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THE EFFECTS ON SURFACE ROUGHNESS OF PARAMETERS IN MACHINING

Cenk Misirli, Mümin Şahin, Mehmet Ceviz

Trakya University, Balkan Yerleskesi, 22030, Engineering Faculty, Edirne, Turkey

Corresponding author: Mümin Şahin, mumins@trakya.edu.tr

Abstract: Every production plant try to find a solution that is cheaper and more durable for products which they want to produce so they aim to decrease intensionally tool changing cost and period. In this work, the manufacturing steel has been machined on a CNC lathe without cutting fluid, at various cutting speed, feed rate and depth of cut. Effect of cutting speed, feed rate and depth of cut on surface rougness were investigated by machining the manufacturing steel by a carbide insert without coating. In the experiments three different feed rate values between 0.1, 0.2, 0.3 mm/dev, three different depth of cut 1, 1.5, 2 mm and three different cutting speed 100, 180, 280 m/min were used and the manufacturing steel (st1050) that is known mechanics and chemical properties was processed. In this experiment, total 27 specimens were turned. Surface roughnesses that was found were measured and wearing rate of cutting tools was investigated. In this way , Surface roughnesses and optimum cutting parameters for the manufacturing steel was determined. In this work, optimum cutting parameters and minimum surface roughnesses were tried to determine for selected material and cutting tip.

Key words: Cutting Tool, Cutting speed, Depth of Cut, Surface Roughness

1. INTRODUCTION

The suitable selection of cutting tools and process parameters is essential to achieve the desired quality of surface finish. Optimization seeks to maximize the performance of a system, part or component, while satisfying design constraints. So that, the process parameters need to be optimized to obtain the desired surface finish [1]. Nowadays in machinability process of metals, various experiments are carried out to create same quality product. In terms of surface roughness and cutting force, cutting parameters which are used on machinability of metals are of capital importance. In terms of quality machined surface structure is one of significant criterions [2]. From the literature reviewed, it has been observed that there is a disagreement between researchers about the use of coolants in hard turning. With this view, in the present work, cutting parameters under dry and minimum quantity lubrication were optimized to address the widely debated topic of application of coolants in hard turning[3]. Machining is a way which has been being applied for years and Today, It preserve its importance as well. In turning which is a common section of machining, machining parameters are the leading of factors that affect directly product quality [4]. Two types of coated cemented cardide inserts were used, various combinations of side cutting edge angles (SCEAs), cutting speeds and feedrates were tested at a constant depth of cut[5]. Cutting results indicate the SCEA, together with cutting speed and feed rate, do play a significant role in determining the tool life of an inset when machining Inconel 718 [6]. The correlations between the cutting parameters and the performance measures, namely, three components of cutting force, surface roughness and tool life were developed based on experimental observations [7].

2. EXPERIMENTAL WORK

In a machning process, the most significant factor of machinability is surface sensitivity of workpiece. Therefore surface roughness that will be determined must be investigated under independent conditions from each other. With priority these independent conditions are feed rate, cutting speed and depth of cut. Experimental studies are required in order to investigate these parameters. For the experiment which will be executed without coating carbide cutting tool (TCMX-WF), three different cutting speed (100, 180, 280 m/min), three different feed rate (0.1-0.2-0.3 mm/dev) and three different depth of cut (1, 1.5, 2 mm) were selected. Total 27 manufacturing steel samples have been considered for this work to show the alteration of surface roughness under different parameters. First of all prepared samples were investigated with spectral analysis and Material combinations and mechanical properties which were determined of these sample are shown in table 1 and table 2.

Table 1. Chemical composition of test sample (%)

S	P	Mn	Si	C
0,045	0,035	0.718	0.158	0.472

Table 2. Machanical properties of test sample

Breaking elongation [%5d]	Yield strength [MPa]	Tensile strength [MPa]	Hardness [HB]
28	400	459.5	128

Afterwards, Cutting edge was selected from catalog which belong to Sandvik firm for manufacturing steel. Cutting edge angle was determined as triangle for every cutting parameters. Selected cutting edge and properties were described below;

ISO standard: TCMX 09 02 02-WF

ANSI standard: TCMX 1.8(1.5)0-WF

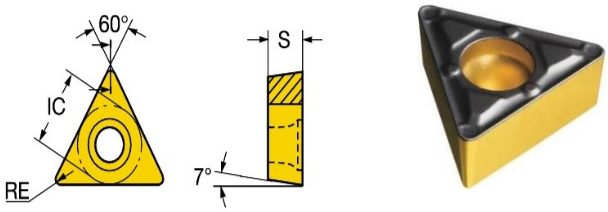

Fig.1. KTCMX-WF Cutting edge dimensions and shape

Finally, In the experiment made, total 27 workpieces were machined by turning three test samples with each of cutting edges of cutting tool and average surface roughnesses were measured. In this way, optimum cutting parameters were designated for selected cutting tool as well.

