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Experimental Investigation on Process Parameters during Turning Process of Mild Steel

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ABSTRACT: Better surface finish and reduced machining time are the most prime requirements of today's industry. The present work investigate the effects of cutting parameters like spindle speed, feed and depth of cut on surface finish and machining time of Mild steel. The experiments have been conducted using 2³ factorial design in the Design of Experiments (DOE) on Computer Numerical Controlled (CNC) lathe machine. Further, the analysis of variance (ANOVA) was used to analyze the influence of process parameters and their interaction during machining. The surface roughness and machining time of mild steel decreases with increase in speed, feed and depth of cut. Meanwhile the hardness of mild steel increases with increase in speed and decreases with increase in feed and depth of cut.

I. INTRODUCTION

TURNING:

Turning is a Conventional machining process where the removal of metal from the outer diameter of a rotating cylindrical work piece. Turning is used to reduce the diameter of the work piece, usually to a specified dimension, and to produce a smooth finish on the metal. Often the work piece will be turned so that adjacent sections have different diameters.

It produces solids of revolution which can be adjusted because of the specialized nature of the operation. This machining is done on a machine called **LATHE** in which the tool is stationary and the part is rotated. When turning, a cylindrical piece of material, made of wood, metal, etc. is rotated. The cutting tool moves along two axes of motion, thereby producing precise depths and diameters. Turning is done either on the inside of the cylinder or outside to produce tubular components to various measurements.

It can be done manually, in a traditional form of lathe, which frequently requires continuous supervision by the operator, or by using a computer controlled and automated lathe which does not. When turning, a piece of material (wood, metal, plastic even stone) is rotated and a cutting tool is traversed along 2 axes of motion to produce precise diameters and depths. Turning can be either on the outside of the cylinder or on the inside (also known as boring) to produce tubular components to various geometries.

PROCESS CYCLE

The time required to produce a given quantity of parts includes the initial setup time and the cycle time for each part. The setup time is composed of the time to setup the turning machine, plan the tool movements (whether performed manually or by machine), and install the fixture device into the turning machine. The cycle time can be



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divided into the following four times:

- ➢ Load/Unload time
- ➤ Cut time
- ➢ Idle time
- ➢ Tool replacement time



Figure : Turning operation

CUTTING PARAMETERS

In turning, the speed and motion of the cutting tool is specified through several parameters. These parameters are selected for each operation based upon the work piece material, tool material, tool size, and more.

There are three primary factors in any turning operation. They are as follows:

- Speed
- Feed
- Depth of Cut

CNC MACHINE

- Computer Numerical Control (CNC) lathe machine.
- In CNC, the instructions are stored as a program in a micro computer attached to the machine. The computer will also handle much of the control logic of the machine, making it more compatible than earlier hard weird components.
- The latest CNC machines are highly time-saving and help to enhance the productivity of the industry.
- CNC lathe machines are available in different sizes and their cost varies according to the purpose they are used for.
- They very effectively and efficiently carry out their functions without any additional human intervention.



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Fig.1 CNC Machine

MILD STEEL MACHINING



Fig. 2 Mild Steel Machining

The diagram for the CNC machining of mild steel is shown in the figure. CNMG tool 120408 is used for machining process. During machining the machining time is noted. Then the machining is carried out under different cutting conditions as shown in the table.



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| Process Parameter | Level 1 | Level 2 |
|-----------------------|---------|---------|
| Speed in rpm | 1000 | 1200 |
| Feed in mm/rev | 0.18 | 0.3 |
| Depth of Cut in mm | 1 | 2 |

II. RESULT

EXPERIMENTAL DESIGN

Any experiment that has the flexibility to make desired changes in the input variables of a process to observe the output response is known as experimental design. Experimental design is a systematic manipulation of a set of variables in which the effect of this manipulation is determined, conclusions are made, and results are implemented. The primary goals of a designed experiment are to:

Determine the variables and their magnitude that influences the response.

Determine the levels for these variables

Determine how to manipulate these variables to control the response

Number of levels: 2

Number of Factors: 3 (Speed ,Feed ,Depth of cut)

Number of experiments: $2^3=8$

L₈ orthogonal array is selected for the experimental design using Design Expert software.

