Optimization of Machining Parameter on Vertical Machining Center of FG 250 Casting for Surface Roughness

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Abstract: ***FG 250 is flange used in water pump which is machined and finished using VMC. Present work focuses on optimization of drilling process parameters of FG 250 flange using taguchi optimization technique. Surface roughness was the response variable investigated. Experimental results indicate that proposed mathematical model suggested adequately describe performance indicator within the limits of factors that are being investigated. Flow rate is the most influencing factor on surface roughness followed speed and feed.***

Keywords: FG 250, surface roughness, Anova, S/N ratio

1. Introduction

Drilling is a process of making round holes in a solid material or widening existing holes with the use of multi-point cutting tools called drills or drill bits. Various cutting tools are available for drilling, but the most common is the twist drill. With the rapidly growing technologies quality and productivity are the major concern. Productivity is concerned with the material removal rate (MRR) during machining operation and quality refers to the product characteristics. So the quality and productivity can be improved through parameters optimization. There are number of research works related to various drilling parameters optimization for achieving the performance responses. Among them surface roughness, material removal rate (MRR) and lubricants on drill bit are the major performance responses. Material removal rate (MRR) is the primary response variable while considering productivity. The material removal rate depends on input parameters and the machine during drilling operation. So the primary objective of optimization analysis during drilling operation is to optimize the input parameters. Also material removal rate (MRR) play a major role in surface roughness [6]. In the aerospace industry depending on the application hole quality is very important and response process variable outputs [7]. Taguchi method analyzes the influence of parameter variation on response

Characteristics. The cutting conditions which influence the machining process are coolant, tool type, speed, feed, depth of cut. Among those, coolant is an important factor largely affects the machining process [2].

2. Methodology

In current experimentation five process parameters are selected as control factors. The remaining process parameters kept as constant. Controlled and constant parameters are given in table 1 and table 2.

Table 1: Controlled parameters

Sr. No	Controlled parameters
1.	Speed(RPM)
2.	Feed(mm/min)
3.	MQL

Table 2: Constant parameters

Sr. No	Constant parameters	
1.	Cutting fluid	W4 CBF
2.	Work material	FG250
3.	Tool holder	SPMG060204DG

For present experimentation, we use L18 design of experiment. There are three process parameters, two process parameter have three levels and one process parameter have two level there parametric combination as shown in Table 3.

Table 3: Parametric combinations

Sr.No	Speed	Feed	Flow rate
1	S1	F1	40
2	S1	F2	40
3	S1	F3	40
4	S2	F1	40
5	S2	F2	40
6	S2	F3	40
7	S3	F1	40
8	S3	F2	40
9	S3	F3	40
10	S1	F1	50
11	S1	F2	50
12	S1	F3	50
13	S2	F1	50
14	S2	F2	50
15	S2	F3	50
16	S3	F1	50
17	S3	F2	50
18	S3	F3	50

For the current experimental work, for drilling of FG 250, the coated carbide drill of dia. 12 was used. Experiment were performed on VMC machine.

3. Results and Discussion

Surface roughness was measured using the Mitutoyo surface roughness tester model name sj-210. The arithmetic average roughness value is measured. The surfaces finish value of the machined FG 250 casting was measured after completion of one machining.

Specifications:
Traverse Speed: 0.5 mm/sec.
Cut off values: 5mm
Display: LCD.
Battery: Alkaline 500
Measurements of 5 mm length

Surface roughness measured on internal face of drilled hole having a stroke length 0.25 x 5 µm. Average of two repetitions for surface roughness is given in table 4

Table 4: Experimental results of surface roughness in µm

Expt. No	Speed	Feed	Flow rate	Surface roughness
1	900	0.111	40	1. 9
2	900	0.138	40	1. 615
3	900	0.166	40	1. 623
4	1000	0.111	40	2. 305
5	1000	0.138	40	2. 282
6	1000	0.166	40	2. 276
7	1100	0.111	40	3. 29
8	1100	0.138	40	3. 206
9	1100	0.166	40	3. 205
10	900	0.111	50	3. 45
11	900	0.138	50	3. 302
12	900	0.166	50	3. 347
13	1000	0.111	50	3. 898
14	1000	0.138	50	3. 893
15	1000	0.166	50	3. 77
16	1100	0.111	50	3. 977
17	1100	0.138	50	3. 962
18	1100	0.166	50	3. 989

