An Experimental Study of the Effects of Coolant Fluid on Surface Roughness in Turning Operation for Brass Alloy

Suhair Ghazi Hussein
Assistant Lecturer
Engineering College-Baghdad University
Email: suhairaaffmm@yahoo.com

ABSTRACT
The effect of different cutting fluids on surface roughness of brass alloy workpiece during turning operation was carried out in this research. This was performed with different cutting speed,while other cutting parameters had been regarded as constants(feeding rate , and depth of cut). Surface roughness of machined parts that will be tested by electronic surface roughness tester .The results show that the standard coolant gives the best values of surface roughness for fixed cutting speed ,followed by sun flower oil that has approximately the same effect, while the air stream as a coolant gave unsatisfied results for the evaluation of surface roughness.
In the other hand the best values of surface roughness were recorded for maximum cutting speed with all other types of cutting fluids.

Keywords: turning operation ,cutting speed ,cutting fluid ,surface roughness

دراسة عملية لتأثير سوائل التبريد على خشونة الاسطح في عملية الخراطة لسبيكة البراص

سهير غازي حسين
مدرس مساعد
كلية الهندسة/ /جامعة بغداد

الخلاصة
تضمن البحث دراسة وتقييم تأثير سوائل قطع مختلفة على خشونة الاسطح لعينات من البراص مشغلة بعملية الخراطة.
حيث تضمنت خطوات العمل اخذ خمسة انواع من سوائل التبريد اضافة الى حالة القطع الجاف ودراسة تأثيرها على القطع المشغلة مع تغيير قيم سرعة القطع للماكنة حيث تم اخذ ست سرع مختلفة حسب امكانية ماكنة الخراطة المستخدمة للدراسة اما بقية عوامل القطع الاخرى فقد تم تثبيتها في الدراسة ، تم فحص الاسطح بواسطة جهاز قياس الخشونة .
اظهرت النتائج ان استخدام سائل التبريد القياسي اعطى افضل نتائج من حيث نعومة السطح مع ثبوت سرعة القطع للماكنة يتبعه زيت الطعام حيث اعطى نتائج مقاربة ، بينما استخدام التبريد بالهواء المضغوط اعطى اسوأ النتائج من حيث نعومة الاسطح.
من ناحية اخرى اظهرت الدراسة ان افضل نعومة للاسطح سجلت عند استخدام اعلى سرعة للقطع لكل انواع سوائل القطع التي استخدمت بالدراسة .

الكلمات الرئيسية : عملية الخراطة،سرعة القطع ، سوائل التبريد، خشونة الاسطح.

1. INTRODUCTION

The machining processes have an important place in the traditional production industry. Cost effectiveness of all machining processes has been eagerly investigated. This is mainly affected selection of suitable machining parameters like cutting speed, feed rate and depth of cut according to cutting tool and workpiece material. The selection of optimum machining parameters will result in longer tool life, better surface finish and higher material removal rate. During machining process, friction between workpiece-cutting tool and cutting tool-chip interfaces cause high temperature on cutting tool. The effect of this generated heat decreases tool life, increases surface roughness and decreases the dimensional sensitiveness of work material. This case is more important when machining of difficult-to-cut materials, when more heat would be observed, **M.B. Da Silva ,1998.** Various methods have been reported to protect cutting tool from the generated heat. Choosing coated cutting tools are an expensive alternative and generally it is a suitable approach for machining some materials such as titanium alloys, heat resistance alloys etc. The application of cutting fluids is another alternative to obtain higher material removal rates. **O. Çakīr and** etal,2007.

Cutting fluids consist of those liquid and gases that are applied to the tool and the material being machined to facilitate the cutting operation.Vast quantities are used annually to accomplish a number of objectives: 1-To prevent the tool from overheating , i.e. so that no temperature is reached where the tool,s hardness and resistance to abrasion are reduced, thus decreasing the tool life. 2- to keep the work cool so preventing machining that results in inaccurate final dimensions . 3- To provide a good surface finish on the work. 4-To wash away the chips / clear the swarf from the cutting area . 5- To prevent corrosion of work , the tool and machine(University of Pretoria) .