ORTHOGONAL ARRAY TABLE

| | Number of Factors | | | | | | | | | | | | | | | | | | | |
|-----|-------------------|----------------|------------------|-----------------------|---------------------|------------------|------------------|--------------------------|--------------------------------|-------------------|----------------------------------|----------------------|-------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|--------------------|--------------------|-------------------|
| | | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| | 4 | 2 ² | 2 ³⁻¹ | | | | | | | | | | | | | | | | | |
| | 8 | | 2 ³ | 2 ⁴⁻¹ | 2 ⁵⁻² II | 2 ⁶⁻³ | 2 ⁷⁻⁴ | | | | | | | | | | | | | |
| SUI | 16 | | | 2 ⁴ | 2 v | 2 ⁶⁻² | 2 ⁷⁻³ | 2 ⁸⁻⁴ | 2 ⁹⁻⁵ | 2 ¹⁰⁻⁶ | 2 ^{11.7} | 2 ^{12 8} | 2 ¹³⁻⁹ | 2 14:10 | 2 ¹⁵⁻¹¹ | | | | | |
| | 32 | | | | 2 ⁵ | 2 ⁶⁻¹ | 2 ⁷⁻² | 2 ⁸⁻³ | 2 ⁹⁻⁴ | 2 ¹⁰⁻⁵ | 2 ¹¹⁻⁶ | 2 ¹²⁻⁷ IV | 2 ¹³⁻⁸ | 2 ¹⁴⁻⁹ _{IV} | 2 ¹⁵⁻¹⁰ | 2 ¹⁶⁻¹¹ IV | 2 ¹⁷⁻¹² | 2 ¹⁸⁻¹³ | 2 ¹⁹⁻¹⁴ | 2 ²⁰⁻¹ |
| | 64 | | | | | 2 ⁶ | 2 7-1 VII | 2 v 8-2 | 2 ⁹⁻³ | 2 ¹⁰⁻⁴ | 2 ¹¹⁻⁵ | 2 12-6 IV | 2 ¹³⁻⁷ | 2 ¹⁴⁻⁸ | 2 ¹⁵⁻⁹ | 2 ¹⁶⁻¹⁰ | 2 ¹⁷⁻¹¹ | 2 18-12 IV | 2 ¹⁹⁻¹³ | 2 ²⁰⁻¹ |
| | 128 | | | | | | 27 | 2 ⁸⁻¹ VIII | 2 ⁹⁻² _{VI} | 2_{v}^{10-3} | 2 v 11-4 | 2 12-5 IV | 2 ¹³⁻⁶ | 2 ¹⁴⁻⁷ _{IV} | 2 ¹⁵⁻⁸ | 2 ¹⁶⁻⁹ | 2 ¹⁷⁻¹⁰ | 2 ¹⁸⁻¹¹ | 2 ¹⁹⁻¹² | 2 ²⁰⁻¹ |
| | 256 | | | | | | | 2 ⁸ | 2 ⁹⁻¹ | 2 10-2 VI | 2 ¹¹⁻³ | 2 12-4 VI | 2 v 13-5 | 2 v 14-6 | 2 v 15-7 | 2 v ¹⁶⁻⁸ | 2 y | 2 ¹⁸⁻¹⁰ | 2 ¹⁹⁻¹¹ | 2 20-1 |
| | 512 | | | | | | | | 2 9 | 2 x 10-1 | 2 ¹¹⁻² _{VII} | 2 12-3 VI | 2 ¹³⁻⁴ | 2 14-5 VI | 2 ¹⁵⁻⁶ _{VI} | 2 ¹⁶⁻⁷ _{VI} | 2 ¹⁷⁻⁸ _{VI} | 2 18-9 VI | 2 V 19-10 | 2 v 20-1 |



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DATA COLLECTION OF MILD STEEL

Table 2 Data Of Mild Steel

| S.NO | SPEED | FEED | DEPTH OF | SURFACE ROUGHNESS | MACHINING TIME | HARDNESS HRB | | |
|------|-------|--------|----------|----------------------|-------------------|-----------------|----------------|--|
| | 1 pm | mm/rev | mm | μm | sec | Before Expt. | After Expt. | |
| 1 | 1000 | 0.18 | 1 | 4.17 | 245 | B49 | B77 | |
| 2 | 1000 | 0.18 | 2 | 2.5 | 218 | B51 | B71 | |
| 3 | 1000 | 0.3 | 1 | 2.4 | 116 | B50 | B78 | |
| 4 | 1000 | 0.3 | 2 | 2.26 | 106 | B53 | B75 | |
| 5 | 1200 | 0.18 | 1 | 2 | 174 | B53 | B83 | |
| 6 | 1200 | 0.18 | 2 | 1.34 | 110 | B51 | B81 | |
| 7 | 1200 | 0.3 | 1 | 1.22 | 122 | B54 | B77 | |
| 8 | 1200 | 0.3 | 2 | 1 | 79 | B48 | B79 | |



Fig. 3 Mild Steel After Machining



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III. GRAPHS

MILD STEEL SURFACE ROUGHNESS



When the surface roughness of the mild steel decreases the speed increases.



As the surface roughness of the mild steel decreases the depth of cut increases.



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Surface Roughness vs Feed

The surface roughness of the mild steel decreases the feed increases.



Surface Roughness Vs feed & Speed

When the feed and speed increases the surface roughness of the mild steel decreases.



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MACHINING TIME



Machining Time Vs Speed

When the speed increases the machining time of the mild steel decreases normally.



Machining Time Vs Feed

As the feed increases the machining time of the mild steel decreases.



Machining Time Vs Depth Of Cut



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When the machining time of the mild steel decreases partially the depth of cut increases .



Machining Time Vs Speed & Feed

The machining time of the mild steel partially decreases with speed and while highly in feed when compared to speed.

HARDNESS



Hardness Vs Speed

As the hardness of the mild steel increases with increase in speed.



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Hardness Vs Feed

When the feed increases the hardness of the mild steel will be normal.



Hardness Vs Feed & Speed

As the speed increases the hardness of the mild steel increases. As the speed increases the hardness of the mild steel increases while the depth of cut increase there is a normal increase in hardness of the mild steel.

IV. CONCLUSION

The current study was done to study the effect of machining parameters on the surface roughness, machining time and hardness of mild steel. From ANOVA analysis it was observed that for mild steel the speed, feed and depth of cut plays a vital role on surface roughness and machining time. Speed plays a vital role on hardness than feed and depth of cut.



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