The Effect of Turning Process Parameters on The Hardness of An En 8 Material Sample Using The Taguchi Method

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Abstract- *The conventional method of manufacturing parts to a specific dimension involves removing excess material by machining with a cutting tool. Turning is one method of removing material from parts. In this work, the relationship between the change in material surface hardness due to turning operation with respect to various machining parameters such as spindle speed, feed and depth of cut was investigated. The Taguchi method was used to plan the experiments, and EN 8 metal was selected as the workpiece, and coated carbide tool was selected as the tool material in this work, and the hardness after turning was measured on a Brinell beam tester. The obtained experimental data were analyzed using signal-to-noise and main effects were measured, as well as the percentage of different process parameters affecting hardness. Keywords: Turing, Taguchi, EN 8 Brinell hardness scale, S/N ratio, regression.*

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I. INTRODUCTION

The globalization of the world market creates a challenge in product marketing because high competition forces the manufacturing industry to produce a better quality product in a shorter period of time and also at a low cost. Using the machine as optimal working conditions, a precise product can be produced. Optimum machining parameters are of great interest in the manufacturing environment, where the economics of machining operations play a key role in market competitiveness.

Lathe machine

lathe is a machine tool that is used to extract metals from a workpiece to obtain the desired shape and size. In other words, it is a machine that is used to hold the workpiece to remove various pieces such as turning, grooving, chamfering, grooving, facing, machining. Rotation A common method of creating a specific dimension involves removing excess material by machining with a cutting tool.

Turning operation

Turning is the process of removing material from cylindrical and non-cylindrical parts. He is used to to reduce the diameter of a workpiece, usually to a specified or other diameter.

Brinell hardness

Brinell hardness was the first widely used and standardized hardness test in engineering and metallurgy, proposed in 1900 by Swedish engineer Johann August Brinell. The large footprint size and potential downside for testing the piece limits its usability. However, it also had the useful property that the VU hardness divided by two gave the steel estimated UTS in KSI. This trait has sometimes contributed to testing toughness in his early round

$$BHN = \frac{\text{applied load in kg}}{\text{area of impression or indention in mm}}$$

II. TAGUCHI METHOD

The Taguchi method is a powerful tool for designing high-quality systems. It provides a simple, efficient and systematic approach to optimizing design for performance, quality and cost. The Taguchi method is an effective method for designing a process that performs consistently and optimally under a variety of conditions. Taguchi's approach to designing experiments that can be easily adopted and applied

by users with limited knowledge of statics has therefore gained wide popularity in the engineering and scientific community. The required cutting parameters are listed in the instructions.

Figure 2.1 Procedure & Steps of Taguchi Perameter Design

III. EXPERIMENTAL SETUP

3.1 Work piece material

The workpiece material selected for investigation is EN 8 steel. En 8 finds a wide range of applications not only for forgings, castings, axle shafts, crankshafts and connecting rods, but is also used for low-cost die material in the tool and die making industry. This steel can be quenched and tempered to provide greater strength and wear resistance compared to low carbon steel. The workpiece used for the experiment is a circular rod with a diameter of 40 mm and a length of 165 mm.

Specification of work material

Chemical composition

Elements

C = 0.35 – 0.45%
Mn = 0.60 – 1.00%
Si = 0.05 – 0.35%
S = 0.06% max
P = 0.6% max

Machining Process

Cutting tests were performed on a medium duty conventional lathe and a coated carbide tool. The experiments were carried out according to the orthogonal array and the hardness for different combinations of parameters was measured using a Brinell hardness tester.

Plan of Experiment

The experiment was planned using an orthogonal Taguchi array in the design of experiments to help reduce the number of experiments. Orthogonal field L9. The identified cutting parameters were spindle speed, feed rate and depth of cut. The control parameters and their level are shown in the table.

Table 3.1Process and parameters and their level

S.No.	Process Parameter	Levels		
		Low	Medium	High
1	Spindlespeed (rpm)	650	950	1250
2	Feed Rate(mm/rev)	0.2	0.3	0.4
3	Depth ofCut (mm)	1	1.5	2

Table 3.2 The Basic Taguchi L9 orthogonal array

Experime nt	P1	P2	P3
1	1	1	1
2	1	2	2
3	1	3	3
4	2	1	2
5	2	2	3
6	2	3	1
7	3	1	3
8	3	2	1
9	3	3	2

Table 3.3 Consolidated design of experiment table

E..N.	**(Ss)**	**(F)**	**(D)**	**Hardness (BHN)**
1	650	0.2	1	213.46
2	650	0.3	1.5	221.96
3	650	0.4	2	200.12

4	950	0.2	1.5	209.98
5	950	0.3	2	211.32
6	950	0.4	1	234.48
7	1250	0.2	2	212.25
8	1250	0.3	1	207.65
9	1250	0.4	1.5	209.05

IV. ANALYSIS OF THE SIGNAL TO NOISE (S/N) RATIO

Higher the better

It is when the occurrences of some undesirable product characteristics is to be maximized.

S/N= -10 X log10(Σ(1/yi2)/N)

Hardness for each of the parameter at each level is calculated. These also called as main effects.

