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Optimization on EN8 Steel by using Process Parameters on CNC Milling Machine

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Abstract: The most critical factors improving the performance of CNC milling operations is the optimization of machining parameters, especially in the case of medium-carbon steel such as EN8, used for automobile and engineering purposes due to its tensile strength and good machinability. The significant process parameters in this research work are optimized; they are Feed Rate, Spindle Speed and Cutting Speed for better surface finish, MRR, and tool wear in CNC milling of EN8. This study is conducted through a number of controlled experiments by the Taguchi's method with the help of statistical tools like ANOVA. Several process conditions are being studied to find the optimized condition which minimizes surface roughness with the simultaneous maximum MRR. From the results, it shows that surface finish is found highly sensitive to Depth of Cut and Spindle Speed; the MRR is much affected by feed rate only. Moreover, it reveals that the tool wearage significantly depends on the interdependence of Feed Rate as well as Feed Rate. The study concludes with the recommendation of an optimum set of process parameters by providing a balance between conflicting requirements of surface quality and productivity. The results are therefore contributions toward better efficiency in the machining operations, that entail less cost, enhanced quality, and longer tool lives during the milling operation for EN8 steel. Potential further research could include optimization based on multi-objective methods by employing genetic algorithms in making further refinements of the process.

Keywords*: CNC Milling, EN8 Steel, Process Optimization, Surface Finish, Material Removal Rate, Taguchi Method, ANOVA, Tool Wear.*

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I. INTRODUCTION

Modern manufacturing encompasses a number of machining processes, and one of the basic processes is CNC milling. This process machines a wide variety of materials with high precision and accuracy. The most commonly used material in CNC machining is EN8 steel, which is a medium-carbon steel alloy having strength, durability, and ease of machining. EN8 steel is used extensively on automotive, aerospace, and engineering industries, where the components are subjected to high stress and need good mechanical properties and toughness.

It heavily relies on a few major parameters processes such as feed rate, cutting speed, depth of cut, and spindle speed for the performance of CNC milling. These are those parameters that directly influence such critical outcomes like surface finish, rate of material removal, productivity in general and tool wear. Poor surface quality is held by selection of poor machining paramaters, too much tool wear, increased production time, and even higher production cost.

Optimization of machining parameters is also required to enhance the efficiency and the quality of the machining process. By identifying an optimum combination of process parameters, manufacturers can enhance the surface finish, increase MRR, minimize tool wear, and reduce operational costs. The manual optimization is difficult because of the interaction between various parameters. Statistical and analytical methods are response surface methodology and Taguchi method can be used for systematic investigation and optimization.

This aims to optimize the CNC milling process parameters while machining the EN8 steel. Series of experiments, with statistical tools in the application process, evaluate the impact of various machining parameters toward the surface finish, MRR, and tool wear in this experiment. The conclusion drawn is for better improvement in the performance of CNC milling and acquiring optimum machining conditions for machining the EN8 steel by ultimately leading toward higher efficiency, better quality products, and reduced manufacturing cost.

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That is, machining process of EN8 steel is improved as well as practical solutions provided for manufacturers to get more output with optimized CNC milling.

II. METHODOLOGY

A. Process Parameters

The parameters can be classified into three main categories:

➢ *Cutting Speed:*

The Cutting Speed is Known as the tool which moves across the workpiece material . It is commonly denoted in SFPM or in m/min. Start with a medium cutting speed according to Material Property and the Cutting Tool Geometry implement. There are charts and equations that assist in estimating cutting speeds. Allow increases in cutting speed where tool wear and surface finish expectations can be maintained within acceptably high limits.

➢ *Feed Rate*

The feed Rate is known as the speed which the tool is travels along the Workpiece. It is denoted by IPM or mm/min. Establish an initial feed rate depending on the cutting velocity and the desired chip load.

➢ *Depth of Cut:*

Depth of cut is known as the material which is removed in a single pass of tool. Depth of cut may be increased steadily until an acceptable range of cutting forces, tool deflection, and surface finish is attained. A shallow depth of cut should be kept in order to prevent vibration chatter or breakage of cutting tools. Perform exploratory investigations with a balanced approach towards material removal rate and tool life along with good surface finish**.**

B. CNC Milling Machine:

CNC milling is understood as a fabrication process in which control of multi-edged rotating cutting tools motion and functioning are done with the help of computer program. In the process, the tool turning around its axis goes over the surface of the workpiece and subsequently cuts out the unsupported portions of the workpiece to produce a given figure.