Surface roughness is a commonly encountered problem in machined surfaces. It is defined as the finer irregularities of surface texture, which results from the inherent action of the production process. Consequently, surface roughness has a great influence on product quality,**Mohd Zulhilmi,2010.**

The product quality depends very much on surface roughness. Decrease of surface roughness quality also leads to decrease of product quality. In field of manufacture, especially in engineering, the surface finish quality can be a considerable importance that can affects the functioning of a component, and possibly its cost. Surface roughness has been receiving attention for many years in the machining industries. It is an important design feature in many situations, such as parts subject to fatigue loads, precision fits, fastener holes and so on. In terms of tolerances, surface roughness imposes one of the most crucial constraints for the machines and cutting parameters selection in process planning, **Mohd Zulhilmi,2010.**

Dry machining means machining the material without any fluids at all, and only atmospheric air surrounding the cutting zone. Dry machining is elimination on the use of cutting fluids. The interest in dry machining is often related to the lower cost, healthy issues and environmentally friendly .

Dry machining requires less power. Cutting dry, the chips will move across the rake face of the tool and so take the point of maximum heat a way back from the tool tip. The tool will get hot, but there is a larger bulk of tool in which to dissipate the heat. In dry machining, bringing the point of maximum heat much closer to the point of cut where there is less material to conduct away the heat; the tool life decrease, **Fig.1** shows an example on dry machining, **Mohd Zulhilmi,2010**. In wet machining, both the tool and the workpiece are cooled using large quantities of lubricant. The coolant is subsequently cleansed and used again, **Fig.2** shows an example on wet machining , Rohaida ,2008.

Raviraj Shetty,et al studies acomparative experiments were carried out in cutting AA6061-15vol.%SiC (25 μm particle size), with cubic boron nitride insert KB-90 grade under conditions of compressed air, oil water emulsion-steam as coolant and lubricant,and dry cutting, respectively. The experimental results show that, with steam as coolant and lubricant ,the friction coefficient and surface roughness value are decreased respectively,

Raviraj Shetty,etal,2008.

Mohd Zulhimi bin Rifin studied minimum quantity of lubrication (MQL) in machining is an established alternative to completely dry or flood lubricating system from the viewpoint of cost, ecology and human health issues. Hence, it is necessary to select MQL and cutting conditions in order to enhance machinability for a given work material. This thesis describes experimental investigations on influence of different lubrication conditions such as minimum quantity lubrication (MQL), dry machining and wet machining on surface roughness. The surface roughness was examined with Perthometer. Three different materials had been chosen as work material.. It was found that, minimum quantity lubricants produced better surface finish as compared to dry and wet machining. The result can significantly reduce cost and environmental pollution by using minimum quantity lubrication, **Mohd Zulhimi,2010.**

*L B Abhang and M. Hameedullah, 2010 used minimum quantity of lubrication of boric acid mixed with base oil SAE 40 has proved to be a feasible alternative to the conventional cutting fluid. In the present work 10% boric acid by weight mixed with base oil SAE 40 is used as a MQL in turning process. Variations in cutting (lubricant) force, cutting temp, chip thickness and surface roughness are studied under different machining conditions. The results indicated that there was a considerable improvement in machining performance with MQL assisted machining compared to dry machining, **L B Abhang,2010**.

Ahmad Dziauddin bin Mohamed, 2010, investigated the different cutting tool length parameter effect of surface roughness in CNC Turning boring operation for an aluminium 6061 workpiece. A fractional factorial design is use to evaluate the effect of five (5) independent variables (cutting speed, feed rate, depth of cut, tool length and diameter of boring bar) on the resulting first cut surface roughness (Ra). This study found that using short tool length always produce a good surface roughness and that only slight improvement on surface roughness can be achieved by properly controlling the cutting parameters and/or the diameter size of boring bar.