Fig.2. Before machining test samples

Fig.3. During machining a picture

Fig.4. Machined test samples

3. SURFACE ROUGHNESS MEASUREMENT

In assignation surface roughnesses of test samples, MARSURF M400 measuring device of surface roughness was utilized. Roughness values were measured for three varied values of each of these parameters. 2 mm length of cut, 10 mm sampling length and (15±1)ºC ambient temperature were selected so as to surface roughness. Measuring device used is shown in figure 5.

Fig.5. Measurement of surface roughness

4. RESULT AND DISCUSSIONS

4.1.According to constant depth of cut changing in Average surface roughness

Average surface roughnesses found was shown in table 3 and figure 6.

Table 3. According to constant depth of cut Surface roughnesses with TCMX-WF cutting edge

Cutting tool	Cutting speed m/min	Constant depth of cut (mm)	feed rate mm/dev	Average Surface roughnesses (µm)
	v	a	f	Ra
TCMX-WF	100	1	0.10	2.35
		1	0.20	3.48
		1	0.30	4.89
TCMX-WF	180	1	0.10	2.00
		1	0.20	3.27
		1	0.30	4.69
TCMX-WF	280	1	0.10	3.35
		1	0.20	4.19
		1	0.30	6.07

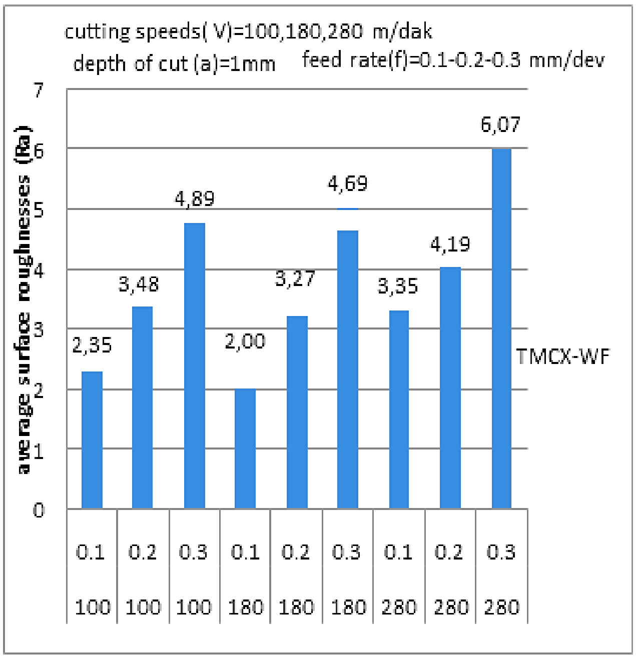

Fig.6. Surface roughnesses dependent on cutting speed and feed rate

According to feed rate (0.1-0.2-0.3 mm/dev) consideration;

When average surface roughness is investigated, it is seen that surface roughness increase as feed rate increase. There is a direct proportion between feed rate and surface roughness as it is seen in table 3. As it is understood, A way of roughness reduction is to decrease feed rate. In other words, in the experiments made, minimum surface roughness was seen to have been obtained with 0,1 mm/dev feed rate. In test samples which were machined with 1 mm constant depth of cut for TCMX-WF carbide cutting tool, while feed rate increased 100% ,surface roughness increased between 51.15% and 209.18% .

According to cutting speed (100, 180, 280 m/min) consideration;

Minimum average surface roughness was seen to have been turned with 180 m/min cutting speed and İt is seen that average surface roughness decrease as cutting speed increase until 180 m/min. Another way of roughness reduction is to increase to a certain extent, which this is the most common known method.

However, As it is seen in figure 7, It is understood that surface roughness increase after cutting speed exceed 180 m/min.

