Studying the Effect of the Percentage of Cutting Fluid and Cutting Speed on Surface Roughness

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Abstract

The purposes of cutting fluids (MWF) which are used in the mechanical machining operation are important to make cutting easy, and increase the rate of productivity. It is now very important subject because the direct effect to produce best surface roughness and negative effect on work environment and worker. This paper studies the effect of using cutting fluids on the surface roughness of the product. The Iraqi soluble cutting type was used, in the experimental work, special study to do a number of experiments to choose the best metal cutting parameter such as (cutting speed, condition depth of cut paper, and feed rate) ,also its effects on the surface roughness. In this paper was used (low alloy steel) and cutting tool of (Tungsten Carbide) were used which have a high hardness. Different cutting speeds were used with constant cutting depth and feed rates. was used three different mixtures in different percentages of the fluid with water and by two methods of using cutting fluid, the first method is flooding method and the second is misting method with average of (480 mL/hrs) for three mixtures from the fluid. From the results appear the best operation case to gain best surface roughness for product is by use flooding method with ratio (1:20) (oil: water) with linear cutting speed (94.2m/min). Which gives surface roughness of (0.01 ^{m} m). Will have noted the direct effect of the cutting fluid and the water drop on the fluid on the surface roughness.

دراسة تأثير نسبة سائل القطع و سرعة القطع على خشونة السطح

الخلاصة

لسوائل قطع المعادن (MWF) المستخدمة في عمليات التشغيل الميكانيكي أهمية في تسهيل عمليات القطع وتشغيل المعادن وزيادة الإنتاجية وتعتبر موضوعاً ذا أهمية بالغة بسبب تأثيراتها المباشرة على خشونة السطح وتأثيرها السلبي على بيئة العمل والعاملين. تضمن هذا البحث دراسة التأثيرات الناتجة من استخدام سوائل القطع على خشونة سطح المنتج. وقد تم استخدام سائل القطع العراقي في الدراسة العملية حيث تضمن الجانب العملي الخاص بالدراسة أجراء عدد من التجارب لاختيار أفضل الظروف الخاصة بعملية قطع المعادن (من سرعة القطع وعمق القطع ومعدل التغذية) من حيث تأثيرها خشونة سطح المنتج.وقد أجريت التجارب على سبيكة من نوع (Low Alloy steel) المخمر وباستخدام عدة قطع من (Tungsten Carbide) عالي الصلادة وتمت عمليات القطع باستخدام سرعات قطع مختلفة و تثبيت معدل تغذية و عمق القطع . كما استخدام ثلاث خلطات من السائل مع الماء العادي وبطريقتين في استخدام السائل الطريقة الأولى هي طريقة الغمر (Flooding) والثانية هي طريقة التقطير و بمعدل تقطير 480 مللي لتر / ساعة للثلاث خلطات من السائل، وقد أظهرت النتائج أن أفضل حالات التشغيل لكي نحصل على أفضل سطح للمنتوج وذات جوده عالية هي عند استخدام سائل التبريد وبطريقة الغمر (Flooding) عندما تكون نسبة الخلط (1:20), (Oil: Water) وعند سرعة قطع (94.2 m/min) حيث أن قيمة خشونة السطح مقداره (0.01µm). .وبذلك نلاحظ التأثير المباشر لسائل القطع وكمية الماء المضاف إلى السائل على خشونة سطح المنتج.

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1 .Introduction

Surface roughness is one of the most important requirements in machining process .The surface roughness value is a Result of the tool wear .When tool wear increases, the surface roughness also increases .The determination of the sufficient cutting parameters is a very important process by giving both minimum surface roughness values.In turning operation, there are many parameters such as the tool geometry including the tool nose radius and other parameters cooling oil, cutting method, and various cutting conditions including the feed rate, depth of cut and cutting speed affecting on the surface roughness.In addition to the changing of the tool with a new one after each run is a very cumbersome and expensive operation .Thus, assessing the effects of all the variables in the same research project seems to be a more useful way from practical and economic points of view.Various studies have been made on the surface roughness in turning operation using different materials, cutting tools, and experimental and optimization methods [1]

$$R_a = \frac{R_{max}}{4 r_e} \quad ....(1)$$

$$R_{max} = \frac{f^2}{8 r_e} \quad .....(2)$$

$$R_a = \frac{f^2}{32 r_e} \quad ....(3)$$

1.2 Occupational Exposures to MWF Cutting fluids are grouped into four major classes :[2, 3].

1 .Straight oil (neat oil) MWF are severely solvent-refined petroleum oils)lubricant-base oils (or other animal, marine, vegetable, or synthetic oils used singly or in combination and with or without additives .Straight oils are not designed to be diluted with water.

