TO ANALYSES THE EFFECTS OF TURNING PARAMETERS ON MATERIAL REMOVAL RATE OF AISI 4041 DIE ALLOY STEEL

Nirpaksh Uppal[1], Rohit Rampal[2], Charanjeet Singh Sandhu[3]

[1]*Student of M.Tech, Dept. of Production Engineering,* ***nirpakash.uppal@gmail.com***
[2&3]*Assistant Professor, Dept. of Mechanical Engineering, SUSCET TANGORI, Punjab, India*
rampal_rohit86@yahoo.co.in, jimmychanni987@yahoo.co.in

Abstract

This experimental investigation analyses the influence of cutting conditions on material removal rate (MRR) during turning of AISI 4041 die alloy steel. Analysis of variance (ANOVA) is employed to investigate the influence of cutting speed, feed rate, and depth of cut on material removal rate (MRR). Conducting the experiments by varying the parameters of turning like cutting speed from 100 m/min to 300 m/min, feed 0.02 mm/rev to 0.06 mm/rev, and depth of cut from 0.2 mm to 0.7 mm are studied in details according to Taguhi's design of experiments. At last results are analyzed using Taguchi, ANOVA and parametric optimization is done for maximum material removal rate (MRR). From the experimentation, it is concluded that for turning of AISI 4041 die alloy steel optimum machining condition for higher material removal rate (MRR) with cutting speed (300 m/min), feed rate (0.06 mm/rev), and depth of cut (0.2 mm).

Index Terms: ANOVA, MRR, Taguch.

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1. INTRODUCTION

AISI 4041 die alloy steel have been increasingly used by manufacturing industry. They offer a range of properties not seen in other types of steel: high strength, wear resistance, fatigue resistance, toughness and high hardness. The versatile properties of AISI 4041 die alloy steel render them suitable for applications in manufacturing industries.

Ersan Aslan et al. (2007) presented an experimental study to show the combined effects of three cutting parameters, namely cutting speed, feed rate and depth of cut on two performance measures, flank wear (VB) and surface roughness (Ra), were investigated employing an orthogonal array and the analysis of variance (ANOVA). Optimal cutting parameters for each performance measure were obtained; also the relationship between the parameters and the performance measures were determined using multiple linear regression. Gaurav Bartarya, and S.K.Choudhury (2012) present work is an attempt to develop a force prediction model during finish machining of EN31 steel (equivalent to AISI 52100 steel) hardened to 60±2 HRC using hone edge uncoated CBN tool and to analyze the combination of the machining parameters for better performance within a selected range of machining parameters. Yilong Wang et al. (2011) investigated two solutions, namely plasma nitriding treatment for work piece surface modification and elliptical vibration cutting for cutting process modification, to determine their effect on reducing tool wear in diamond machining of AISI 4140 die steel. Further more a new approach by combining the two solutions was also explored. Experimental results showed that diamond tool wear could be reduced by several orders of magnitude and mirror-quality surface can be obtained by using either the plasma nitriding treatment or the elliptical vibration cutting. R. Suresh et al. (2012) study, performance of multilayer hard coatings (TiC/TiCN/Al2O3) on cemented carbide substrate using chemical vapor deposition (CVD) for machining of hardened AISI 4340 steel was evaluated. An attempt has been made to analyze the effects of process parameters on machinability aspects using Taguchi technique. Response surface plots are generated for the study of interaction effects of cutting conditions on machinability factors.

This necessitates a process optimization to determine optimal values of cutting parameters, such as cutting speed, feed rate and depth of cut, to fully evaluate the performance of turning on hardened materials. The present study is an attempt to achieve this goal when turning hardened AISI 4041 die alloy steel.

2 EXPERIMENTAL PROCEDURE

Experiments will be conduct based on Taguchi's method with three factors at three levels each. The levels of parameters will be deciding through detailed study of literature. The values take by factor are termed to be levels. The factors will be study and their levels chosen are detailed in the Table1.

Table 1: Cutting Parameters and Their Levels to be used in lathe Machine

S.No	Input Parameters	Levels		
		1	2	3
1	Cutting Speed (m/min)	100	200	300
2	Feed Rate (mm/rev)	0.2	0.4	0.6
3	Depth of Cut (mm)	0.2	0.5	0.7

Taguchi method, a powerful tool in the design of experiment, is to be used to optimize the lathe machine parameters of effective machining of AISI 4041 die alloy steel. Determine the S/N ratio, and analysis of variance (ANOVA) for indicating the most significant parameters affecting the machining performance criteria, i.e., material removal rate.

3. RESULTS AND DISCUSSION

The investigated results of Material Removal Rate (MRR) obtained during turning of AISI 4041 die alloy steel. The results were obtained at variation of Cutting Speed e.g. from 100 to 300 m/min, feed rate e.g. from 0.2 to 0.6 mm/rev, and depth of cut from 0.2 to 0.7 mm.