Four stages involved on CNC Milling process are:

- CAD model design
- CAD-to-CNC Program Conversion
- Installation of CNC Milling Machine
- Performing Milling Operation

C. Cutting Tools:

In this machining process we use two types of cutting tools they are

- Cemented Carbide
- High Speed Steel (H.S.S.)

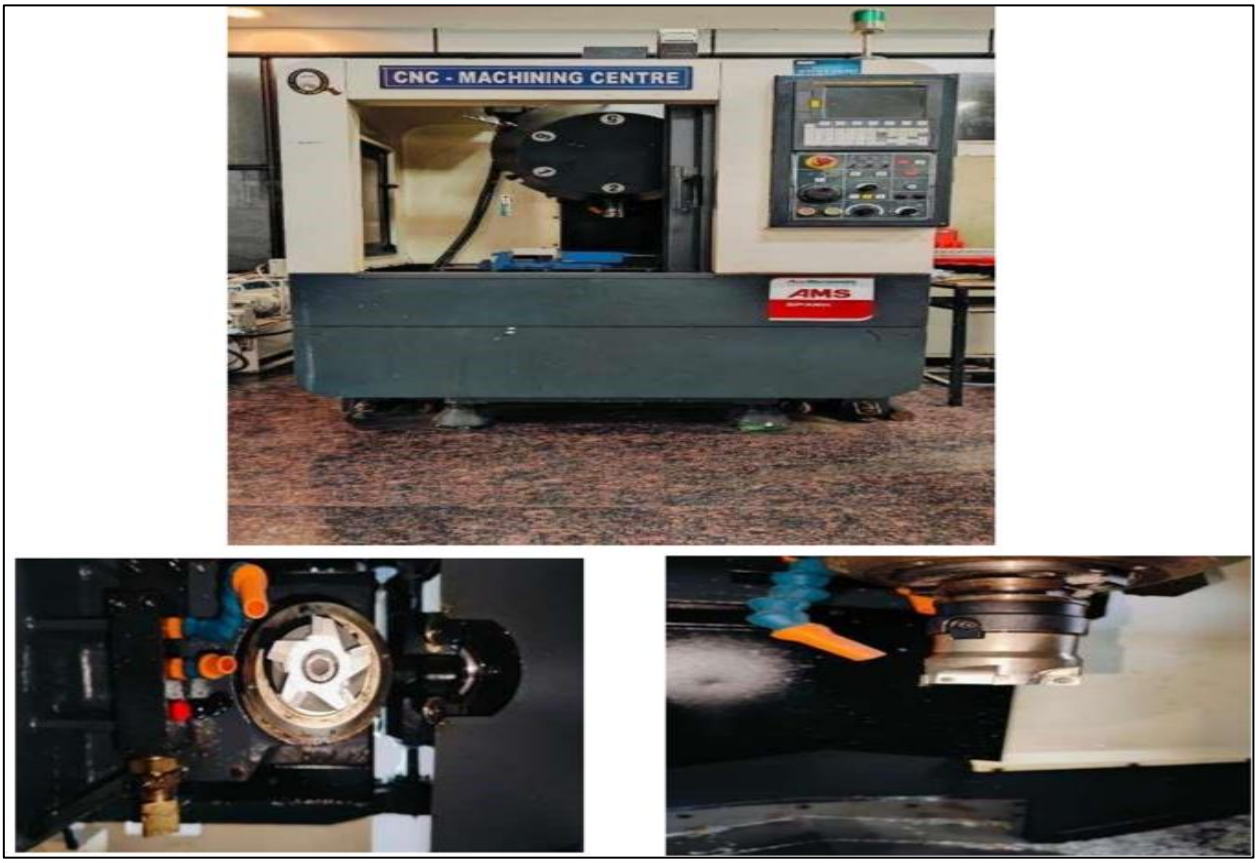

Fig 1 CNC Milling Machine and Multipoint Cutting Tool

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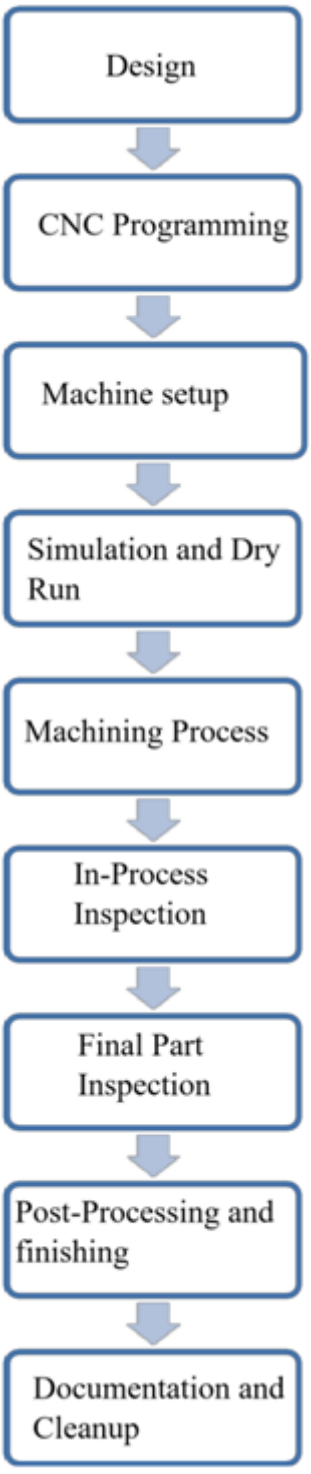

Fig 2 Process Appriach CNC Milling

III. IMPLEMENTATION

A. Material of Work Piece

Generally, an EN8 steel has heat treated forms and is well structured metallurgically giving it consistency in machining properties due to its high tensile strength which is most useful in several engineering uses. Some typical applications include: dynamo and motor shafts, studs, heat treated bolts, connecting rods, driving rings and flanges, screws, rollers, gears, stressed pins, railway couplings and axles, brackets, housings and their constituents that do not experience high stress or wear; keys et cetera.

Table 1 Chemical Composition of EN8 Steel

C	Mn	Si	S	P
0.35-0.45	0.60-1.00	0.10-0.35	0.050 Max	0.050 Max

Table 2 Substance Characteristics of EN8 Material Metallic Alloy

Max stress	850 N/mm-2
Yield stress	465 N/mm2
Elongation	16%
Proof Stress (0.2%)	450 N/mm2
Density	7.87gm/cm3
Hardness	201-255 Brinell

When polymethyl (acrylic) resins will be delivered by the manufacturer, they will mostly look like dry powder or granules. This is due to the fact that these materials are thermoplastic and are, therefore, produced and supplied in molded articles or sticks or transformed into powdery form for the sole purpose of easy… 34851 Words 140 Pages

