASUREMENT

The surface roughness test was done by using Mitutoyo surface roughness tester 'Surftest SJ 201'. The probe was adjusted to measure the Ra value. The probe was moved a distance of 3mm.

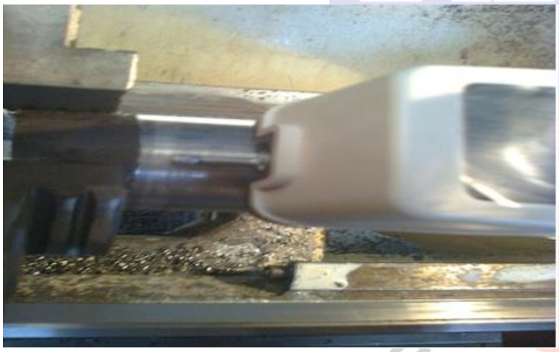

Figure3.6: Probe of surface roughness tester

## III. DATA COLLECTION

Work piece of diameter 50 mm and length 140 mm required for conducting the experiment have been prepared first. Nine numbers of samples of same material and same dimensions have been made. Then, using different levels of the process parameters nine specimens have been turned in CNC lathe in dry and wet conditions accordingly. After machining, surface roughness measured precisely with the help of a portable stylus-type profilometer, Talysurf (Taylor Hobson, Subtonic 3+, UK).

The results of the experiments have been shown in Table 3.7& 3.8. Analysis has been made based on experimental data in the following chapter. Optimization of surface roughness has been made by Taguchi. Confirmatory tests have also been conducted finally to validate optimal results.

**Table 3.7: Experimental Data Related to Surface Roughness Characteristics for dry turning**

| Experiment no. | Spindle speed (rpm), N | Feed rate (mm/rev), f | Depth of cut (mm), d | Surface roughness, Ra (µm) | S/N ratio of surfaces roughness |
|---|---|---|---|---|---|
| 1 | 160 | 0.3 | 0.7 | **2.14** | -7 |
| 2 | 160 | 0.4 | 0.8 | **5.17** | -15.07 |
| 3 | 160 | 0.5 | 0.9 | **5.84** | -15.46 |
| 4 | 320 | 0.3 | 0.8 | **5.41** | -14.55 |
| 5 | 320 | 0.4 | 0.9 | **4.92** | -13.75 |
| 6 | 320 | 0.5 | 0.7 | **6.12** | -15.66 |
| 7 | 620 | 0.3 | 0.9 | **2.95** | -9.27 |
| 8 | 620 | 0.4 | 0.7 | **3.82** | -11.54 |
| 9 | 620 | 0.5 | 0.8 | **5.07** | -14.06 |

Table 3.8: Experimental Data of Surface Roughness Characteristics for Wet Turning

| Experiment no. | Spindle speed (rpm), N | Feed rate (mm/rev), f | Depth of cut (mm), d | Surface roughness, Ra (µm) | S/N ratio of surfaces roughness |
|---|---|---|---|---|---|
| 1 | 160 | 0.3 | 0.7 | **2.23** | -6.52 |
| 2 | 160 | 0.4 | 0.8 | **3.45** | -10.62 |
| 3 | 160 | 0.5 | 0.9 | **3.65** | -11.17 |
| 4 | 320 | 0.3 | 0.8 | **2.41** | -7.49 |
| 5 | 320 | 0.4 | 0.9 | **3.81** | -11.34 |
| 6 | 320 | 0.5 | 0.7 | **2.84** | -8.94 |
| 7 | 620 | 0.3 | 0.9 | **2.26** | -6.48 |
| 8 | 620 | 0.4 | 0.7 | **3.82** | -11.54 |
| 9 | 620 | 0.5 | 0.8 | **2.92** | -8.94 |

## IV. RESULTS AND DISCUSSIONS

### 4.1. ANALYSIS OF VARIANCE

The outcomes got from the analysis were checked with the assistance of ANOVA, which predicts the essentialness of information parameter for any ideal reaction work. It demonstrates the most huge parameter which impacts the outcomes.

### 4.2 ANOVA FOR SURFACE ROUGHNESS IN DRY AND WET TURNING

Results gotten by trial results dissected with ANOVA are appeared in the Table 4.1 and Table 4.3. The F worth determined through MINITAB 19 programming is appeared in the second last section of ANOVA table which proposes the importance of the components on the ideal attributes. Bigger is the F esteem higher is the essentialness (considering certainty level of 95%). The outcomes demonstrate that lone feed is the most noteworthy factor in dry turning and profundity of cut is the most critical factor in wet turning.. Feed is the most critical factor in dry turning and profundity of cut is the most noteworthy factor in wet turning.