	C1	C2	C3	C4	C5
	Vc	FR	DC	MRR	SNRA2
1	1	1	1	0.747	-2.5336
2	1	1	2	0.710	-2.9748
3	1	1	3	0.610	-4.2934
4	1	2	1	0.679	-3.3626
5	1	2	2	0.659	-3.6223
6	1	2	3	0.631	-3.9994
7	1	3	1	1.168	1.3489
8	1	3	2	0.659	-3.6223
9	1	3	3	0.620	-4.1522
10	2	1	1	2.198	6.8406
11	2	1	2	2.051	6.2393
12	2	1	3	1.831	5.2538
13	2	2	1	2.336	7.3695
14	2	2	2	2.172	6.7372
15	2	2	3	2.034	6.1670
16	2	3	1	2.198	6.8406
17	2	3	2	2.051	6.2393
18	2	3	3	1.831	5.2538
19	3	1	1	3.115	9.8692
20	3	1	2	2.840	9.0664
21	3	1	3	2.615	8.3494
22	3	2	1	3.398	10.6245
23	3	2	2	3.077	9.7625
24	3	2	3	2.615	8.3494
25	3	3	1	3.398	10.6245
26	3	3	2	3.077	9.7625
27	3	3	3	2.816	8.9927
28					

Fig 1: Showing the results of Turning Parameters on Mean of MRR

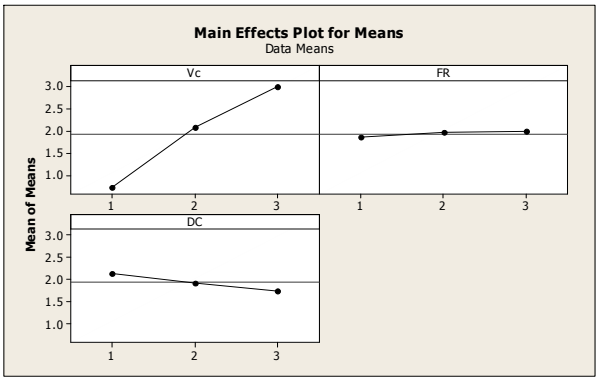

Fig 2: Showing the effect of Turning Parameters on Mean of MRR

Fig 2 shows effect of various turning parameters on the mean of MRR plotted utilizing the machining results obtained of AISI 4041 die alloy steel. From the figure, it is observed that the mean value of MRR is increase by increasing the Cutting Speed from 100 to 200 m/min and 200 to 300 m/min. The mean of MRR is increase by increasing the value of feed rate from 0.2 to 0.4 mm/rev, and from 0.4 to 0.6 mm/rev. The mean of MRR is decrease by increasing depth of cut from 0.2 to 0.5 mm and 0.5 to 0.7 mm.

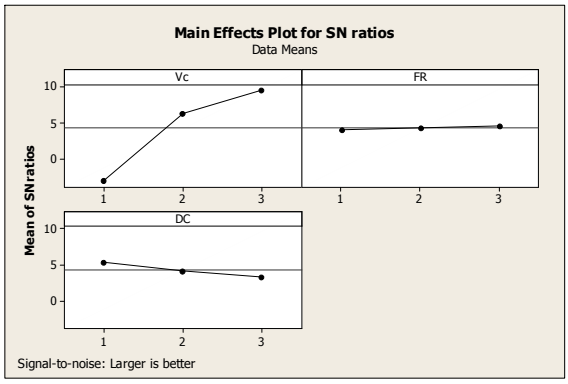

Fig 3: Showing the effect of Turning Parameters on Mean of S/N ratio of MRR

Fig 3 shows effect of various turning parameters on the mean of S/N ratio of MRR plotted utilizing the machining results obtained of AISI 4041 die alloy steel. From the figure, it is observed that the mean value of S/N ratio of MRR is increase by increasing the Cutting Speed from 100 to 200 m/min and 200 to 300 m/min. The mean of S/N ratio of MRR is increase by increasing the value of feed rate from0.2 to 0.4 mm/rev, and from 0.4 to 0.6 mm/rev. The mean of S/N ratio of MRR is decrease by increasing depth of cut from 0.2 to 0.5 mm and 0.5 to 0.7 mm.

The results are analyzed using ANOVA for identifying the significant factor affecting the performance measure of turning on AISI 4041 die alloy steel. An ANOVA result shows that cutting speed and depth of cut are significant factor because their P values for both are 0.000. Other factor feed rate is not significant because their P value is larger than .05.

