Experimental Investigation of Turning Operation Using Other Edges of Carbide Turning Insert

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Abstract— This paper represents an investigation on optimization of effect of cutting parameters on work piece surface roughness by using other edge turning boring bar & other edge of CNMG 120408 insert. This size is mainly used in industry for turning operations. CNMG is a negative insert having angle 80 & its four edges are used .But other edges are not used which are available in insert. Therefor we use other edge boring bar, which is prepared according to size of CNMG insert for this experiment. In this work we optimize the effect of this other edge tool & insert on the surface of work piece .This is the economical machining process , because mostly in industry the inserts are dispose off after usage of four edges , but we can use other four edges . Therefore we are able to use the eight edges of insert ,which is beneficial .By using other edges of inserts we can able to reduce the tooling cost as well as per piece cost . In this experimental work we use the other edges of PVD coated carbide turning insert due to its properties &characteristics .The design of experiment is prepared by using taguchimethodlogy .In this experiment EN8 steel material is used. In this, we analyses the effect of Surface Roughness and Material Removal Rate (MRR) due to cutting parameters by using Taguchi method. The optimization is done using twenty seven experimental runs based on L’27 orthogonal array of the Taguchi method, and are performed to derive objective functions to be optimized within the experimental domain.

Keywords: Other edge boring bar (32mm) , PVD coated CNMG 120408 insert , Surface roughness , Taguchi Method

I. INTRODUCTION

In industry the cutting tools are used in each machingprocess . There are several grades of cutting tools, boring bars, inserts which are used daily & these are considered under consumable items. But if we develop some tools or try to use the scrap tools in other machining process ,than we can able to save the tooling cost as well as production cost .In this experiment we use the other edges of turning inserts ,which are dispose off after using .We use a special boring bar for this experiment which is designed for single pass turning process. CNMG is a turning insert which have eight edges, but four of them are used .In this experiment our main main aim to obtain the results i.e. material removal rate, surface roughness, tooling cost . In industry EN8 is widely used . EN8 is known as 080M40.An unalloyed medium carbon steel .EN8 is a medium strength steel, good tensile strength suitable for shafts, stressed Pins, studs keys etc. We use a work piece of diameter 40mm & length 90mm. Mainly CNC & conventional lathe is used for operation. We apply this tool for performing the machining operations. In this PVD coated carbide insert is used due to its load resistance& dry cutting properties.

II. EXPERIMENTAL DETAIL

This experiment is performed on conventional lathe machine. Three cutting speed, feed & depth of cut are taken as input parameters. All experiment can run for 30 seconds. The work poece used is EN8 having dia 40mmx90mm length. The design of experiment is prepared by taguchi method.

Parameter	Unit	Level1	Level2	Level3
Cutting Speed	rpm	260	393	593
Feed	mm/min	0.2	0.1	0.05
Depth of cut	mm	1	2	3

Table 1: Factors and their levels of interest

Figure 1: Other Edge CNMG 120408 Boring Bar (32mm)

A. *TAGUCHI METHOD AND DESIGNS OF EXPERIMENT*

Taguchi method of design provides a simple, efficient and systematic approach for optimization of experimental designs for performance quality and cost. In this, firstly the input factors are selected which are used in experiments and these factors values are entered in Taguchi design .The experimental values are obtained by design of experiment technique.

In Taguchi method the results are analyzed to achieve to one or three following objectives

- To establish the best or optimum condition for product or a process
- To estimate the contribution of individual factors
- To estimate the response under optimum condition.

The optimum condition is identified by studying the main effects of each of the factors. The process involves minor arithmetic manipulation of numerical results and usually can be done by using simple calculator. The main effects indicate the general trend of influence of factors.

Signal-to-noise ratio or the SN number is calculated for each variable to determine the effect on the output. In the equations below, y_i is the mean value and s_i is the variance. y_i is the value of the performance characteristic for a given experiment.

$$SN_i = 10 \log \frac{\bar{y_i}^2}{{s_i}^2} \quad \text{....(1)}$$

where

$$\bar{y}_i = \frac{1}{N_i} \sum_{u=1}^{N_i} y_{i,u}$$

$$s_i^2 = \frac{1}{N_i - 1} \sum_{u=1}^{N_i} (y_{i,u} - \bar{y}_i)$$

i= Experiment number
u= Trial number
N_i= Number of trials for experiment i

For the case of minimizing the performance characteristic, the following definition of the SN ratio should be calculated:

$$SN_i = -10 \log \left(\sum_{u=1}^{N_i} \frac{y_u^2}{N_i} \right) \quad \text{....(2)}$$

For the case of maximizing the performance characteristic, the following definition of the SN ratio should be calculated:

$$SN_i = -10 \log \left[\frac{1}{N_i} \sum_{u=1}^{N_i} \frac{1}{y_u^2} \right] \quad \text{....(3)}$$

The table1 indicates the factors and levels for selecting the orthogonal array. For experiment degree of freedom(DOF) is to be calculated. The DOF for orthogonal array should be greater than or at least equal to those for design parameters. In this experiment, L9 orthogonal is used having four columns and nine rows. This array has eight degree of freedom and it can be handle three level design parameter. The surface roughness, were analyzed by using this methodology.