EN8 steel is medium carbon steel which is suitable for the construction of various automotive parts. This steel has good wear resistance and it is somewhat tough in nature although it has low ductility. Geometrical Forms of EN8 Plain Carbon and Alloy Steel Grade Tube Prototypes These include pipes, tubes, hollow tubes, piping, and other shapes.

B. EN8 Material Applications:

The EN8 material steel can be appropriately applied in almost all forms of engineering work whenever there is a need for higher strength than mild steel. This includes:

- Axles,
- Wheels,
- Fasteners,
- Shaft Sleeves,
- Parts used in the automobile industry and other engineering sectors

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C. Experimentation Table for Machining process:

Table 3 Process Parameters

S. NO.	Cutting Speed C s (rpm)	Feed Rate F (mm/rev)	Depth of Cut Dc (mm)
1	900	180	0.3
2	900	200	0.5
3	900	220	0.7
4	1100	180	0.5
5	1100	200	0.7
6	1100	220	0.3
7	1300	180	0.7
8	1300	200	0.3
9	1300	220	0.5

IV. METHODOLOGY

A. Preparation
- Design and Planning
- CNC Model
- Material Selection
- Workpiece
- Material
- Cutting Tool

B. Machine Setup
- Workpiece Preparation
- Stock Material
- Mounting
- Machining Preparation
- Tool Setup
- Program Loading

C. Dry Machining
- Step of the Process
- Cutting Velocity
- Refers to the Cutting
- Feed
- The Depth of the Cut

D. Rate of material removal
- Setup
- MRR system

E. Face Milling

Face milling is a form of machining in which the milling cutting is applied perpendicular to the workpiece. This is to say that the milling cutting is “face down” towards the top of the workpiece. Upon engaging, the top of the milling cutting grinds away at the surface of the workpiece so as to consecutivey gain reduction of some of its material.

