Optimization of Surface Properties of HCHCR by using other Edge Milling Cutter by using Taguchi Methodology

Honey Kumar
PG Student
Department of Mechanical Engineering
RIET, Phagwara

Jasvarinder Chalotra
Research Scholar
Department of Mechanical Engineering
RIET, Phagwara

Harvinder Lal
Assistant Professor
Department of Mechanical Engineering
RIET, Phagwara

Hardeep Singh
PG Student
Department of Mechanical Engineering
RIET, Phagwara

Abstract

In this paper the experimental work, where AISI D3 material is machined by using other four edges of CNMG 120408 is explained. In this work, we also compare the scrap edges of CNMG with SPKN 1203 R, which is commonly used in milling. In this work we use a special milling cutter having dia 50mm .The cutter has five pockets & we use the scrap edges of CNMG for milling. We also optimize the influence of the tool on the end results by using Taguchi methodology .The design of experiment used for experiment is L18. In production the tooling cost is very effective due to its high cost. By using scrap inserts & special make tools like milling cutters, boring bars, we are able to reduce the tooling cost. Mostly in industries the welded tool are used for milling & turning or tooling of high cost is used. But by using these scrap inserts we can reduce labor cost as well as tooling cost. Steam jet act as transportation carriers carrying the heat away from the cutting region, and the efficiency of this cooling method largely depends on jet pressure. The input parameters used in this work is Speed, Feed, Depth of cut, Pressure. Four level of input parameters are used i.e. speed (450 rpm, 900 rpm, 2900 rpm), feed (20mm/min, 35mm/min, 65 mm/min), Depth of cut (0.5 mm, 0.75 mm, 1mm). The material used in this thesis is AISI D3 block (60mmx70mm).In this, we analyses the effect of micro Hardness, Surface Roughness and Material Removal Rate (MRR) due to cutting parameters by using Taguchi method. The optimization is done using eighteen experimental runs based on L'18 orthogonal array of the Taguchi method, and are performed to derive objective functions to be optimized within the experimental domain.
Keywords: Other edge indexable 50 mm milling cutter, CNMG120408 insert, MRR, Surface Roughness, Taguchi Methodology

I. INTRODUCTION

The use of carbide scrap inserts are very useful in present industry because the high cost of tooling effects the production cost as well as per piece cost. We can also develop indexable tools according to job and machine to avoid the welding tools, which are very time consumable as well as based on estimation. So if we use the scrap inserts we can easily save time as well as cost. In this paper we used specially designed milling cutter, which is designed according to CNMG insert. This CNMG insert is basically a turning insert having angle 80 degrees. All most all the industries used these inserts where turning processes are running. This insert is used in CNC turning machines, turning lathe machines. We mostly used the top and bottom edges but do not use the other side edges of this inserts, if we use these edges and design the tools according to this size we definitely successful in reducing the cost as well as time where welding tools are used for turning.

Table-1
Factors and Their Levels of Interest

Factors	*Factors designation*	*Level1*	*Level2*	*Level3*
Steam jet pressure (lb/in^2)	*A*	*15*	*25*	
Speed (rpm)	*B*	*450*	*900*	*2900*
Feed rate (mm/min)	*C*	*20*	*35*	*65*
Depth of cut (mm)	*D*	*0.5*	*0.75*	*1*

II. TAGUCHI METHOD AND DESIGNS OF EXPERIMENT

The designs that are being provided by Taguchi Method are very simple and give a systematic approach for optimization. The input factors are selected which are problem dependent and these are entered in Taguchi design. Taguchi is beneficial method as it conducts balanced experimental combination. The efficiency provided by it is one of its main advantages as multiple factors are considered at once. The optimal parameters can be identified with fewer experimental resources than traditional approach. It allows looking into variation caused by control factors and noise factors while Noise factors are ignored in traditional methods.