2 .Soluble oil (emulsifiable oil) MWF are combinations of 30 %to 85 % severely refined lubricant-base oils and emulsifiers that may include other performance additives.Soluble oils are diluted with water at ratios of 1 part concentrate to 5B40 parts water.

3 .Semi synthetic MWF contain a lower amount of severely refined lubricant-base oil in the concentrate (5 %to 30%), a higher proportion of emulsifiers, and 30 %to 50 %water . The transparent concentrate is diluted with 10 to 40 parts water.

4 .Synthetic MWFs contain no petroleum oils and may be water soluble or water dispersible .The synthetic concentrate is diluted with 10 to 40 parts water.

2 .Theoretical Model of Surface Roughness

The standard equation for modeling surface roughness in hard turning is as follows :

Where,

Ra :surface roughness (mm)

R_{max} :maximum surface roughness (mm)

f :feed rate (mm/rev).

re :tool nose radius (mm)

According to this model, we need only decrease the feed rate or increase the tool nose radius to improve our surface roughness.There are several problems with this model.First, it does not take into account any imperfections in the process– such as tool vibration or chip adhesion [4] Secondly, there are practical limitations to this model, as certain tools (such as CBN) require specific geometries to improve tool life.[5]It has been shown that the actual surface roughness in experiments with low feed rates does not match the theoretical surface roughness. There are two main effects that lead to the degradation of surface roughness – adhesion and ploughing. The frictional interaction between the tool and work piece has a significant impact on surface quality.[6]At low velocities, friction is largely due to local adhesion and shearing at contact surfaces .[7]In the case of turning, this friction is at the tool-chip interface.Thus, at lower velocities, the chip hits the tool on a secondary cutting surface where there is significant friction.As the adhesion is increased, the tool's effect on the work piece is converted from shearing to ploughing.The divergence from theoretical surface roughness at low feeds can be attributed to this increased adhesion and ploughing .[6]To minimize this effect.The setup should provide that the minimum unreformed chip length should be equal to the critical depth of penetration of the cutting edge.[6]

3 .Experimental Arrangement

3.1 Machine

The experimental work has been performed on universal turning machine factorymodel (SN 40B-50B),

Cooling Equipment:

- Coolant tank capacity:30 liters.
- Output of electrical pump: 10L/min.
- Output of pump motor: 0.115kw.
- Speed of pump :2800r.p.m

4 .Cutting Tools

One type of the turning cutting tool is used to study their effects on the roughness of the work piece Carbide Tungsten.

Tool specifications:

- Tool material specifications
- The tool geometry is
- Rake angle g = (200)
- Relief angle =80
- Primary approach angle = 450
- Secondary approach angle = 300
- Nose radius angle =600

5 .Roughness Apparatus Measurement

Roughness apparatus measurement was used (Talysurf-4).

5.1 Practical Machining Work:

The practical work includes machining a number of sample work pieces carried out on a lathe, to select the most suitable cutting conditions from the environmental point of view, and machine specificationsFor this purpose, many tests were done using annealed low alloy steel work piece to be machined with tungsten cutting tool, without chip breaker, and with flooding coolant stream, as a start.

1 .Two cases of machining conditions were applied, as follows:

- Mist machining.
- Flooding machining.

2 .Work piece dimensions were fixed for all samples as follows:

The original diameter solid of 62 mm was machined to 60 mm after removing surface irregularities.

The work piece length was 280 mm, and then divided partially to four parts each equal to 50 mm.The work piece was clamped on the machine between the lathe chuck jaws and the tailstock center.

