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Evaluation of MRR in CNC Drilling Through Optimization of En-8D

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Abstract: The present work aims at achieving the integrated approach to solve the optimization problem of CNC Drilling process. At any stage, the dominance factor of the input variables and output variables contained in the constrained and objective functions can be computed. This technique helps in getting the reliable multi-objective decisions under constrained penalties for the constrained optimization of such process. The aim of my work is to optimize the Material Removal Rate (MRR), surface Roughness (Ra) have been considered and obtained for the each run of the experiment. The various factors included in this thesis is spindle speed, feed by keeping the depth of cut remains constant, to optimize the MRR and Surface Roughness (Ra). The Taguchi Technique was used for design of experiment so that minimum number of experiments, the complete problem can be solved as compared to full factorial design.

Keywords: Taguchi's Method, EN-8D, Process Parameters, MRR, Ra, S/N Ratio.

1. Introduction

The present work compiled in this thesis aims at achieving the integrated approach to solve the optimization problem of CNC Drilling process. At any stage, the dominance factor of the input variables and output variables contained in the constrained and objective functions can be computed. This technique helps in getting the reliable multi-objective decisions under constrained penalties for the constrained optimization of such process. This present work based on the Optimization of process parameters of CNC Drilling process through the Taguchi optimization technique. Optimization is a mathematical results and numerical methods for finding and identifying the best candidate from a collection of alternatives without having to explicitly enumerate and evaluate all the possible alternatives. The process of optimization lies at the root of engineering, since the classical function of the engineering is to design new, better, more efficient and less expensive system as well as to devise plans and procedures for the improved operation of existing systems.

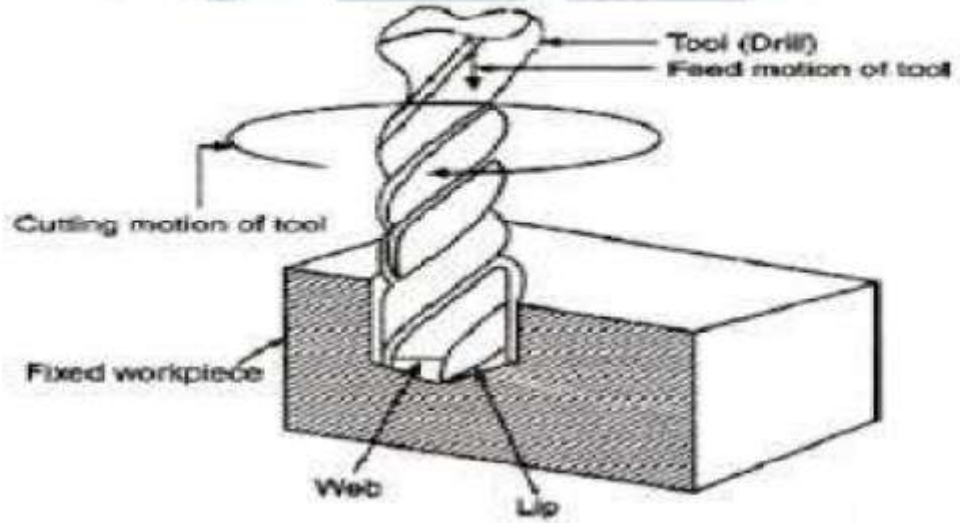

Fig 1: Principle of operation

2. Experimental work and Procedure

In the present paper, Taguchi method is used for the optimization of the process parameters like MRR and Surface Roughness through various process parameters like spindle speed, feed, by keeping the depth of cut remains constant.

2.1 Work Material

The material of the work piece selected in this present investigation was EN-8D alloyed carbon steel. The length of the work piece is 40.82- 40.88mm. The outer diameter is 22.13- 22.17mm, and inner diameter is 14.20- 14.30mm. This type of work material is used in the Bush which are used in bike and two wheeler automobile. The chemical composition of work material EN-8D are given as below

Constituents	compositions
Carbon	0.36 -0.44
Silicon	0.10-0.40
Manganese	0.6- 1.00 max
Sulphur	0.050 max
Phosphorous	0.050 max

2.2 Cutting Tool (Drill)

In this work, the cutting tool used for cutting the EN-8D is of Carbide having diameter is equal to 14mm.