### 4.3 DRY AND WET TURNING ANOVA METHOD

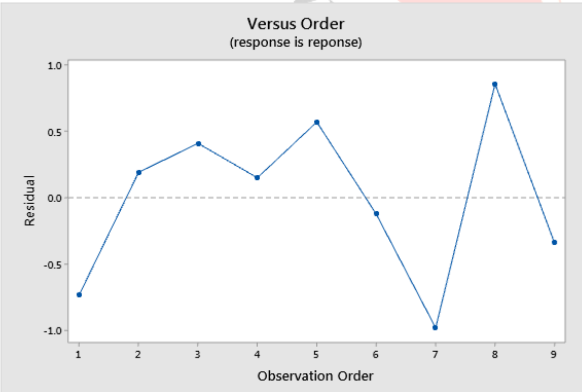


Figure 4.1 dry turning Anova graph

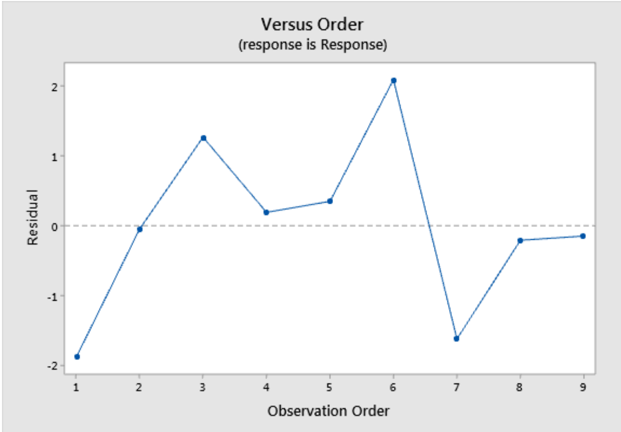


Figure 4.2 dry turning Anova graph

### 4.3 DETERMINATION OF OPTIMUM SOLUTION

Ideal state of the turning procedure is worried about limiting the surface unpleasantness yet this can't be accomplished all the while with a specific blend of control parameter settings. Ideal parameter setting for surface harshness in dry and wet turning has been resolved through surface unpleasantness meter. The ideal settings and the anticipated ideal qualities for surface unpleasantness in dry (A1 B1 C1) and wet turning (A3 B3 C3) (are resolved exclusively by Anova approach. Table 4.5& 4.6 demonstrates these individual ideal qualities and its relating settings of the procedure parameters for the predetermined presentation attributes. Ideal outcome has been checked through corroborative test demonstrated tasteful outcome.

**Table 4.5: Parameters and their selected levels for optimal surface roughness in dry turning**

| Parameter designation | Process parameters | Optimal levels |
|---|---|---|
| **A** | Spindle speed (rpm), N | **(160 rpm)** |
| **B** | Feed rate (mm/rev), f | **(0.3 mm/rev)** |
| **C** | Depth of cut (mm), d | **(0.7 mm)** |

**Table 4.6: Parameters and their selected levels for optimal surface roughness in wet turning**

| Parameter designation | Process parameters | Optimal levels |
|---|---|---|
| **A** | Spindle speed (rpm), N | **(620 rpm)** |
| **B** | Feed rate (mm/rev), f | **(0.5 mm/rev)** |
| **C** | Depth of cut (mm), d | **(0.7 mm)** |

## V. CONCLUSIONS

In the investigation Taguchi L9 configuration was utilized to contemplate the impact of shaft speed, feed rate and profundity of cut on surface harshness in dry and wet condition. ANOVA was utilized to think about the hugeness of different parameters. From the analysis following outcomes were acquired.

### 5.1.1. CONCLUSIONS FROM SURFACE ROUGHNESS IN DRY TURNING

The accompanying ends are done from the examination:

- The Surface unpleasantness is mostly influenced by feed rate, profundity of cut and axle speed. With the expansion in feed rate the surface unpleasantness likewise increments, as the profundity of cut builds the surface harshness first increment and decline and as the shaft speed increment surface harshness diminishes.
- From ANOVA investigation, parameters making critical impact on surface harshness are feed rate and profundity of cut.
- The parameters taken in the analyses are enhanced to acquire the base surface unpleasantness conceivable. The ideal setting of cutting parameters for amazing turned parts is as :-

1. Spindle speed = 160 rpm
2. Feed rate = 0.3 mm/rev
3. Depth of cut = 0.7 mm

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