Suleiman Abdul-kareem, et al.,2011, investigated the influence of the three most important machining parameters of depth of cut, feed rate and spindle speed on surface roughness during turning of mild steel. The individual parameters effect as well as effect of interactions between the machining parameters on the surface roughness height Ra is analyzed using various graphical representations. Using multiple linear regressions, mathematical models correlating the influence of machining parameters on the surface roughness Ra during the machining process were developed.

2. SELECTION OF SUITABLE CUTTING FLUIDS

The selection of cutting fluids in machining processes depends on various factors. The selection of cutting fluids is carried out according to factors mentioned below:

a. Type of machining processes
b. Type of machined workpiece material
c. Type of cutting tool material

The most important parameter in the selection of cutting fluids is the characteristics of machining process.

In turning, milling and grinding machining processes water based cutting fluids are more suitable due to using new cutting tool materials such as hard metals and high cutting speeds. The contact period between

Cutting tool and workpiece material is small when high cutting speeds are used. Therefore penetration of cutting fluid will not be sufficient. The type of crater wear on cutting tool can be seen more oftrn. Water based cutting fluids will reduce the effect of generated heat on cutting tool wear, S. **Ebbrell,et al,2000**.

The other factor for selection of suitable cutting fluids in machining processes is the type of workpiece material. The application of emulsion cutting fluids or thin mineral oils should be selected for copper and copper based alloys machining. High pressure additive cutting oils are preferred for brass machining ,**S. Ebbrell,et al,2000**.

The third influential parameter for selection of cutting fluid in machining processes is the cutting tool material. Various cutting tool materials are commercially available for all kind of machining processes. High speed steel cutting tools can be used with all type of cutting fluids. However waterless cutting fluids are preferred when difficult-to-cut materials are machined.

3.EXPERIMENTAL WORK

In this research , a series of experiments was done to study the effect of cutting speed and type of lubricants on resulting surface quality. The turning machiene in workshop was used with brass alloy workpeice material chemical composition shows in **Table 1**, dimension of the workpeice was 10mm diameter١٢٠ ×mm . Carbide tools was used in the machining trials.see **Fig .3**.

The cutting speed were chosen that ranged from the available on the machiene in three levels as shown in **Table 2**, only one level of feed rate 0.2mm and depth of cut was applied to the limited effect of the axial depth of cut on the surface roughness in the turning operation.

Six types of conditions were chosen in turning trials: dry condition ,wet condition contains: water, soluble water water and soap solution in percentage (3) soap to (10) water , sun flower oil, standard coolant , and air stream. For every condition of cutting we use the variable values of cutting speed to examine the effect of the cutting fluids with cutting speed on surface roughness .

After turning operation was accomplished the work piece had been taken to measure its surface roughness by Electronic surface roughness tester as shown in **Fig. 4**. The measuring device was calibrated with the standard sample.

The readings of each measured value are repeated three times and the average was taken.

4. RESULTS AND DISCUSSION

The surface roughness of the machined pieces was recorded, (Ra) : this parameter is known as the arithmetic mean roughness value,AA(arithmetic average)or CLA(center line average).Ra is universally recognized and the most used international parameter of roughness, **Dr.Mike ,et al,1998.**

a. Cutting speed affecting on surface roughness:

Figs. 5 to **10** show the surface roughness for dry,water,soulable water,oil ,standard coolant,and air stream for brass alloy turning respectively. It was clearly revealed that in every condition decrease in surface roughness with increase in cutting speed, because it is generally well known that an increase in cutting speed improves machine ability. This may be due to the continuous reduction in the build up edge formation as the cutting speed increases, **Mohammad T.Hayajneh, et al., 2007.**

b. Coolant affecting on surface roughness

Figs. 11 to 16 show the relation ship between the surface roughness and cutting fluid in every cutting speed . It was noticed that the maximum reduction in surface roughness was observed to be in standard coolant condition , followed it the sun flower oil , after these the soluble water . This is because the reduction metal cutting forces. The decrease in surface roughness due to standard coolant can be considering interest lubricating properties; this reduces frictional forces at the chip-tool interface and tool work piece interface. This decrease the temperature at the cutting zone and results in surface quality improvement.

