The Evaluation of Machinability and Surface Roughness of AISI 1060 Carbon Steel in Conventional Lathe Machine

M.A.M. Daud[1,2,*], K.A. Zakaria[1,2] and M. B. Ali[2]

[1)] Fakulti Kejuruteraan Mekanikal, Universiti Teknikal Malaysia Melaka,
Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia.
[2)] Centre for Advanced Research on Energy, Universiti Teknikal Malaysia Melaka,
Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia.

[*]Corresponding e-mail: ahadlin@utem.edu.my

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ABSTRACT – The purposes of this research are to evaluate the relationship between machinability and surface roughness of AISI 1060 carbon steel under different conditions by using conventional lathe machine. In addition, the conditions have been used in this research are dry condition, coolant condition and lubricant condition. The machining parameters have been manipulated are spindle speed and feed rate. While for the cutting tool which is used in this research is carbide. After turning process and surface roughness test have been conducted, the result of each specimen will be compared and find the optimized machining parameter of each types of material by analyzing the value of surface roughness. The optimized machinability and surface finish at spindle speed 1100 rpm and feed rate 0.094 mm/rev.

1. INTRODUCTION

Generally, turning is one of the processes that can be operated by using conventional lathe machine. It is probably the most wide used process among all the machining processes. About one third of the machines in production are employed in turning. It is a machining process that is used to produce round parts in shape by a single point cutting tool. Other than round shape, it normally produces straight, conical, curved, or grooved work pieces. Its working principle is on removal of materials by traversing in a direction parallel to the axis of rotation of axis or along a specified path to form a complex rotational shape. The tool is fed either linearly in a direction parallel or perpendicular to the axis of rotation. During turning operation, there are three fundamental cutting parameters that need to be identified which spindle speed, feed rate and depth of are cut [1].

Surface finish is surface texture or as known as characteristics of surface. The challenging part of machining industries nowadays is mostly emphasised on the achievement of high quality. In industries, the quality of surface finish is very important because quality of surface finish is able to influence the quality of product. Bad quality of surface leads to fatigue failure easily. Surface roughness is vital feature as it could affect the effectiveness of mechanical components as well as the production costs [2,3]. So, it is important to find out appropriate machining parameters and condition to obtain better surface finish with lower roughness. Manufacturing industries require high demand on the quality of surface finish but require low machining cost. Yet, better surface finish quality may lead to higher manufacturing cost. Hence, identifying trend of machining parameters is very important in manufacturing industries. Surface roughness brings undesired effect on some functions of work piece such as fatigue resistance, contact causing surface friction, wearing, heat transmission, lubricant distribution plus hold ability and coating [4,5].

The objectives of this project are to evaluate the relationship between machinability and surface roughness of AISI 1060 carbon steel under different conditions by using conventional lathe machine and study the effect of machining parameters on quality of surface roughness of AISI 1060 carbon steel.

2. METHODOLOGY

The experiment is carried out with a conventional lathe machine and its model is G-330 E from Gate Machinery with carbide as cutting tool. The samples size is 1.5 cm diameter and 12 cm length. After fabricating all the work pieces, seventy five surfaces are obtained. These are produced by two machining parameters which are spindle speed and feed rate under three conditions as shown in Table 1.The depth of cut are set as constant machining parameter which are 0.3 mm for three different conditions which are dry condition, coolant condition (95%water & 5%solube oil) and lubricant condition (shell helix mineral oil) in this experiment.

Spindle Speed (rpm)	300	550	770	1100	1400
Feed Rate (mm/rev)	0.094	0.188	0.272	0.376	0.468

Surface roughness test is conducted by using Time Surface Roughness Tester TR-200. It is used to measure the parameter of surface roughness of test specimens. The result obtained is the arithmetic mean surface roughness, Ra.

3. RESULTS AND DISCUSSION

In order to visualize the relationship between surface roughness and feed rate, three line graphs are plotted as shown in **Figure 1, Figure 2 and Figure 3,**

according to different spindle speed and feed rate conditions.

It is noticeable that surface roughness is low when feed rate is low. In other words, it can be said that surface roughness is proportional to the feed rate [1]. However, there are some lines obtained are fluctuating. These may due to vibration and ineffective handling during turning process is implemented.

The results show that 1100 rpm are the most appropriate spindle speeds that can be used for turning operation with 0.3 mm depth of cut. Meanwhile, 0.094 mm/rev is the most appropriate feed rate to be used in conventional lathe machine in order to get low roughness surface. At the same time, the best condition to produce good surface finish is lubricant condition.