3 .The selected cutting conditions in each case were:

- Depth of cut ap = 1 mm.
- Feed rate 0.72 mm/rev
- The rotational speeds (N) varied as :355, 500, 710 , 1000 , 1400 rpm., and tool speed equation was:

$V = \pi \times D \times N / 1000$ …(4)

Using the equation of linear speed gives:

- The linear cutting speeds (V) are :66.88, 94.2, 133.76, 188.4, and 263.76 (m/min) respectively, calculated for 60 mm of the work piece diameter.

4 . Water soluble oil (coolant):

1 .It was flooded with tab water in 1:10 ratio (oil :water) then tests were done to obtain some of the results .

2 .It was misted with tab water in 1:10 ratio (oil :water), then tests were done to obtain some of the results .

3 .It was flooded with tab water in 1:15 ratio (oil :water) then tests were done to obtain some of the results .

4 .It was misted with tab water in 1:15 ratio (oil :water) then tests were done to obtain some of the results.

5 .It was flooded with tab water in 1:20 ratio (oil :water) then tests were done to obtain some of the results.

6 .It was misted with tab water in 1:20 ratio (oil :water) then tests were done to obtain some of the results.

6 .Result and Discussion

Figures (.1, 2, 3, 4, 5and 6) shows that increasing cutting speed to (263.76 m/min) causes increasing surface roughness to (0.045 µm) in 1:10 ratio (oil : water) according to fig (1) and minimum cutting speed was (175 m/min) which introduce low surface roughness equal to (0.028 µm) . Also the same reson for figures (2, 3, 4,5and 6) the maximum cutting speed was (263.76 m/min) and minimum cutting speed was (66.88 m/min) with maximum roughness (0.045 µm) at different ratio and minimum roughness value was (0.01µm) in figure (3) .

7 .Conclusions

The present work has reached the following conclusions

1. Using way of Metal Working Fluid (MWF) and rate of mixing it with normal water have clear effect on surface roughness .This gives better surface during cutting process .
2. Flooding rate of mixture of (1:20) with linear cutting speed (94.2 m/min) and feed rate (0.72 mm/rev) which gives the better surface roughness of (0.01) µm.

3. The effect of feeding value at (0.8) is clear on surface roughness in all cases and the reason is machine speed is (1:1) but the other feed rate value in other case is (1:8).

8 .References

[1] Abas .F .Ibrahim"Studying Machine Parameters Effects in End Milling Process" Thesis, University of Technology. (2007)
[2] CRC .CRC handbook of lubrication; theory and practice tribology .Booser ER, ed .Vols . 1B2 .Boca Raton, FL :CRC Press, Inc .(1985)
[3]ILMA .Comments submitted to NIOSH, .Arllington, WV : Independent Lubricant Manufacturers Association(May 31, 1996)
[4] 4 .A .E .Diniz, R .Micaroni, "Cutting conditions for finish turning process aiming :the use of dry cutting," International Journal of Machine Tools & Manufacture", Vol .42, 2002, pp .899-904.
[5]5 .J.D .Thiele, S.N .Melkote, "Effect of cutting edge geometry and work piece hardness on surface generation in the finish hard turning of AISI 52100 steel", Journal of Materials Processing Technology, Vol.94, 1999, pp . 216-226.
[6]6 .W .Grzesik, "A revised model for predicting surface roughness in turning", Wear, Vol .194, 1996, pp .143-148.
[7]7 .F .Moore, Principles and Applications of Tribology, Pergamon, Oxford, 1975.
[8]8 .Juneja, B.L., Machining Processes theory and Practice, CBS Publishers and Distributors, 2nd edition, 19

It has the following specification:

Type and model	universal center lathe SN 40B-50B.(M/C)
Manufacturer	Czechoslovakia, Tos Trencin.
Total power of machine without extra equipment	6.6 KW for 50Hz.
Spindle speed	(22.4-2000) r.p.m
Feed rate	(0.08-6.4) mm/min
Center length	1500 mm

Table (1) Chemical Composition of workpiece

No.	Metal	Low alloy steel%	No.	Metal	Low alloy steel%
1.	F_e	95.16 %	9.	P	0.0618 %
2.	C	0.543 %	10.	Cu	0.175 %
3.	Si	0.288 %	11.	S	0.005 %
4.	Mn	0.817 %	12.	Ti	0.005 %
5.	Cr	0.709 %	13.	V	0.724 %
6.	Mo	0.268 %	14.	W	0.015 %
7.	Ni	1.85 %	15.	B	0.0014 %
8.	Al	0.0315 %			