5. CONCLUSIONS

In this study, the effected of cutting fluid on surface roughness has been carried out . The surface roughness has been recorded by surface roughness measurement device, the following conclusions can be drawn:

1. The standard coolant is found to be the best choice of cutting fluid to obtain finer surface roughness, followed by sun flower oil that has the same affecting, so it can be use the sun flower oil instead of standard coolant to give the same results with lowest cost .
2. Machining with high cutting speed decreases the surface roughness with all types of cutting fluids ,and with dry cutting ,too.
3. The best results of surface roughness has been obtained with (2200 rpm) ,standard coolant , this value is (.125 µm).

6. REFERNCES

Ahmad dziauddin bin Mohamed,2010, *Effect of Process Parameters on Surface* Roughness Produced *by Turning Boring Operation Aproject Report Submitted in Partial Fulfillment of The Requirement for the Award of Degree of Master of Engineering* .

Dr. Mike S.Lou, Dr. Joseph C.Chen & Dr.Caleb M.Li, 1999, *Surface Roughness Prediction Technique for CNC End-Milling*,volume*15*, Number 1- November 1998 to January .

LB Abhang and M.Hameedullah, 2010, *Experimental Investigation of Minimum Quantity Lubricants in Alloy Steel Turning*. International Journal of Engineering Science and Technology Vol.2(7).

M.A. El Baradie, Cutting Fluids, 1996, *Part I:Characterisation, Journal of Materials Processing*. Technology 56 ,786-797

M.B. Da Silva, J. Wallbank, 1998, *Lubrication and Application Method in Machining*, Lubrication and Tribology 50 , 149-152 .

Mohd Zulhimi bin Rifin, 2010, *Effect of Lubrication Condition on Surface Roughness in Turning Operation*.

Mohammed T.Hayajneh, Montasser S.Tah At , Joachim Bluhm, 2007,*A Study of The Effects of Machining Parameters on the Surface Roughness in the End-Milling process.*Volume1,Number 1,Sep.

O.Cakir, A. Yardimeden, T. Ozben, E. Kilickap, 2007, *Selection of Cutting Fluids in Machining*. processVolume 25 Issue 2 December .

Raviraj Shetty,etal ,2008, *Steam as Coolant and Lubricant in Turning of Metal Matrix Composites*, journal of Zhejiang, University Science A .

Rohaida binti Mohd, 2008 , *Effect of Lubrication Condition on Surface Croughness By Using Lathe Machine* .

S. Ebbrell, N.H. Woolley, Y.D. Trimidas, D.R. Allanson, W.B. Rowe, 2000, *The Effects of Cutting Fluid Application Methods on the Grinding Process*, International Journal of Machine Tools and Manufacture. Vol40 , 209-223

Suleiman- Abdulkareem1, Usman Jibrin Rumah1 and Apasi Adaokoma1, 2011, *Optimizing Machining Parameters during Turning Process*, International Journal of Integrated Engineering, Vol. 3 No. 1 , p. 23-27

Table 1. Chemical composition of alloy .

Items	Cu	Al	Fe	Pb	Ni	Si	Sn	Zn
Percentage	58	.8	.7	1.5	.8	.05	1.2	36

Table 2. Cutting parameters**.**

Cutting parameters	1	2	3	4	5	6
Feed (mm)	0.2					
Speed (RPM)	325	420	575	925	1400	2200

Table 3 . Surface roughness of machined pieces in variable conditions.

Condition	level	speed (Rpm)	Ra (μм)	condition	level	speed (Rpm)	Ra (μм)
DRY	B	325	13.32	OIL	B	325	2.421
	C	420	10.52		C	420	1.652
	A	575	6.22		A	575	1.141
	A	925	4.75		A	925	0.882
	C	1400	3.54		C	1400	0.661
	C	2200	2.33		C	2200	0.432
WATER	B	325	8.95	S.COOLANT	B	325	0.736
	C	420	6.64		C	420	0.4995
	A	575	4.134		A	575	0.338
	A	925	3.182		A	925	0.264
	C	1400	2.346		C	1400	0.202
	C	2200	1.556		C	2200	0.125
WATER &SOAP	B	325	6.211	AIR	B	325	11.145
	C	420	4.659		C	420	8.353
	A	575	2.845		A	575	5.175
	A	925	2.12		A	925	3.94
	C	1400	1.634		C	1400	2.956
	C	2200	1.083		C	2200	1.954