Table 4.1 S/N Ratio Summary Sheet

Exp. No	Hardness (BHN)	S/N ratio (dB)
1	213.46	46.58
2	221.96	46.92
3	200.12	46.02
4	209.98	46.44
5	211.32	46.49
6	234.48	47.40
7	212.25	46.53
8	207.65	46.34
9	209.05	46.40

Table 4.2 Mean response table for hardness

Symbol	**Factors**	**Hardness (BHN)**		
		L	**M**	**H**
Ss	Spindle speed (rpm)	213.84	**218.59**	209.65
F	Feed Rate (mm/rev)	211.89	213.64	**214.55**
D	Depth of Cut (mm)	**218.53**	213.66	207.89

Table4.3 Mean response of S/N for hardness

Symbol	**Controllable Factors**	**S/N ratio**		
		L	**M**	**H**
Ss	Spindle speed (rpm)	46.50	**46.77**	46.42
F	Feed Rate (mm/rev)	46.51	46.58	**46.60**
D	Depth of Cut (mm)	**46.77**	46.58	46.34

the level that gives the highest value of parameter in each level in the experimental region denoted by bold letter. The estimated main effects can be used for this purpose.

V. MAIN EFFECTS

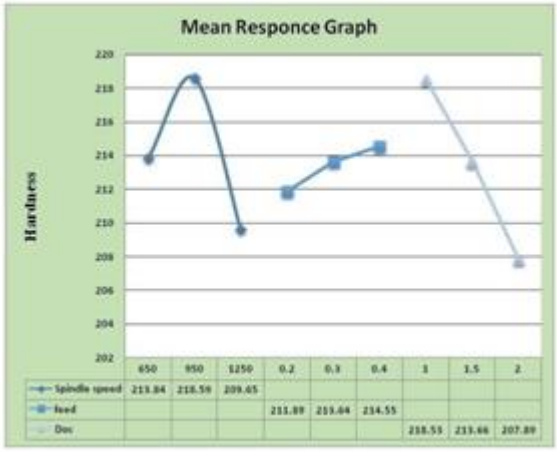

Figure 5.1 Mean response graph for three turning paremete

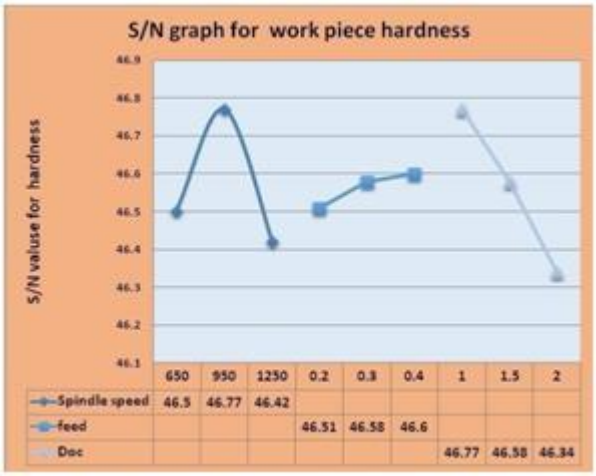

Figure 5.2 Mean S/N graph for hardness

Table 5.3 final comparison of confirmation of experiment for hardness

Results	Actual Experimental Value	Prediction (Taguchi Method)	Prediction (Regression Modelling)
Level	S2 + F3+ D1	S2 + F3+ D1	S2 + F3+ D1
Hardness (BHN)	234.48	224.95	219.65
S/N Ratio (dB)	47.40	47.04	46.83

From the response graph plotted between turning parameters and hardness of EN 8, it is observed that there is increase in hardness as the speed is increased at 950 rpm but when speed is further increased hardness goes decreased. The hardness increases when feed rate is changed from 0.2 mm/rev to 0.3 mm/rev and 0.3 to 0.4 mm/rev, but when depth of cut is 1 mm then hardness increases, but as the depth of cut is further increased then hardness decrease considerably.

Conformation of experiment

While considering three factors the experiments were conducted and result is that the combination of Higher Spindle speed (Ss3), higher Feed rate ((F3) and lower Depth of cut (D1), then the Hardness is maximum.

Table 5.4 final confirmation of experiment

Hardness (BHN)	S/N ratio (dB)
234.48	47.40

VI. ATHEMATICAL REGRESSION MODELLING

For the combination of parameters setting hardness value for EN 8 is tabulated. Empirical formula has fined out by using regression modeling. Modeling of parameters To generalize the results, the Modeling of input parameters (Spindle Speed, Feed rate, Depth of cut) and output parameter (Hardness) is done using REGRESSION MODELLING and MATLAB Software R2011b.

H = 236.37 (Spindle speed) -0.0087* (Feed rate) 0.0150* (Depth of cut) -0.0694-1

Comparison of Result

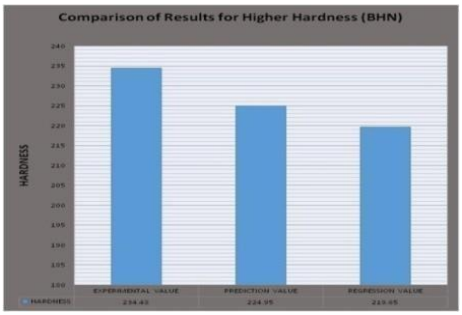

Figure 6.1 Comparison of result for higher hardness

Summry

In the present work, the relationship between hardness and various process parameters namely spindle speed, feed rate and depth of cut has been developed. Taguchi method has been adopted for the design of experiments and the results have been analyzed by maximize S/N ratio.

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