Optimization of Boring Process Parameters By Using Taguchi Method

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Abstract : - **In order to produce any product with desired quality by machining , proper selection of parameter is essential surface an indicator of surface quality is one of the prime customer requirement for machined parts. In this paper Taguchi parameter optimization methodology is applied to optimize cutting parameter as speed, feed and coolant flow for mild steel SAE1541 using regression analysis method. The surface roughness were selected as the quality targets. The result analysis show that feed rate and cutting speed have present significant contribution on the surface roughness and coolant flow rate have less significant contribution on surface roughness.**

INTRODUCTION :

Metal based industry are focused to increase productivity and quality of the machined parts. For these purpose all aspects of every process need to be monitored. Certain desired parameter of a machined parts are chosen and checked against desired degree of a quality.

Surface finish is one of these important parameter in a manufacturing. It directly affects performing efficiency of a mechanical parts as well as their production cost. The ratio between cost and quality of a products n each production stage has t be monitored and immediate corrective action have to be taken in case of a deviation from a desired trend.

BORING :For internal machining ,Boring is a precision operation. It increases whole diameter and also it gives desired degree of a surface roughness provided that parameters affecting are maintained under control conditions as observed in experimental analysis. This process used after drilling or cast.

Boring is a unit process in manufacturing as a mass reduction step, used for enlarging and accurately sized existing hole by means of a single point of a cutting tool with multiple cutting edges

Boring is used to achieve greater accuracy of the diameter of the hole and can be used to a cut tapered hole. Boring is done with the conjunction with turning, facing or other machined operation. Because of the limitation on tooling design imposed by the fact the work piece mostly surrounded the tool ,boring is inherently somewhat more challenging than turning. Boring Can be viewed as the internal diameter counterpart to turning ,which cuts external diameter.

SURFACE ROUGHNESS AND MEASUREMENT

Surface roughness of a machined product could affect several of the product's functional attributes, such as contact causing surface friction, wearing, light reflection, heat transmission, ability of distributing and holding a lubricant, coating, and resisting fatigue. There are several ways to describe surface rough- ness. One of them is average roughness which is often quoted as Ra symbol. Ra is defined as the arithmetic value of the departure of the profile from the centerline along sampling length as shown in Fig. 1. It can be expressed by the following mathematical relationships.

$$\text{Ra} = \frac{1}{L}\int_0^l |Y(x)|\, dx(l)$$

where
Ra=the arithmetic average deviation from the mean line, and
Y =the ordinate of the profile curve.

There are many methods of measuring surface roughness, such as using specimen blocks by eye or fingertip, microscopes, stylus type instruments, profile tracing instruments, etc. The tools measuring surface roughness with probes, measure, and control in appropriate length and circumferences. The probe comes in and out holes while traveling on the surface. The probe is made up of diamond nip which very high in cost.

LITERATURE REVIEW

1) Show-shynlin (2009) investigated the optimization of 6061T6 CNC boring process using the Taguchi method and grey relation analysis. the surface properties of a roughness average roughness and maximum roughness as well as the roundness were selected as to quality targets. Analysis of variance (ANOVA) is also used to analyze the influence of the cutting parameter during machining. The result related that the feed rate is the most influence factor on the average roughness and maximum roughness and the cutting speed is the most influential factor to the roundness. [1]

2) Adel H.Suhail et.al [2010](2) conducted experimental study to optimize the cutting parameter using two

performance measure work piece, surface temperature and surface roughness. He has used carbon steel AISI 1020 and its dimension were 250mm long with 50 mm dia. Optimal cutting parameter for each performance were obtained using Taguchi techniques. The orthogonal array, signal to noise ratio and ANOVA were employed to study the performance characteristics in operation. The experimental result showed that the work piece surface temperature can be sensed and used effectively as an indicator to control the cutting performance and improves the optimization process.