`

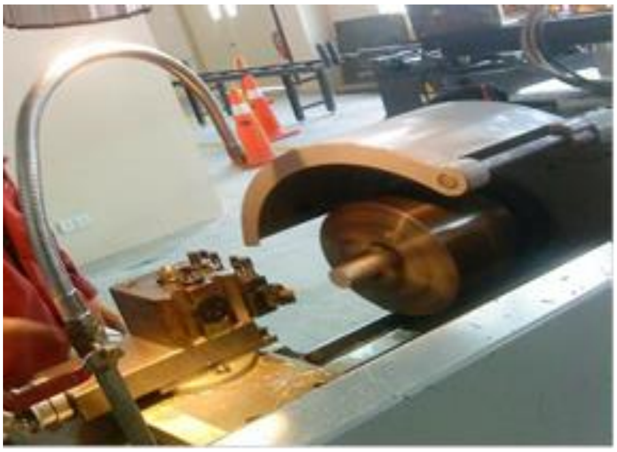

Figure1. Dry machining ,Mohd Zulhilmi,2010.

Figure2. Wet machining, Rohaida ,2008.

Figure 3 . Turning machiene with work piece.

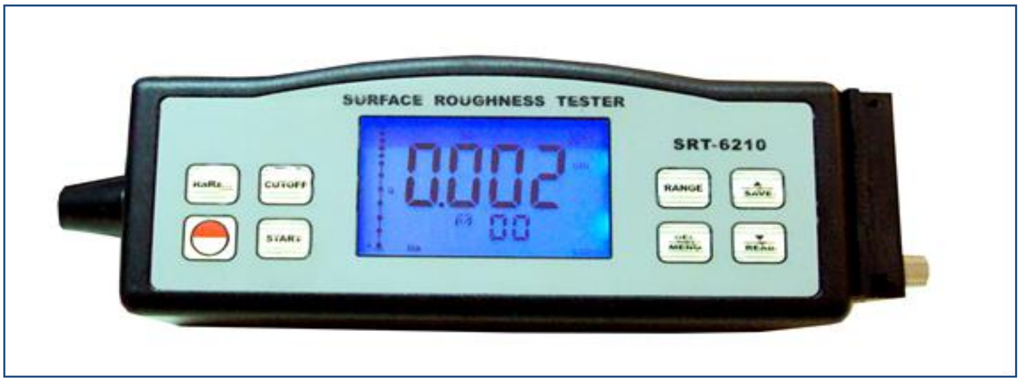

Figure 4. Electronic surface roughness tester.

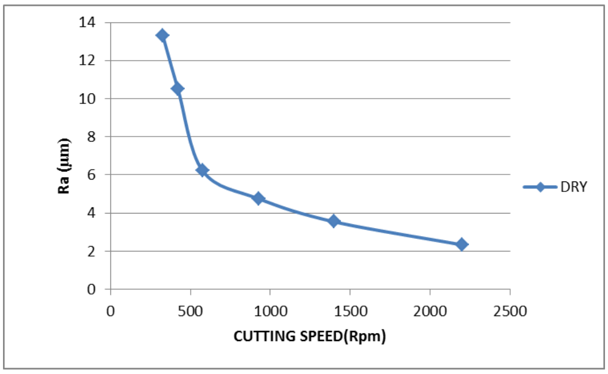

Figure 5. Cutting speed effective on surface roughness in dry condition.

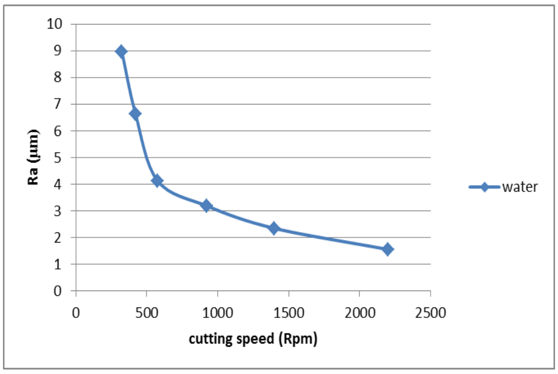

Figure 6. Cutting speed effective on surface roughness in water condition.