Table (2) Chemical Composition of Cutting Tool

No.	Metal	Carbide Tungsten%	No.	Metal	Tungsten Carbide %
1.	F_e	64 %	8.	Co	7.38 %
2.	C	1.85 %	9.	Cu	4 %
3.	Si	1.8 %	10.	Nb	3 %
4.	Mn	3.49 %	11.	Ti	0.134 %
5.	Cr	3.15 %	12.	V	1 %
6.	Mo	6 %	13.	W	4 %
7.	Ni	0.005 %	14.	Al	0.183 %

Table (3) Specification for the roughness apparatus measurement

Specification	Value
Amplification	100,000 times
Supplied voltage	260,170,130,185 volts
Accuracy	3% from the main scale per amplification
Measuring speed of value	305mm/min
Maximum travel of probe	11mm
Probe speed	3-76.2mm/min

Coolant Specifications:

Table (4) For mixing ratio (1:10); (Oil: Water)

PH	8.8
Specific gravity @ 15.6 ^{0}C	0.9985
Flash Point	102 ^{0}C
Viscosity (CST) @ 50 ^{0}C	0.84
Pour Point	**Zero**

Table (5) for mixing ratio (1:15); (Oil: Water)

PH	8.3
Specific gravity @ 15.6 ^{0}C	**1**
Flash Point	61 ^{0}C
Viscosity (CST) @ 50 ^{0}C	0.72
Pour Point	+3

Table (6) for mixing rtio (1:20; Oil: Water)

PH	8.16
Specific gravity @ 15.6 ^{0}C	1.0235
Flash Point	100 ^{0}C
Viscosity (CST) @ 50 ^{0}C	0.84
Pour Point	+3

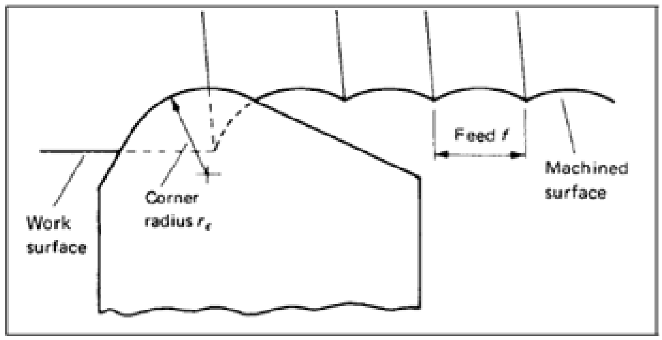

Figure (A1) Ideal surface roughness based on feed and nose radius of tool

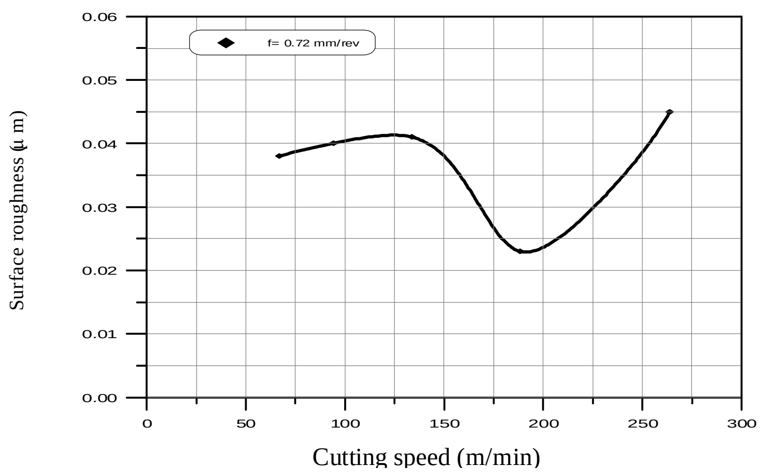

Figure (B1) Relationship between surface roughness and cutting speed for turning at constant feed rate at flooding (1:10) B

