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Optimization Milling Process When Machining C45 Steel by Ball Nose Mill for Minimum Tool Wear using Taguchi Method

Vu Nhu Nguyet[1], Do Duc Trung[2*]

[1]Faculty of Mechanical Engineering, Thai Nguyen University of Technology, 3/2 street, Tich Luong ward, Thai Nguyen City, Vietnam.
[2]Faculty of Mechanical Engineering, Hanoi University of Industry, No. 298, Cau Dien street, Bac Tu Liem district, Hanoi, Vietnam
*Corresponding author : dotrung.th@gmail.com or doductrung@haui.edu.vn

ABSTRACT

In this paper, Taguchi method with L16 was used to experimental research in order to present the influence of cutting parameters and feed way on the tool wear when machining C45 by ball nose mill. The experimental result shows the influence of above parameters on tool wear and the value of cutting parameters and feed way for minimum of tool wear.

Keywords : Milling, Ball Nose Mill, Tool Wear, C45 Steel, Taguchi Method.

I. INTRODUCTION

In mechanical engineering, milling is a common method that has high effective. Milling process by ball nose mill can be used in many cases of curve surface, that has a high accuracy and productivity. In those cases, tool wear has the significant influence on productivity and accuracy of milling process. A research on the influence of processing parameters on tool wear proposed the determination of the reasonable value (or optimum value) of them to get minimum tool wear. Basim A. Khidhir and Bashir Mohamed [1] proposed the influence of velocity speed, feed rate, depth of cut and nose radius on surface roughness and tool wear when machining nickel based hastelloy – 276 by response surface method, experimental matrix was Box-Behnken; Duong and Tran [2] presented the influence of velocity speed, feed rate and depth of cut on tool wear and surface roughness when machining Inconel 718 material by response surface method. In this wwork, experimental matrix was central composite design. Study on the influence of velocity speed, feed rate, depth of cut and machining time on tool wear and surface roughness when milling Stainless Steel (316L) was done by Ali Abbar Khleif and Mostafa Adel Abdullah [3]; Taguchi method was applied to determine the influence of cutting speed, milling direction, insert number and cutting tool material on tool wear and surface roughness when machining Inconel 718 material [4];… This paper presents the experimental research when machining C45 steel by ball nose mill. Taguchi method with 16 points in experimental matrix (L16) was used to study the influence of parameters on the wear of flank-tool wear. The four input parameters include velocity speed, feed rate, depth of cut and feed way. Finally, this work shows the optimum value of above parameters for minimum value of tool wear.

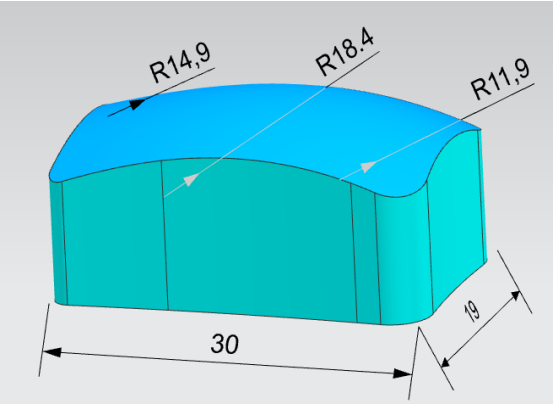
II. EXPERIMENTAL MILLING

2.1. Components

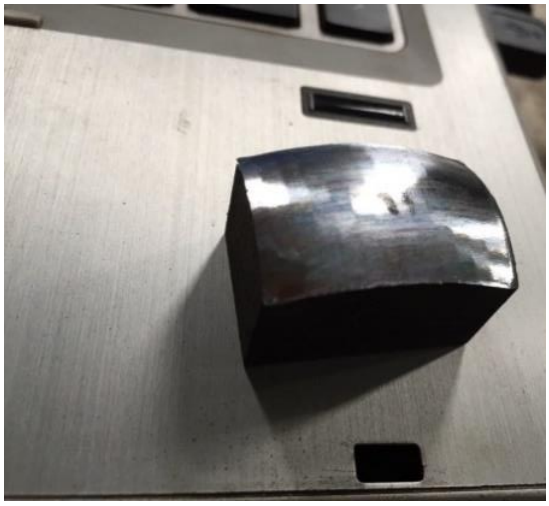
The component material was C45 steel, with heat treating 40÷42HRC. Chemical composition of steel is shown in Table 1. Dimensions of the experimental sample are shown in Fig.1.

Table 1. Chemical composition of steel

C(%)	Si(%)	Mn(%)	P(%)	S(%)	Cr(%)
0.42	15	0.5	0.025	0.025	0.2



a) Dimensions of experimental sample



b) Experimental sample

Fig 1. Experimental Component

2.2. Tool

The ball nose mill, P3202-XWM25 was used, diameter f8, flutes 02, helix angle 15^0, angle of rake -14^0, as shown in Fig. 2

Fig 2. Ball nose mill

2.3. Machine-tool

Milling experiments were conducted on Mazak VCS530C, as shown in Fig. 3.

Fig 3. Experimental machine-tool

2.4. Measurement devices

VHX-6000 scanning electron microscope was used, as shown in Fig 4. Each component was measured in three times.

Fig. 4. VHX-6000 scanning electron microscope

2.5. Design of experiment

The Taguchi method with 16 runs was used. Four parameters are velocity speed v_c, feed rate f_t, depth of cut t and feed method F_m. Experimental matrix is showns in Table 2.