3) Harriman Singh sodhi (2012) Investigated cutting parameters for surface roughness of a mild steel in boring process using Taguchi method. He investigated that the influence of the three most important machining parameter of depth of cut, feed rate and the cutting speed on surface roughness during turning of a mild steel by using carbide tool of 0.06 mm of a noise radius. ANOVA is used to analyze the influence of the machining parameter of the surface roughness. Results shows that the cutting speed and feed rate have present significant contribution on the surface roughness and depth of cut have less significant contribution on surface roughness.

4) GauravVhora (2013) investigated that the analysis and optimization of a boring process parameter by using Taguchi method. In investigation boring parameters for a CNC turning center such as speed, feed experiment ,dept of cut is done on a aluminum to achieve the highest possible material removal rate and at that same time minimum surface roughness by using the Taguchi method. The objective of the study was to identify the performance characteristics and select process parameter to be evaluate and to determine the no. of parameters level for the process and possible interaction between the process parameter.

Experimental

Medium carbon low alloy steel ASI1541is nothing but the mild steel. It was used as work piece material (Hardness,51-59 HRC).Chromium (Cr) ,Manganese (Mn) and Silicon (Si) alloyed materials offers a very good polish ability and this material we are using to make a gear shifting fork. Material composition of work piece is as follows : C,0.41; Mn,1.52; Si,0.205; Cr,0.1; Al,0.25; Cu,0.15% by wt.

Table 1: Chemical composition of work-piece component

C	Mn	Si	Cr	Al	Cu	HRC
0.39	1.52	0.205	0.103	0.255	0.155	52-59

TAGUCHI METHOD

Taguchi method based design of experiment has been used to study effect of three machining parameters like speed, feed, coolant flow on one important parameter like surface roughness. for selecting appropriate orthogonal arrays, degree of freedom of array is calculated. There are eight degree of freedom owing to three machining input parameters, so Taguchi based L9 arrays is selected. Accordingly,9 experiment were carried out the study the effect of machining input.parameters. Each experimentwas repeated three times in order to reduce experimental errors. In all tests, roughness was measured using surface roughness tester made by MITITOYO model no.SJ400.The roughness tester having measuring force 075mN-4mN and Diamond tip 5μm stylus having accuracy ±0.03μm.The probe comes in and out holes while traveling on the surface. The probe is made up of diamond nip which very high in cost

EXPERIMENTAL CONDITIONS

A series of experiments were carried out on Hyundai WIA F500DI (VMC) (Sanjeev Auto). From OVAT analysis four input controlling parameters selected having three levels. Details of parameters and their levels used shown in the table:

Table 2. Machining parameters and their levels

Parameter	Level 1	Level 2	Level 3
Speed (rpm)	1700	1900	2100
Feed (mm/min)	90	110	130
Coolant flow (lit/min)	20	40	60

EXPERIMENTAL PROCEDURE

High performance HYNDAI WIA f 500D CNC Milling machine (working space, X, Y and Z movements being 600×460×570 mm) variable spindle speeds, optimum 8000 rpm; main spindle power,14.7 kw.having table size 700×500mm was employed to perform experiments for boring rough bar (Material, cemented carbide K20 grade; cylinder shank helix angle 0° and chafer 90°).The tool bar having overall length (l1) 140 mm; ,flute length (l2) 85mm; cutting diameter (d1), 16.04mm and shank diameter (d2), 15.5mm. S/N ratio for Ra was calculated.