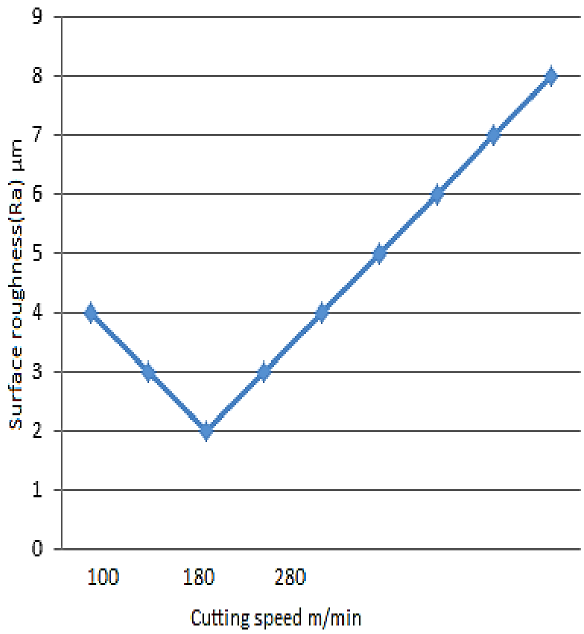

Fig.7. Effect to surface roughness of wear which occurs on without coating cutting tool

The reasons for the increase in surface roughness are high temperature occurring dependent on friction, wear occurring on shear edge of cutting tool and vibration. Notch and Flank wears which consisted of high cutting speed were enlarged sixty times by using optical microscope and were shown in figure 8 and 9.

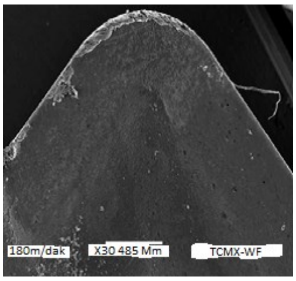

Fig.8. Flank Wear

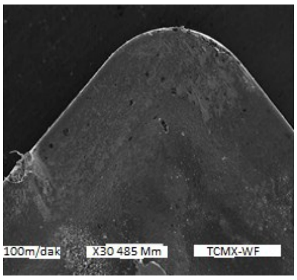

Fig.9. Notch Wear

4.2.According to constant feed rate changing in Average surface roughness;

Second experiment was made in a constant feed rate (0.3 mm/dev) and effects of depth of cut and cutting speed on surface roughness were investigated.In this section, total nine pieces were turned.

Table 4. According to constant feed rate Surface roughnesses with TCMX-WF cutting edge

Cutting tool	Cutting speed m/min	Constant depth of cut (mm)	feed rate mm/dev	Average Surface roughnesses (µm)
	v	a	f	Ra
TCMX-WF	100	1	0.30	2.15
		1.5	0.30	2.75
		2	0.30	4.23
TCMX-WF	180	1	0.30	2.12
		1.5	0.30	2.67
		2	0.30	4.17
TCMX-WF	280	1	0.30	2.06
		1.5	0.30	2.58
		2	0.30	3.98

According to cutting speed (100, 180, 280 m/min) consideration:
Minimum average surface roughness was seen to have been turned with 280 m/min cutting speed and İt is seen that average surface roughness decrease as long as cutting speed increase. In test samples which were machined with 2 mm constant depth of cut for TCMX-WF carbide cutting tool. In 100 m/min cutting speed, while surface roughness was obtained as 4.29 µm Respectively, in 180 m/min and 280 m/min cutting speed, surface roughnesses were obtained as 4.23 µm and 4.04 µm. As it is seen in table 4. It is seen that surface roughness decrease as cutting speed increase. In higher cutting speeds, Minimum surface roughness may be obtained, However, during the process, that temperature increase cause to notch and wear should not be forgotten.
Coated cutting tools must be preferred for high cutting speeds.
According to depth of cut (1, 1.5, 2 mm) consideration:
Minimum average surface roughness was seen to have been turned with 1mm depth of cut and İt is seen that average surface roughness decrease as long as depth of cut decrease.
As it is seen in table 4, Another way of surface roughness reduction is to decrease depth of cut.
In the experiment which was made, Minimum surface roughness was determined with 1mm depth of cut and 280 m/min cutting speed for manufacturing steel (st1050). The main reason of increasing of surface roughness is permanent deformation which is occurred by high temperature on cutting tool.Increase of depth of cut enlarge contact surface of cutting tool and temperature rise occur during the process.This temperature rise which take place by increasing the permanent deformation cause to increase of surface roughness. Consequently, there is a direct proportion between depth of cut and surface roughness.