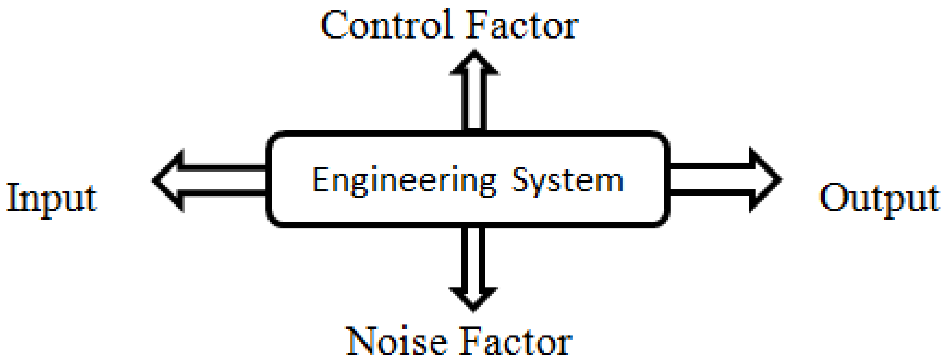

Fig. 1: Taguchi Method and Designs of Experiment

A. Taguchi Procedure:

- System Design
- Parameter Design
- Tolerance Design

1) *System Design* adds conceptual level involve creativity and innovation.
2) *Parameter Design* allows the parameters to be chosen so as to minimize the effects on performance arising from variation in main factors, environment and cumulative damage.
3) *Tolerance design* successfully completed parameter design and provides an understanding of the effect that the various parameters have on performance, resources can be focused on reducing and controlling variation in the critical few dimensions.

Table 2
Response Characteristics

Response Name	*Response type*	*Units*
Material Removal Rate (MRR)	*Higher the better*	*mm^3/min*
Surface Roughness	*Lower the better*	*Microns*
Surface Hardness	*Higher the better*	*HRB*

III. EXPERIMENTAL SET UP

For this research, vertical milling machine is used. In this the machine runs at three different speeds, feeds. Three types of cuts are considered in this experiment. Steam jet approach is also used at two different pressures. In this we used the dispose off carbide insert and milling cutter of dia 50mm, which is developed according to size of inserts. The blocks of 55mmx70mm of d3 steel grade are used in milling. The experiment is performed according to design of experiment, which is obtained by Minitab 16. Each piece is run for continuously 3 min.

Table-3
Results for MRR

Experiment No:	*Pressure (lb/in^2)*	*Speed (rpm)*	*Feed Rate(mm/min)*	*DOC(mm)*	*MRR (mm^3/min)*	*S/N Ratio*	*Mean*
1.	*15*	*450*	*20*	*0.50*	*65.9*	*45.9201*	*197.7*
2	*15*	*450*	*35*	*0.75*	*123*	*51.3452*	*369.2*
3	*15*	*450*	*65*	*1*	*260.3*	*57.8530*	*781*
4	*15*	*900*	*20*	*0.50*	*55.9*	*44.4907*	*167.7*
5	*15*	*900*	*35*	*0.75*	*136.6*	*52.2514*	*409.8*
6	*15*	*900*	*65*	*1*	*307.3*	*59.2937*	*921.9*
7	*15*	*2900*	*20*	*0.75*	*65.9*	*45.9245*	*197.8*
8	*15*	*2900*	*35*	*1*	*200.5*	*55.5847*	*601.5*

9	*15*	*2900*	*65*	*0.50*	*238.5*	*57.1164*	*717.5*
10	*25*	*450*	*20*	*1*	*86.1*	*48.2492*	*258.5*
11	*25*	*450*	*35*	*0.50*	*79.4*	*47.5425*	*238.3*
12	*25*	*450*	*65*	*0.75*	*169.3*	*54.1190*	*508.1*
13	*25*	*900*	*20*	*0.75*	*67.9*	*46.1798*	*203.7*
14	*25*	*900*	*35*	*1*	*118.4*	*51.0143*	*355.4*
15	*25*	*900*	*65*	*0.50*	*129.7*	*51.8035*	*389.2*
16	*25*	*2900*	*20*	*1*	*99.6*	*49.5105*	*298.9*
17	*25*	*2900*	*35*	*0.50*	*111.7*	*50.4541*	*333.2*
18	*25*	*2900*	*65*	*0.75*	*299.7*	*59.0723*	*898.7*

Table-4
Results for Surface Roughness (Ra)