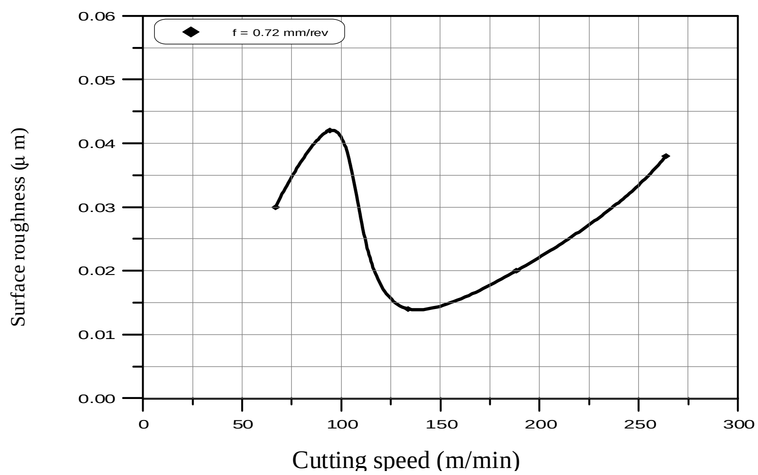

Figure (2) Relationship between surface roughness and cutting speed for turning at constant feed rate at misting (1:10)

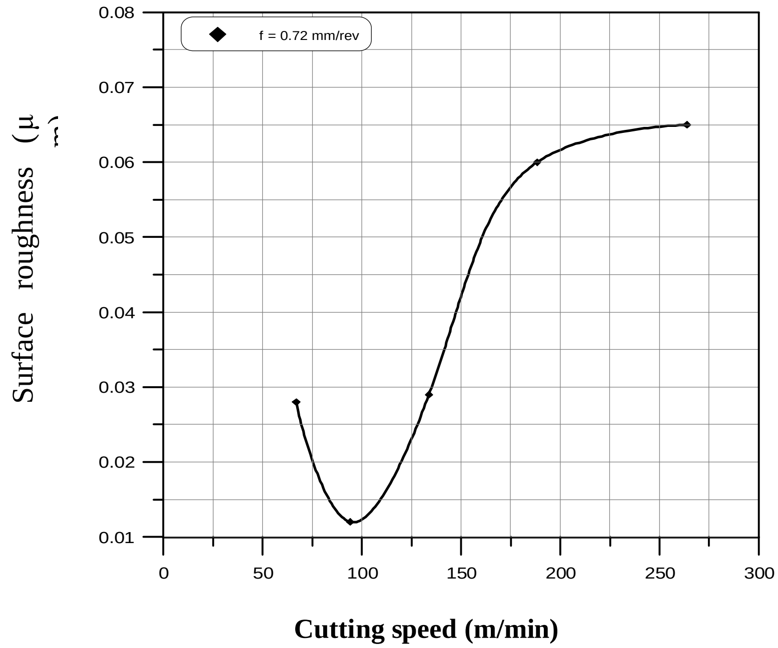

Figure (3) Relationship between surface roughness and cutting speed for turning at constant feed rate at flooding (1:15)