4.3.According to constant cutting speed changing in average surface roughness

Third experiment was made in a constant cutting speed (100 m/dak) and effects of depth of cut and feed rate on surface roughness were investigated.In this section, total nine pieces were turned.

Table 5. According to constant cutting speed Surface roughnesses with TCMX-WF cutting edge

Cutting tool	Cutting speed m/min	Constant depth of cut (mm)	feed rate mm/dev	Average Surface roughnesses (µm)
	v	a	f	Ra
TCMX-WF	100	1	0.10	3.35
		1	0.20	4.20
		1	0.30	4.95
TCMX-WF	100	1.5	0.10	3.47
		1.5	0.20	4.32
		1.5	0.30	5.07
TCMX-WF	100	2	0.10	3.54
		2	0.20	4.39
		2	0.30	5.18

According to depth of cut (1, 1.5, 2 mm) consideration:
It is seen that surface roughness increase as depth of cut increase. As it is seen in table 5, Minimum average surface roughness was seen to have been

turned with 1mm depth of cut and 0.1 mm/dev feed rate. In three different feed rates, Average surface roughnesses values along with standard deviation are seen in table 5. As it is understood in table 5 above, In 100m/min cutting speed and 0.1 mm/dev feed rate, Average surface roughnesses based on three different depth of cut (1, 1.5, 2 mm) were obtained respektively as (3.35, 3.47, 3.54 µm).
According to feed rate (0.1-0.2-0.3 mm/dev) consideration:
When average surface roughness is investigated selected three different feed rates, it is seen that surface roughness increase as feed rate increase. There is a direct proportion between feed rate and surface roughness. In the experiment made, Minimum average surface roughness was seen to have been turned with 0,1 mm/dev feed rate and 1mm depth of cut for manufacturing steel (AISI 1050). As it is understood in table 5, Another way of roughness reduction is to decrease feed rate.

5. CONCLUSIONS

In test samples which were machined with 1 mm constant depth of cut for TCMX-WF carbide cutting tool, while feed rate increased 100% ,surface roughness increased between 51.15% and 209.18%.
In test samples which were machined with 0.30 mm/dev constant feed rate for TCMX-WF carbide cutting tool, while depth of cut increased 50%, surface roughness increased between 95.23% and 270.65%.
In test samples which were machined with 100 m/min constant cutting speed for TCMX-WF carbide cutting tool, while cuting speed increased about 80%, surface roughness decreased about 60%.
İt was seen that surface roughness increase as feed rate increase, therefore there is opposite relationship between surface texture and feed rate.
During the machining, sort of cutting tool, wear, notch, built-up edge, high temperature and vibration were determined as factors that increase surface roughness.
In selection of cutting tool, Machine tool capacity must be considered as well as properties of test samples and If material are machined in high cutting speed, Coated cutting tools must be selected. Cooling liquid also should be used to decrease surface defects which high temperature create during the machining**.**
In inadequate machine tool power, because feed rate is a circumstance associated with machine tool capacity, the machine tool may stop and this situation might cause to surface deformation while materials are machining with a high feed rate. Machine tool power is significant to choose depth of cut as well.
If debth of cut and feed rate are chosen extremely, Cutting tool may be destroyed and complete soon its life.
Experimental results demonstrated that, in a constant ambient temperature and same cutting conditions, the experiment need to be repeated several times so as to investigate surface texture of a test sample. In this way results that be closest to truth might be achieved.
This work has shown that under certain conditions, in a range of tolerances, high cutting speed, coated cutting tool, low feed rate and depthof cut should be chosen in order to obtain minimum surface roughness.
In assignation surface roughnesses of test samples, on surface of test samples, least three measurement values must be determined to decrease measuring errors. Indeed, these measurements should be increased as far as possible. If there are big differences among the iterative measurements, whether edge of cutting tool is abraded must be controlled.
In some test samples, in constant 1 mm depth of cut, It is understood that surface roughness increase after cutting speed exceed 180 m/min. The reasons for the increase in surface roughness are high temperature occurring dependent on friction, wear occurring on shear edge of cutting tool.
In future works, the experimental studies will be made to inveatigate How different cutting tool coatings (For instance PVD, CVD coating), materials and if cooling liquid is used affect surface roughness and tool life. Also experiments will be made for more test samples.In this context, a date base is being intended to be created.

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