Trail No.	*Pressure (lb/in2)*	*Speed (rpm)*	*Feed Rate(mm/min)*	*DOC(mm)*	*Surface Roughness(µm)*	*S/N Ratio*	*Mean*
1.	*15*	*450*	*20*	*0.50*	*0.28*	*11.0568*	*0.28*
2	*15*	*450*	*35*	*0.75*	*0.49*	*6.1961*	*0.49*
3	*15*	*450*	*65*	*1*	*0.71*	*2.9748*	*0.71*
4	*15*	*900*	*20*	*0.50*	*0.29*	*10.7520*	*0.29*
5	*15*	*900*	*35*	*0.75*	*0.55*	*5.1927*	*0.55*
6	*15*	*900*	*65*	*1*	*1.23*	*-1.7981*	*1.23*
7	*15*	*2900*	*20*	*0.75*	*0.49*	*6.1961*	*0.49*
8	*15*	*2900*	*35*	*1*	*0.81*	*1.8303*	*0.81*
9	*15*	*2900*	*65*	*0.50*	*1.14*	*-1.1381*	*1.14*
10	*25*	*450*	*20*	*1*	*0.37*	*8.6360*	*0.37*
11	*25*	*450*	*35*	*0.50*	*1.05*	*-0.4238*	*1.05*
12	*25*	*450*	*65*	*0.75*	*1.08*	*-0.6685*	*1.08*
13	*25*	*900*	*20*	*0.75*	*0.81*	*1.7237*	*0.81*
14	*25*	*900*	*35*	*1*	*1.14*	*-1.1381*	*1.14*
15	*25*	*900*	*65*	*0.50*	*1.41*	*-2.9844*	*1.41*
16	*25*	*2900*	*20*	*1*	*0.99*	*0.0873*	*0.99*
17	*25*	*2900*	*35*	*0.50*	*1.17*	*-1.3637*	*1.17*
18	*25*	*2900*	*65*	*0.75*	*1.01*	*-0.0864*	*1.01*

IV. RESULT

A. Result Of MRR:

The effect of parameters i.e. Pressure, cutting speed, feed rate, depth of cut and interaction effect between speed and feed were evaluated using ANOVA and factorial design analysis. A confidence interval of 95% has been used for the analysis. One repetition for each 18 trails was completed to measure the Signal to Noise ratio (S/N Ratio). ANOVA table shows that feed with F value 35.66, depth of cut with F value 5.70 and speed with F value 2.17 are the factors that significantly affect the MRR, with % contribution of 67.1%, 8.17% and 2.17% to MRR. The other factor speed and pressure × speed were found to be insignificant. For S/N ratio cutting speed, feed and depth of cut were significant to reduce the variation of MRR. With 95% confidence interval mean value of MRR was found to be 851.8 ± 143.22 mm3/min.

B. Surface Roughness:

The effect of parameters i.e. pressure , cutting speed, feed rate, depth of cut and interaction effect between speed and feed were evaluated using ANOVA and factorial design analysis. A confidence interval of 95% has been used for the analysis. One repetition for each 18 trails was completed to measure the Signal to Noise ratio (S/N Ratio). In this experiment work surface roughness (Ra) has measured at position center. ANOVA table shows that feed with F value 43.45, speed with F value 3.9 and pressure with F value of 15.32 are the factors that significantly affect the surface roughness with % contribution of 43.75 %, 13.93 % and 23.93 % to surface roughness. The other factors pressure × speed was found to be insignificant. For S/N ratio pressure, cutting speed, feed, and depth of cut were significant to reduce the variation of surface roughness. With 95% confidence interval mean value of surface roughness was found to be 0.2089 ± 0.146 µm.

V. CONCLUSION

The present study was carried out to study the effect of input parameters on the MRR, Surface Roughness. The following conclusions have been drawn from the study:

1) MRR is mainly affected by feed rate, depth of cut and speed.
2) Surface roughness is mainly affected by pressure, feed rate and cutting speed.
3) The interactions between speed & pressure do not make any effect, as it remains insignificant in all cases.
4) It is clearly observe the tools used by us in this experiment effects the tooling cost. The tool bears loads & do not show any chattering during experiment.
5) The scrap inserts we use for conducting experiment provide the required results, which we observe during the results of MRR.

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