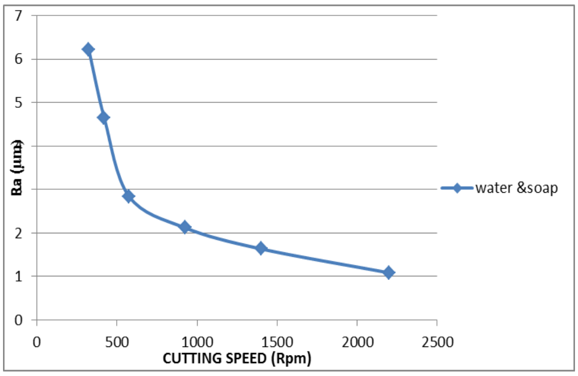

Figure7. Cutting speed effective on surface roughness with water &soap.

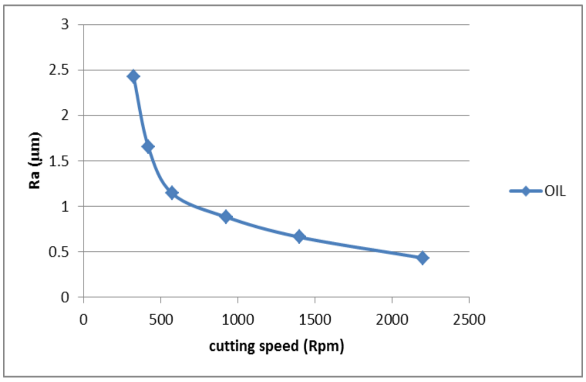

Figure 8. Cutting speed effective on surface roughness with oil

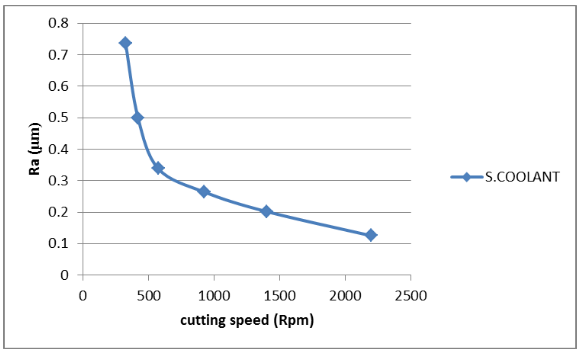

Figure9. Cutting speed effective on surface roughness with s. coolant.

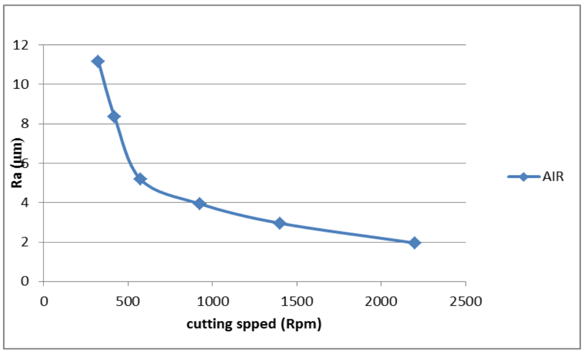

Figure10. Cutting speed effective on surface roughness with air.

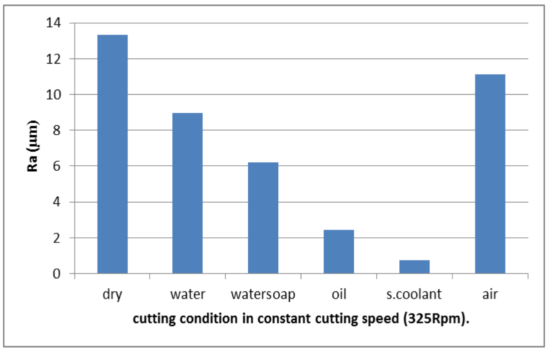

Figure 11. Effect of cutting fluid on surface roughness with fixed cutting speed (325Rpm).