Table 3: Experimental design matrix of L9 Orthogonal Array by Minitab 14

Exp No	A Speed (rpm)	B Feed (mm/min)	C Coolant Flow Rate (Lit/min)
1	1700	90	20
2	1700	110	40
3	1700	130	60
4	1900	90	40
5	1900	110	60
6	1900	130	20
7	2100	90	60
8	2100	110	20
9	2100	130	40

RESULTS AND ANALYSIS

A table is got after actual experimentation, showing Ra values and S/N ratios for each trials. Table is given below:

Table 4 Response table for Ra

SPEED	FEED	COOLANT FLOW RATE	Ra	S/N Ratio
1700	90	20	0.77	2.2710
1700	110	40	1.10	-0.8278
1700	130	60	1.36	-2.6707
1900	90	40	0.69	3.2230
1900	110	60	0.76	2.3837
1900	130	20	1.06	-0.5061
2100	90	60	0.62	4.1521
2100	110	20	0.66	3.6091
2100	130	40	1.13	-1.0615

Table 5 Analysis of Variance for Means

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Speed	2	0.133	0.1334	0.0667	55.0	0.018
Feed	2	0.379	0.3794	0.1897	156.	0.006
Coolant Flow	2	0.031	0.0108	0.0155	12.8	0.047
Residual Error	2	0.002	0.0024	0.0012		
Total	8	0.546				

S = 0.0348010 R-Sq = 99.56%

R-Sq(adj) = 98.23%

In table 4 Analysis of Variances had been done (ANOVA) and it reflects that the value P is less than 0.05 in all three parametric sources.Therefore it is clear that all three parameters have significant effect on the surface roughness while boring.

Table 6 Response Table for Means (smaller is better) for Ra

Level	Speed	Feed	Coolant Flow
1	1.0767	0.6933	0.8300
2	0.8367	0.8400	0.9733
3	0.8033	1.1833	0.9133
Delta	0.2733	0.4900	0.1433
Rank	2	1	3

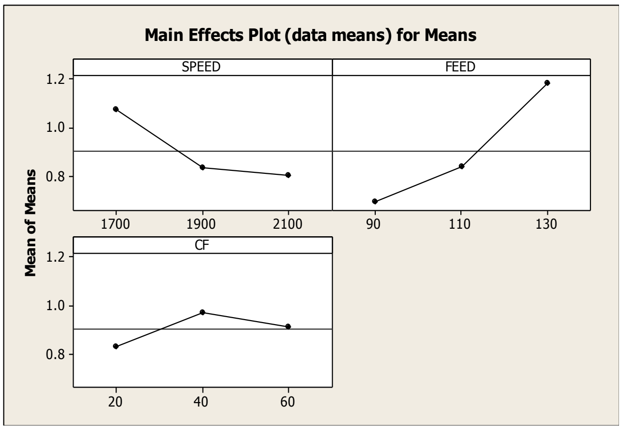

Fig1.main effect plot for Ra

It is clear form main effect plot as shown in figure 2 that surface roughness is increasing with increasing inspeed from 1700 rpm to 2100 rpm but it decreases with the change in further increases in speed from 1900 to 2100 rpm. Similarly in the case of feed rate we will get the minimum surface roughness at 90mm/revolution. Minimum value of surface roughness lies at 20 liter/min.

Table 7 Analysis of variance for S/N ratio

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Speed	2	11.71	11.718	5.8594	38.6	0.025
Feed	2	33.47	33.473	16.736	110	0.009
Coolant Flow	2	2.777	2.7779	1.3890	9.17	0.042
Residual Error	2	0.303	0.3030	0.1515		
Total	8	48.27				

S = 0.389243 R-Sq = 99.37%

R-Sq(adj) = 97.49%

Table 8 Response Table for S/N ratio

Level	Speed	Feed	Coolant Flow
1	-0.4095	3.2151	1.7911
2	1.7002	1.7217	0.4445
3	2.2332	-1.4128	1.2884
Delta	2.6427	4.6279	1.3465
Rank	2	1	3