S.NO	RPM	FEED	CUT	Ra(µm)	Ra(µm)	Ra	S/N Ratio
1.	260	0.05	1	0.666	0.671	0.67	-6.4931
2	260	0.05	2	1.81	1.8	1.8	-8.692
3	260	0.05	3	2.69	2.69	2.7	-9.5731
4	260	0.1	1	0.89	0.89	0.9	-7.1795
5	260	0.1	2	1.91	1.91	1.9	-9.3816
6	260	0.1	3	2.9	2.89	2.98	-10.2595
7	260	0.2	1	1.78	1.81	1.8	-9.4496
8	260	0.2	2	3.71	3.7	3.7	-11.6517
9	260	0.4	3	2.6	2.655	2.65	-12.5296
10	400	0.05	1	0.961	0.9	0.96	-8.5945
11	400	0.05	2	2.81	2.80	2.8	-10.7966
12	400	0.05	3	3.8	3.8	3.8	-11.6745
13	400	0.1	1	1.61	1.6	1.6	-9.3839
14	400	0.1	2	3.31	3.30	3.3	-11.5860
15	400	0.1	3	3.21	3.20	3.2	-12.4639
16	400	0.2	1	5.8	5.8	5.8	-13.1957
17	400	0.2	2	3.6	3.61	3.6	-15.3978
18	400	0.2	3	4.61	4.6	4.6	-16.2757
19	600	0.05	1	3.81	3.79	3.8	-12.5876
20	600	0.05	2	4.10	4.11	4.1	-14.7897
21	600	0.05	3	4.8	4.80	4.8	-15.6675
22	600	0.1	1	4.888	4.91	4.89	-13.8916
23	600	0.1	2	5.11	5.12	5.1	-16.0937
24	600	0.1	3	5.20	5.21	5.2	-16.9715
25	600	0.2	1	5.71	5.71	5.7	-14.5404
26	600	0.2	2	5.4	5.41	5.4	-16.7525
27	600	0.2	3	5.5	5.51	5.5	-17.6204

Table 2: Results for Surface Roughness (Ra)

B. *EFFECT ON TOOLING COST*

In tooling cost analysis, it is observed that other four scrap edges are capable to give the almost same results as useful edges. Resultant quality is also same as there is no tooling marks or other problems occurred during turning process. So by using other four edges that are disposed off as scrap directly effects the tooling and operational cost.

Parameters	Useful four edges	Other four edges (Scrap Inserts)
Per Edge Capacity	180-200	180-190
Cost(In Rs.)	190	0

Table 3: Comparison between Useful and other (scrap) edges of insert

III. CONCLUSIONS & DISCUSSIONS

The present study was carried out to study the effect of input parameters on the MRR, surface roughness and surface hardness. The following conclusions have been drawn from the study:

- Surface roughness is mainly affected by feed rate and cutting speed.
- The interactions between speed & feed does not make any effect , because it remains insignificant in all cases.

- It is clearly observe the tools used by us in this experiment effects the tooling cost . The tool bears loads &donot show any chattering during experiment .
- The scrap inserts we use for conducting experiment provide the required results , which we observe during the results of surface rougness.

IV. SCOPE FOR FUTURE WORK

With increasing competitiveness as observed in recent times, manufacturing system in the industry are being driven more and more aggressively. So there is always need for perpetual improvements. Thus for getting more accurate results we can take into account few more parameters as given below:

(1) CNC machines can be used for the experimentation to have the better control of the process variables and also parameters can be set to the desired accuracy.
(2) The present work can be extended with different point radius of inserts i.e. (0.4,0.8,1.2,1.6)
(3) By using scrap inserts, high tooling cost can be reduced.
(4) These scrap turning inserts can also be used in milling processes for example face milling.
(5) By proper handling and selection of cutting inserts better surface finish can be achieved .
(6) PVD coating supports dry cutting due to its properties during machining processes. So by using this technique usage of coolant can be reduced which is economical.
(7) By selecting grades ,these scrap edges are used for different materials for example aluminium,cast iron ,mild steel etc
(8) After using all the eight edges of inserts, these inserts are sold in a scrap rate to scrap dealer. This also reduces the cost of inserts.

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