2.3 Design of Experiment

In the present work, the experiments were designed by using Taguchi's technique. Dr. Genichi Taguchi, a scientist from Japan developed a technique based upon the orthogonal array of the experiments so that the entire space could be studied with the minimum number of experiments. In the present research paper two input process parameters such as spindle speed and feed . For all of them three different levels are selected. So based on the number of control factors and their levels, Taguchi L9(3^2) was selected. Table 1 and Table 2 as shown below which are showing the levels and their assigned value.

Table -1: Levels of various control factors

Control factors	Spindle speed	feed
A	2000	0.04
B	2500	0.05
C	3000	0.06

Table-2: Experimental plan with assigned value

Run	Spindle speed	Feed	Cycle time
1	2000	0.04	38
2	2000	0.05	36
3	2000	0.05	32
4	2500	0.04	28
5	2500	0.05	25
6	2500	0.06	23
7	3000	0.04	21
8	3000	0.05	20
9	3000	0.06	18

2.4 Experiment Work

The present work was performed on the CNC Drilling. Following steps were involved in cutting the excess material**.** The basic parts of the CNC Drilling machine are as base, table, tool holder, drill various programming used to run the machine to done the operation.

Figure 2: CNC Drilling machine during the drilling operation

2.5 Selected process responses

In the present research paper two process responses are selected to calculate in the run of the experiment against the control factors. These two process response are calculated as Material Removal Rate and surface Roughness.

The MRR is calculated by the formula :

MRR= (π/4D^2)×f×N

Where D= Drill
diameter f=feed
N=spindle speed
And the surface roughness is measured by Contact Profilemeter

3. Results and Discussion

The result of the present work obtained are analysed by using S/N Ratio Graphs with the help of Minitab. Minitab is a computer software designed to perform the basic and advanced statistical functions. It is a popular statistical analysis package for the scientific applications in particular in the design and analysis of experiments.

Table-5: Results Table

S.No.	Spindle speed(rpm)	Feed(rev/min)	MRR(mm3/min)	Ra(μm)
1	2000	0.04	16.578	0.943
2	2000	0.05	17.687	0.915
3	2000	0.06	19.898	0.834
4	2500	0.04	22.232	0.891
5	2500	0.05	25.950	0.861
6	2500	0.06	27.717	0.876
7	3000	0.04	29.880	1.163
8	3000	0.05	31.687	0.792
9	3000	0.06	35.520	1.320

3.1 Selection of the Best Parameter selection

Taguchi Analysis: MRR and Ra versus spindle speed and feed is shown in the table 6 for MRR and table 7 for Ra and the graphs are also shown as below-

Table-6: Response table for S/N ratios for MRR

Larger is better

Level	Feed	MRR
1	67.84	66.02
2	67.84	66.02
3	67.84	66.02
4		67.96
5		67.96
6		67.96
7		69.54
8		69.54
9		69.54
Delta	0	3.52
Rank	2	1

Table 7: Response table for mean for MRR

Level	Speed	MRR
1	2500	2000
2	2500	2000
3	2500	2000
4		2500
5		2500
6		2500
7		3000
8		3000
9		3000
Delta	0	1000
Rank	2	1

Table 8: Response table for S/N ratios for surface Roughness

Smaller is better

Level	Spindle speed	feed
1	.95267	0.06687
2	1.15077	1.36567
3	-.56586	0.10504
Delta	1.71663	1.29880
Rank	1	2

Table-9: Response table for means for surface roughness

Level	Spindle speed	feed
1	0.8973	0.9990
2	0.8760	0.8560
3	1.0917	1.0100
Delta	0.2157	0.1540
Rank	1	2