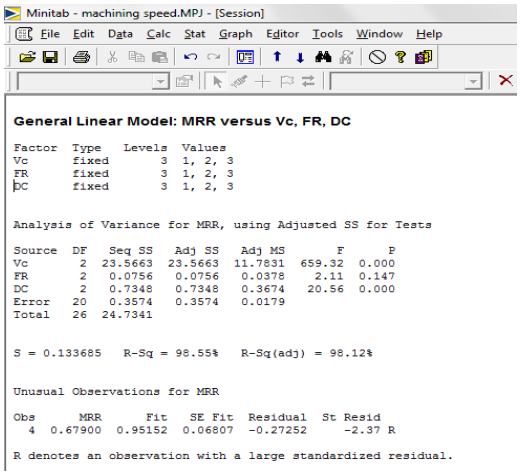

Fig 4: ANOVA Test for Means

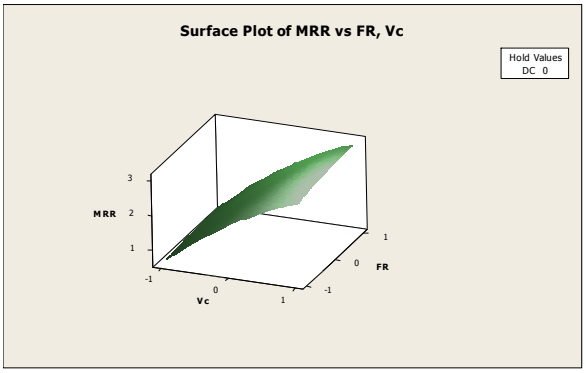

Fig 5: Surface Plot of MRR, Cutting Speed vs. Feed Rate

Fig 5 shows the surface plot of MRR, cutting speed vs. feed rate. From this figure it is clear that the maximum MRR is notice at higher level of feed rate and higher level of cutting speed.

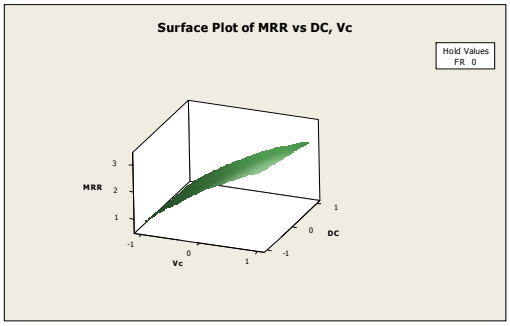

Fig 6: Surface Plot of MRR, Cutting Speed vs. Depth of Cut

Fig 6 shows the surface plot of MRR, cutting speed vs. depth of cut. From this figure it is clear that the maximum MRR is notice at higher level of depth of cut and higher level of cutting speed.

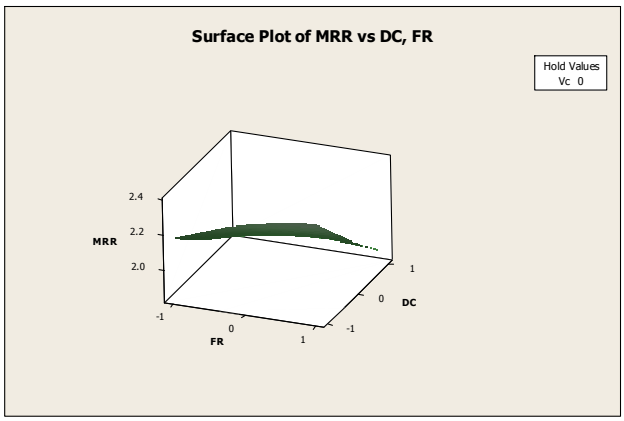

Fig 7: Surface Plot of MRR, Depth of Cut vs. Feed Rate

Fig 7 shows the surface plot of MRR, Depth of Cut vs. feed rate. From this figure it is clear that the maximum MRR is notice at lower level of depth of cut and higher level of feed rate

CONCLUSIONS

1. It is noted that the maximum value of MRR is 3.398 mm3/sec which is at 300 m/min cutting speed, 0.06 mm/rev feed rate, and 0.2 mm depth of cut.
2. The mean value of MRR is larger for 300 m/min of cutting speed which is 2.9946 mm3/sec.
3. It is observed that the mean value of MRR is larger for 0.06 mm/rev of feed rate which is around 1.9798 mm3/sec.
4. It is observed that the mean value of MRR is larger for 0.2 mm of depth of cut which is 2.1374 mm3/sec.
5. For AISI 4041 optimum machining condition for MRR with cutting speed (300 rpm), feed rate (0.06 mm/rev), and depth of cut (0.2 mm).

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BIOGRAPHIES

Nirpakash Upaal is pursuing his part time M.Tech from Shaheed Udam singh college of engineering & technology tangori. he has completed his B.tech from Shaheed Bhagat singh college of engineering & technology Ferozpur in 2010.he has published one paper in international journal

Rohit Rampal is working as Asst. Professor in Shaheed Udam singh college of engineering & technology tangori, he has completed his B.Tech from Sri Sai University in 2003 and M.Tech from Sukhmani college of engg. & technology in 2008.he has total 6 year expreince and area of interest is non conventional machining .he has published research papers in 2 international journals, 3 international conferences and 1 national conference.

Charanjeet Singh sandhu working as Asst.Professor Professor in Shaheed Udam singh college of engineering & technology tangori.He has completes his B.Tech from G.G.S.C.E.T Tawndi Sabbo & M.Tech from G.N.E Ludhiana & published 3 papers in international journals.