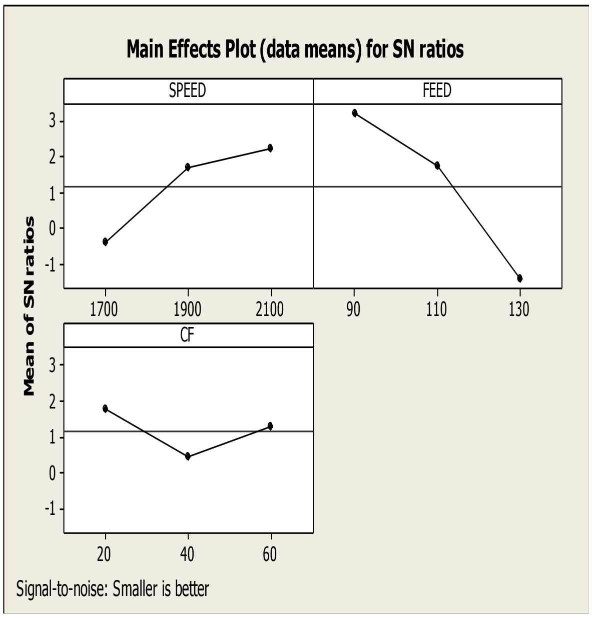

Fig.2 Main effets plot for S/N ratios

From main effect plot in figure 6.It has been shown that the value of a S/N ratio is maximum at speed of 2100 rpm and minimum at 1700 rpm. . further it has been shown that the value of S/N ratio is increasing initially but it decreases further with the increasing in feed rate.

Taguchi statics for Ra

Firstly data has checked for its normality by probability plot (see figure). As data points are distributed all along the normal line and having negligible outliers, so data can be concluded as normally distributed. The second plot doesn't show any trend while plotting residual verses fitted value of data which implies Taguchi model chosen is well fitted with given data set. Third plot is frequency histogram showing data distribution and at last residue verses order plot highlights the random data points which signifies non-significance of experimental order as far as first response (Ra) is concerned.

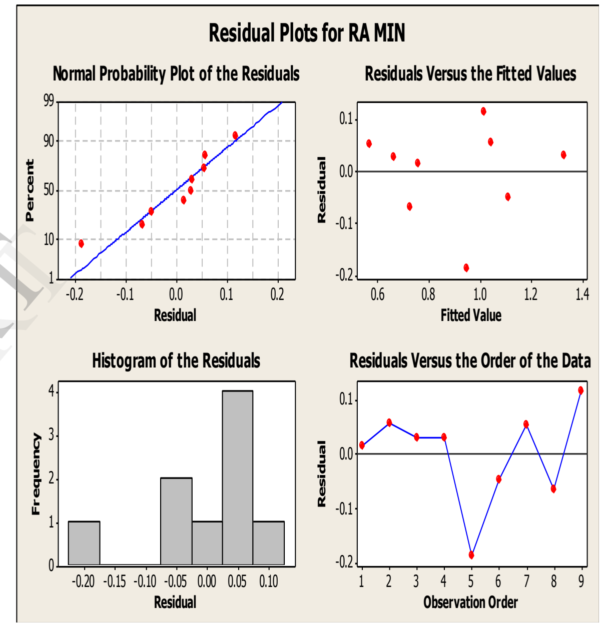

Fig.3 Residual plot for Ra mean

CONFORMATION TEST

Table 9 Conformation Test

Sr no.	Predicted Ra mean	Exp. Trial 1	Exp. Trial 2	Exp. Ra mean	% Error
1	0.51	0.478	0.521	0.499	-2.07

CONCLUSION

This study discussed an application of the Taguchi method of optimizing the cutting parameters of boring operation. from this research, following conclusion could be reached with a fair amount of confidence.

Regardless of the category of the quality characteristics, the lower the better for surface roughness the lowest feed rate (F=90 mm/min),the highest cutting speed (S= 2100 rpm) and the lowest coolant flow (C=20 lit/min) lead to the optimal surface roughness value.

for solving machining optimization problems, various conventional techniques had been used so far, but they are not robust and have problems when applied to the boring process , which involves a numbers of variables and constrains. To overcome the above problems, Taguchi method is used in this work. since Taguchi method is experimental method it is realistic in nature. According to this study the prime factor affecting surface finish is feed and after that cutting speed and coolant flow.

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