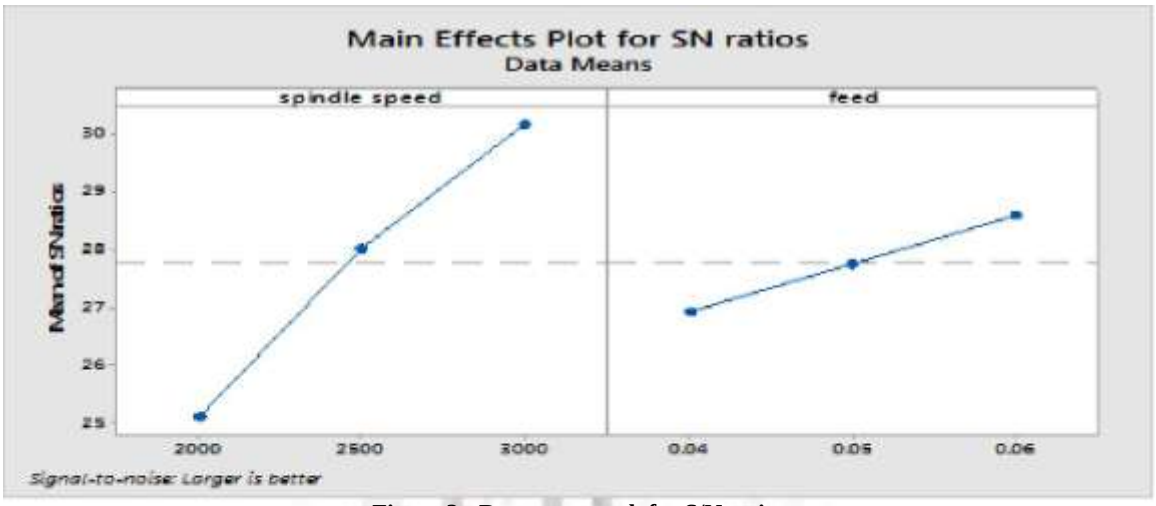

Figure 3: Response graph for S/N ratio

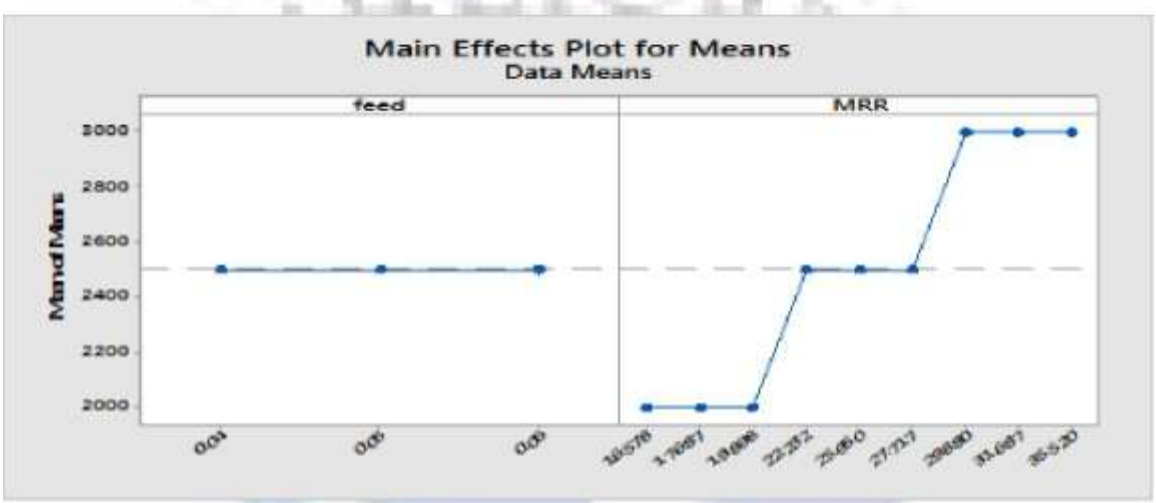

Figure 4: Response graph for mean for MRR

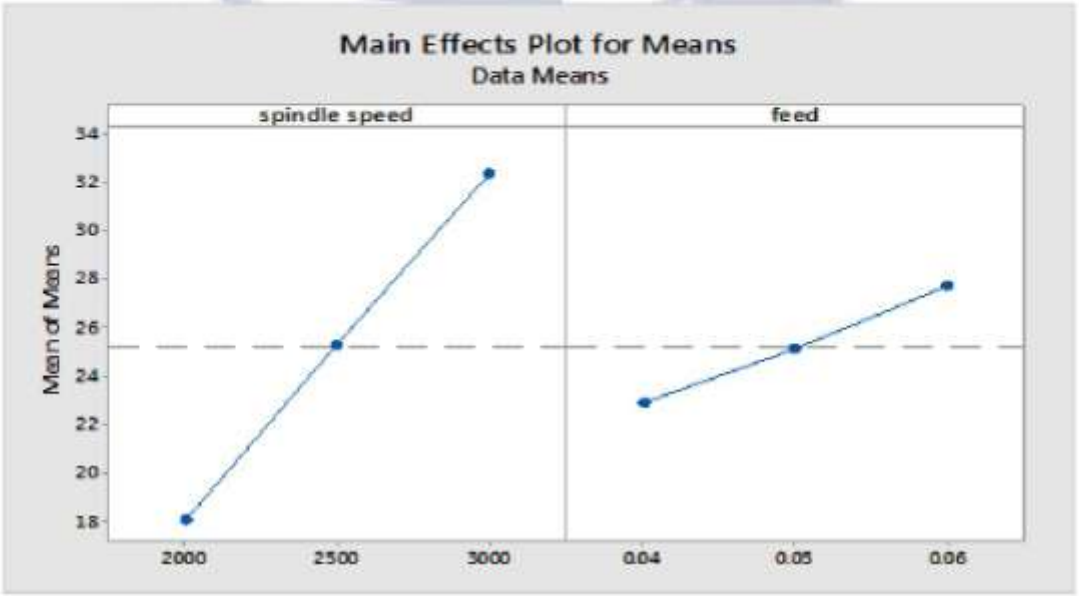

Figure 5: Response graph for mean for MRR

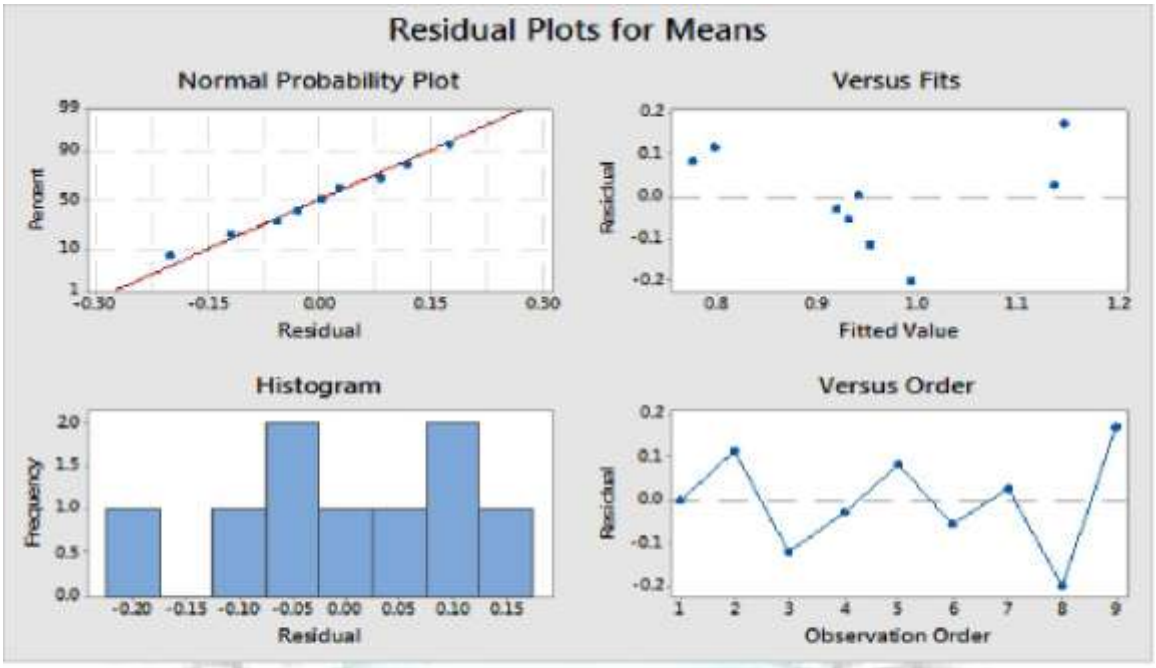

Figure 6: Residual plots for mean for surface roughness

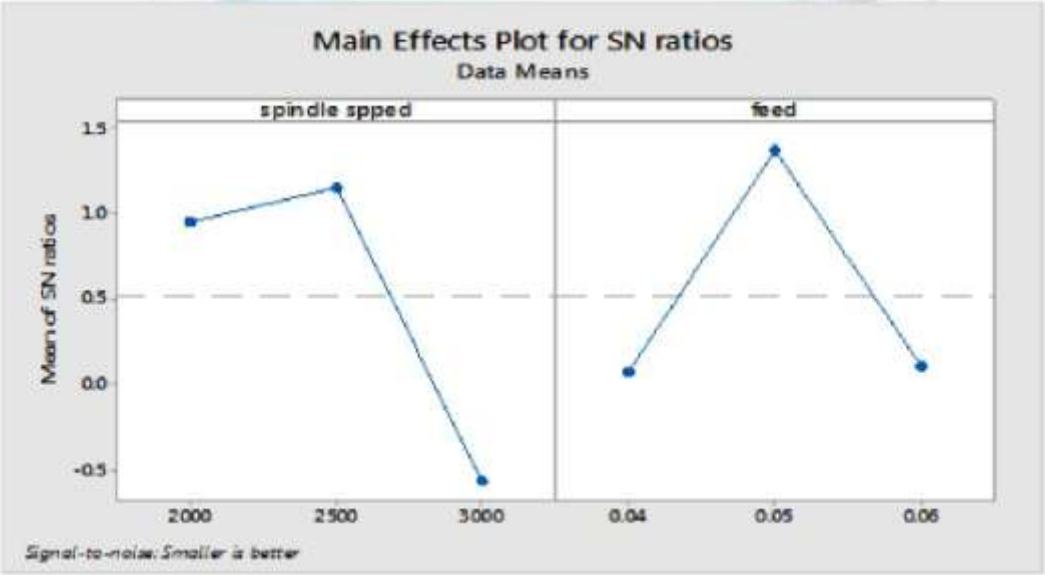

Figure 7: Main effects plots for S/N ratios for Ra

Conclusions

After studying the results and discussions the following conclusions were made in the present work:

1. The better MRR is obtained on the following parameters as spindle speed is 3000rpm and feed should be 0.06mm.
2. The better surface roughness is obtained in this paper work is also at the spindle speed 3000rpm and feed should be 0.06mm.
3. The order strength for mean is MRR and feed.
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5. The order strength for S/N ratio for surface roughness is spindle speed and feed.
6. The order strength for mean surface roughness is also spindle speed and feed.

Future Scope

1. The present work is performed on EN-8D medium carbon steel. So the procedure can be performed on the other grades of medium carbon steel and stainless steels.
2. The work also can be performed by changing the process parameters and process responses.
3. The work also can be done with the use of different techniques like RSM, GRA etc.

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