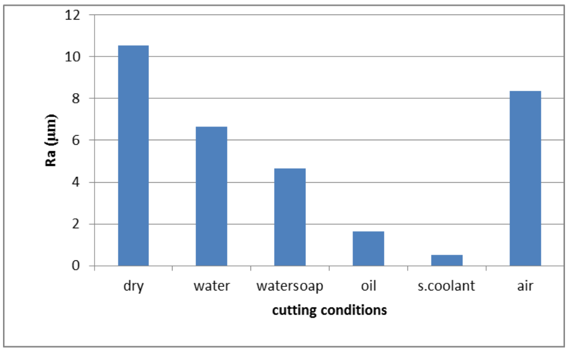

Figure 12. Effect of cutting fluid on surface roughness with fixed cutting speed . (420Rpm).

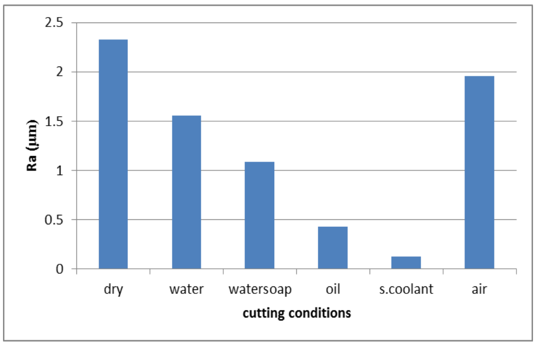

Figure 13. Effect of cutting fluid on surface roughness with fixed cutting speed (2200rpm).

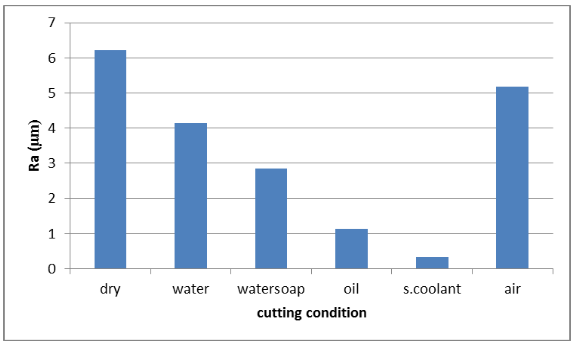

Figure 14. Effect of cutting fluid on surface roughness with fixed cutting speed (575rpm).

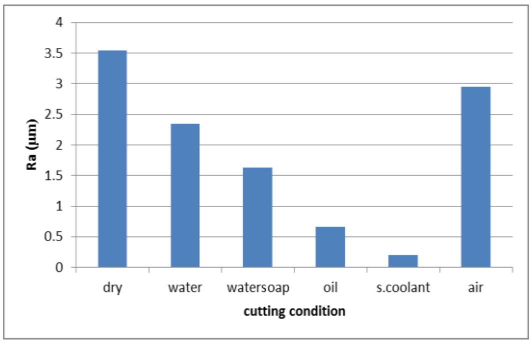

Figure 15.. Effect of cutting fluid on surface roughness with fixed cutting speed (1400rpm).

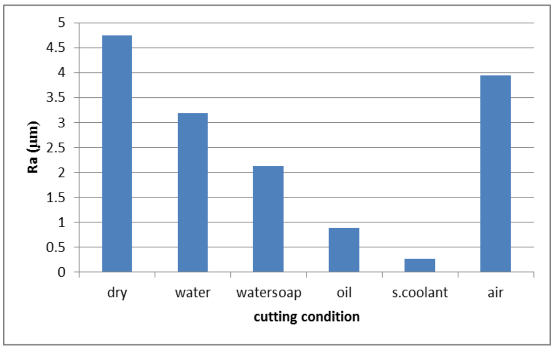

Figure 16. Effect of cutting fluid on surface roughness with fixed cutting speed (925rpm)