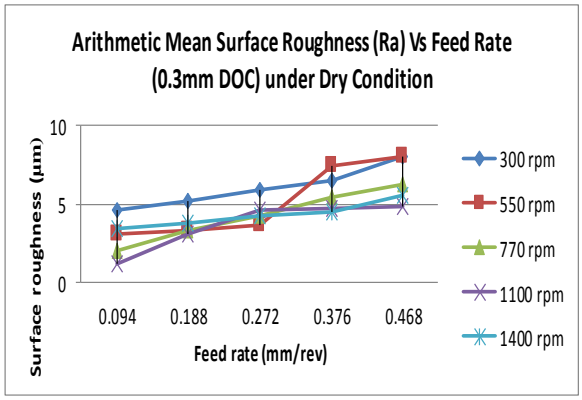

Figure 1 Arithmetic mean surface roughness (Ra) Vs feed rate under dry condition

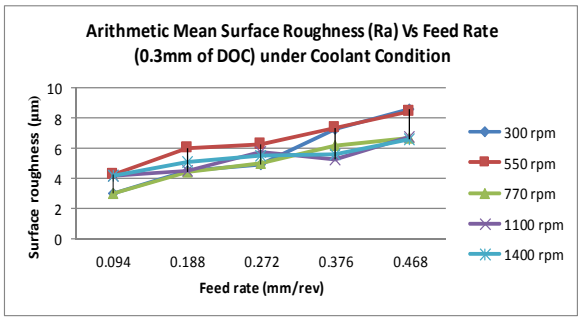

Figure 2 Arithmetic mean surface roughness (Ra) Vs feed rate under coolant condition

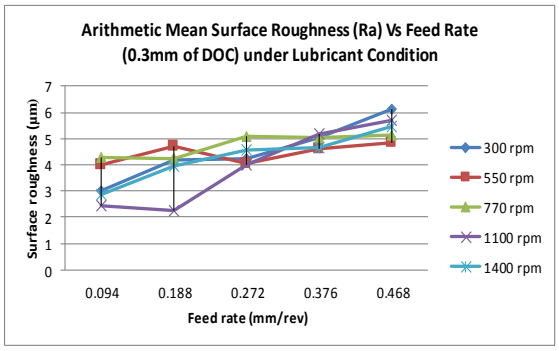

Figure 3 Arithmetic mean surface roughness (Ra) Vs feed rate under lubricant condition

Table 2 The best surface of AISI 1060 with 0.3 mm DOC under three conditions

Total Average Surface roughness, Ra (µm)	Condition	Spindle Speed (rpm)	Feed Rate (mm/rev)
286	Dry	1100	0.094
264	Coolant	770	0.094
244	Lubricant	1100	0.188

From **Table 2**, it can be said that 1100 rpm is the most suitable spindle speed to be used to get good surface finish for 0.3 mm depth of cut as it contributes twice to get the best surfaces. Meanwhile, 0.094 mm/rev is the most suitable feed rate to be used to attain surface with low roughness as it contributes twice to get the best surfaces in this study regardless the conditions.

4. CONCLUSIONS

The objective in this project have been achieved. The optimized machininability and surface finish of AISI 1060 carbon steel are at feed rate 0.094 mm/rev and spindle speed of 1100 rpm. Moreover the best condition for good surface finish is lubricant.

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REFERENCES

[1] A. H. Suhail, N. Ismail, S.V. Wong, N.A. Abdul Jalil (2010). "Optimization of Cutting Parameters Based on Surface Roughness and Assistance of Workpiece Surface Temperature in Turning Process". *Journal of Engineering and Applied Sciences,* vol. 3, pp. 102-108.

[2] C. Natarajan, S. Muthu and P. Karuppuswamy (2011). "Investigation of cutting parameters of surface roughness for a non-ferrous material using artificial neural network in CNC turning". *Journal of Mechanical Engineering Research*, vol. 3(1), pp. 1-14.

[3] S. Thamizhmanii, S. Saparudin, S. Hasan (2007). "Analyses of surface roughness by turning process using Taguchi method". *Journal of Achievements in Materials and Manufacturing Engineering* vol. 20, issue 1-2, pp. 503-506.

[4] M. Brezocnik and M.Kovacic. (2003)."Integrated Genetic Programming and Genetic Algorithm Approach to Predict Surface Roughness: *Journal of Material and Manufacturing Processes*". Volume 18. No 3. pp. 475 – 491.

[5] S. Kalpakjian & S. R. Schimid "*Manufacturing Engineering and Technology*". 6ed. Singapore. Prentice Hall. 2010.