V. EXPERIMENTAL METHODOLOGY

Table 3: The specimens have a dimensions of 40 mm diameter and 100 mm length prior to machining and of 30 mm diameter after machining. Following Taguchi's L9 orthogonal array technique, a total 9 Experiments were conducted, with three input process parameters each at three levels. Therefore, 9 experiment were performed for each setup. Figure illustrates the arrangement of the experimental setup, displaying photographs of the EN8 steel specimen before and after two finishing steps I the CNC Milling Machine.

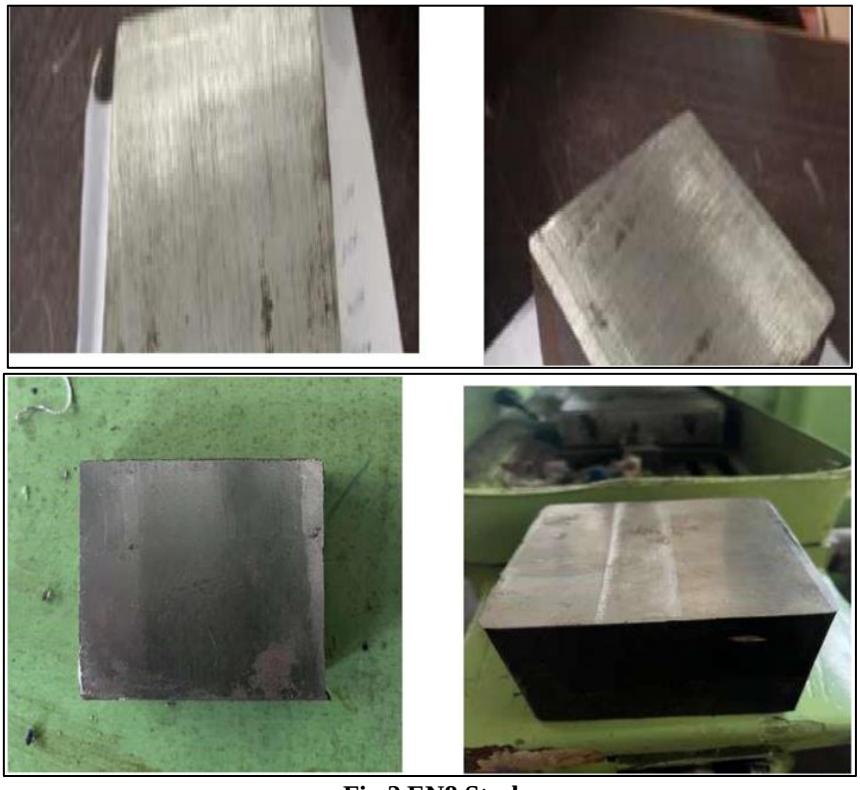

Fig 2 EN8 Steel

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VI. CNC PROGRAMMING FOR FACE MILLING

- N01 G90 G40 G21 G95;
- N02 M06 T0202;
- N03 M03 S900 M08;
- N04 G00 X-25.0 Y0.0 Z10.0;
- N05 G01 Z-0.3 F180;
- N06 G01 Y25.0;
- N07 G01 X100.0;
- N08 G01 Y50.0;
- N09 G01 X0.0;
- N10 G01 Y75.0;
- N11 G01 X100.0;
- N12 G01 Y100.0;
- N13 G01 X0.0;
- N14 G01 Z5.0;
- N15 G28 X0.0 Y0.0 Z0.0;
- N16 M05 M09;
- N17 M30

VII. RESULT ANALYSIS AND DISCUSSION

Optimizing the EN8 steel in CNC Milling Machine by using Process Parameters is a matter of great concern. EN8 is among the most popular types of medium carbon steel and it is machined quite easily in any condition. The following factors are the parameters of the milling operations on CNC. Increased Material Removal Rate: It deals with the maximum amount of material removal during machining.

- Minimum Cutting Force: In the machining process, this is quite important for the tool life and productivity as well.
- Minimal Surface Roughness: As far as the manufactured components are concerned, the finish of the surface ought to be homogenous.

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