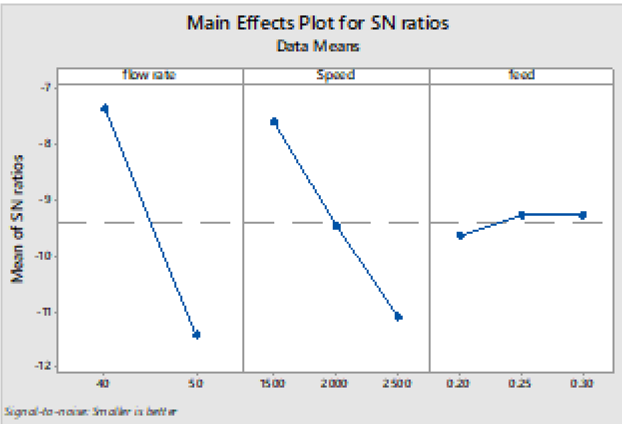

Figure 1: Main effect plot of S/N ratio for surface roughness.

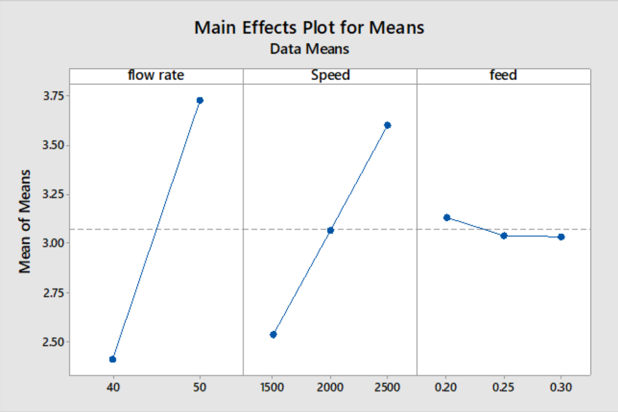

Figure 2: Main effect plot of mean for surface roughness

In main effect plot of S/N ratio for tool war, X-Axis indicates different levels of process parameters and Y-Axis shows average of S/N ratio. It can be observed from figure 2 that surface roughness increase as speed increases and decreases as feed increases whereas as flow rate increase surface roughness increases

Table 5: Analysis of variance for surface roughness

Source	DF	Adj.SS	Adj.MS	F value	P value
Flow rate	1	7.8487	7.84872	117.67	0.000
Speed	2	3.4048	1.70241	25.52	0.000
Feed	2	0.0382	0.01912	0.29	0.756
Error	12	0.8004	0.06670		
Total	17	12.0921			

Table 6: Response Table for S/N Ratios for Ra value, Smaller is better

Level	Flow rate	Speed	Feed
1	-7.343	-7.595	-9.623
2	-11.416	-9	-9.265
3		-11.091	-9.251
Delta	4.073	3.496	0.372
Rank	1	2	3

As seen from Table 6 coolant is the most influence parameter for surface roughness followed by speed and feed. The optimal level for different performance parameters are given below.

a) For surface roughness: - S1-F3-Flow rate 1

The purpose of the confirmation experiment is to verify the conclusions drawn during the analysis phase.
The response was correlated with the factors using the first order polynomial. The relationship between surface roughness and process parameters;

Regression Equation

Ra value =-4.748 + 0.1321* flow rate + 0.001065* speed-1.02* feed

For this model R^2 value = 93.32%, R^2 (adj) = 91.89% this indicate that the model is desirable and 91.89% variability is explained by the model after considering significant parameters.

Ra value =-4.748 + 0.1321* 40+ 0.001065* 1500- 1.02* 0.3= 2.1029µm

Table 7: Confirmation of experiments for surface roughness

	Prediction	Experiment
Level	S1-F3-Flow rate 1	
Surface roughness (µm)	2.1029	2.108

Experiments are conducted by using optimal level for each parameter. Table 7 shows the comparison of the predicted and the actual responses obtained during experimental trial. The predicated and actually measured response for surface roughness is in good agreement, indicating that optimization of the control parameters was appropriate.

4. Conclusions

Taguchi's design of experiment is used tool for conducting analysis in current experimentation. Most significant parameters and their contributions for surface roughness is determined with help of ANOVA. The optimal value and optimal level for performance characteristics is also finding out.

The following are conclusions obtained from the experimentation.

1) From the response table for surface roughness indicates that flow rate is most influencing factor for surface roughness followed by speed and feed.
2) The first level of speed is 900 rpm, third level of feed is 0.166 mm/min and flow rate of 40 ml/hr indicates minimum value of surface roughness.

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