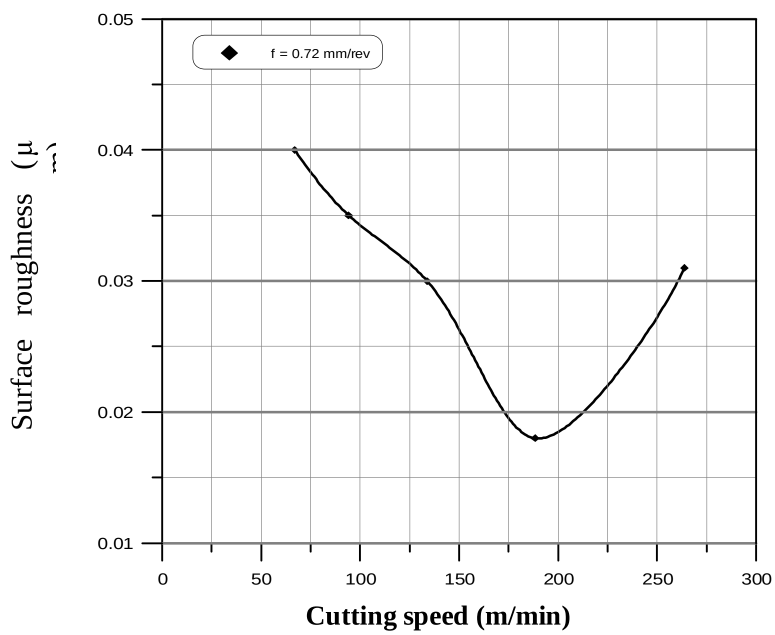

Figure (4) Relationship between surface roughness and cutting speed for turning at constant feed rate at misting (1:15)

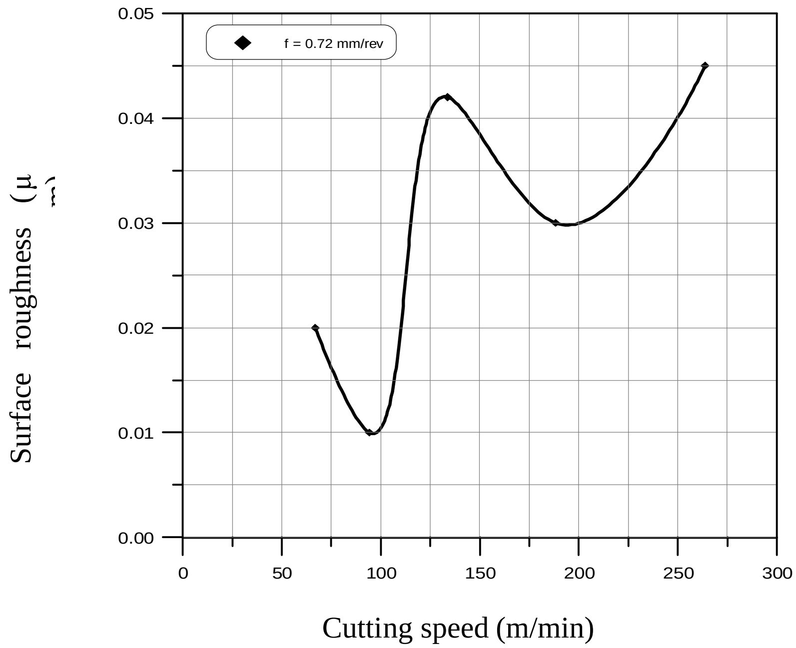

Figure (5) Relationship between surface roughness and cutting speed for turning at constant feed rate at flooding (1:20)

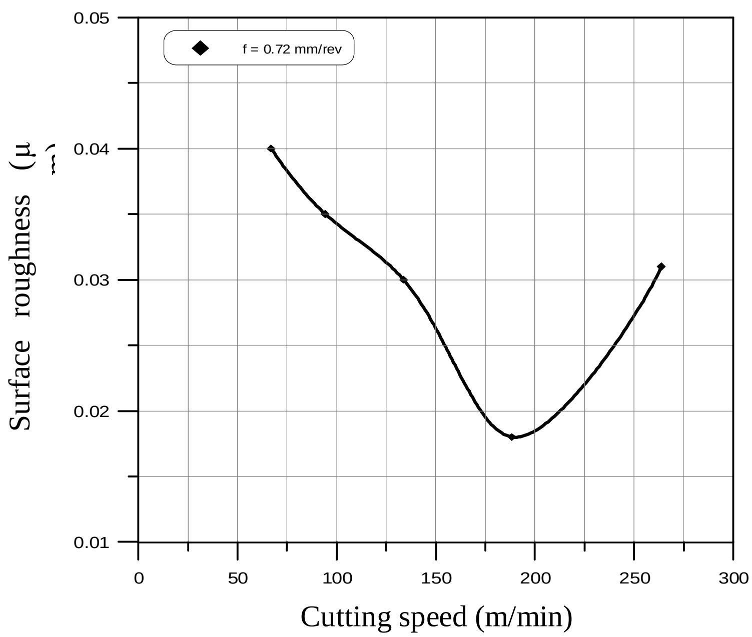

Figure (6) Relationship between surface roughness and cutting speed for turning at constant feed rate at misting (1:20)