III. EXPERIMENTAL RESULTS ANALYSIS

The tool wear is the average reading of three consecutive measurements, as shown in Table 2.

From results in Table 2, experimental data was analyzed by Minitab 16. The results are shown in Table 3, Fig.5 and Fig.6.

Table 2. Experimental design matrix

Run	$v(m/min)$	$f\left(\frac{mm}{tooth}\right)$	$t(mm)$	F_m	$wear\ (\mu m)$
1	80	0.02	0.10	zigzag	32.23
2	80	0.05	0.15	zig	15.84
3	80	0.08	0.12	zig with contour	29.49
4	80	0.10	0.08	Follow periphery	24.60
5	100	0.02	0.15	zig with contour	24.57
6	100	0.05	0.10	Follow periphery	17.64
7	100	0.08	0.08	zigzag	11.56
8	100	0.10	0.12	zig	13.54
9	120	0.02	0.12	Follow periphery	29.39
10	120	0.05	0.08	zig with contour	18.83
11	120	0.08	0.10	zig	21.75
12	120	0.10	0.15	zigzag	32.56
13	160	0.02	0.08	zig	38.14
14	160	0.05	0.12	zigzag	29.46
15	160	0.08	0.15	Follow periphery	20.37
16	160	0.10	0.10	zig with contour	22.14

Table 3. Experimental data analysis

Run	$v(m/min)$	$f\left(\frac{mm}{tooth}\right)$	$t(mm)$	F_m	$wear\ (\mu m)$	SNRA	MEAN
1	80	0.02	0.10	zigzag	32.23	-30.1661	32.2333
2	80	0.05	0.15	zig	15.84	-23.9951	15.8400
3	80	0.08	0.12	zig with contour	29.49	-29.3925	29.4867
4	80	0.10	0.08	Follow periphery	24.60	-27.8187	24.6000
5	100	0.02	0.15	zig with contour	24.57	-27.8069	24.5667
6	100	0.05	0.10	Follow periphery	17.64	-24.9316	17.6433
7	100	0.08	0.08	zigzag	11.56	-21.2617	11.5633
8	100	0.10	0.12	zig	13.54	-22.6324	13.5400
9	120	0.02	0.12	Follow periphery	29.39	-29.3650	29.3933
10	120	0.05	0.08	zig with contour	18.83	-25.4970	18.8300
11	120	0.08	0.10	zig	21.75	-26.7479	21.7467
12	120	0.10	0.15	zigzag	32.56	-30.2546	32.5633
13	160	0.02	0.08	zig	38.14	-31.6276	38.1400
14	160	0.05	0.12	zigzag	29.46	-29.3856	29.4633
15	160	0.08	0.15	Follow periphery	20.37	-26.1812	20.3733
16	160	0.10	0.10	zig with contour	22.14	-26.9049	22.1433

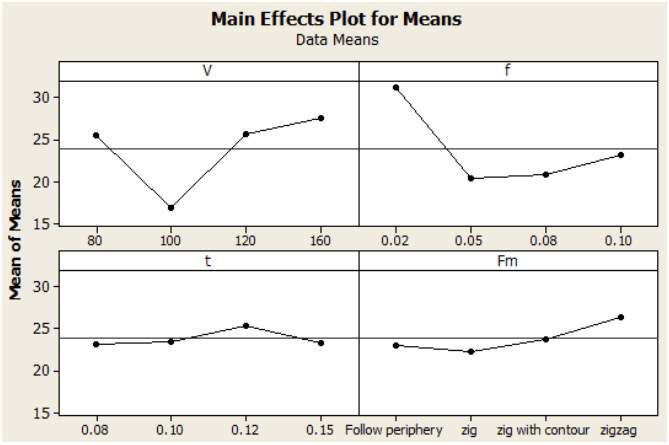


Fig 5. Influence of parameters on tool wear

Fig.5. shows that the velocity speed has the biggest influence on tool wear, the following parameters are feed rate, depth of cut and feed way respective.

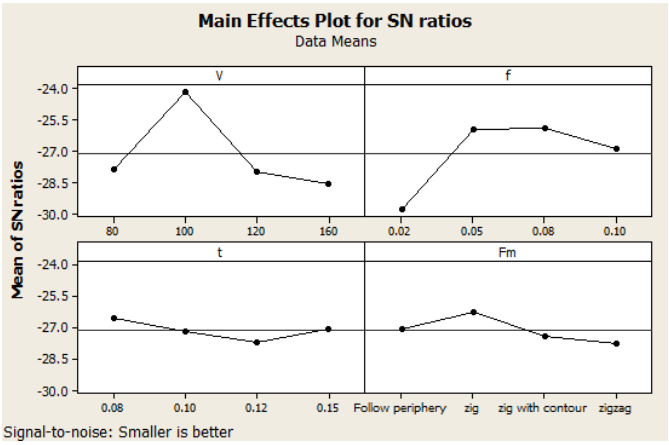


Fig. 6. Chart on S/N ratio

Fig.6. shows that the optimization value of velocity speed, feed rate, depth of cut are 100(m/min), 0.05(mm/tooth), 0.08(mm) respectively, and feed way is zig. This is optimization condition for minimum value of tool wear.

IV. CONCLUSION

This paper presents the researching on the influence of cutting parameters and feed way on the tool wear when machining C45 steel by ball nose mill using Taguchi method. The influence of above parameteters on the tool wear was proposed. Also, this work is shown the value of above cutting parameter and feed way for minimizing the value of tool wear.

V. ACKNOWLEDGEMENTS

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