PERFORMANCE EVALUATION OF DIFFERENT PROCESS CONDITIONS WHEN HARD TURNING ASSAB 760

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To my beloved parents

Azman Shamaan & Khairiah Abdullah

To my beloved wife and son

Surtina Mohamed & Afif Jazimin Azri

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In the name of Allah, the most Gracious and most Compassionate

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ABSTRACT

The need to have more precision tolerances and better product surface roughness has driven the metal cutting industry to continuously improve the metal cutting processes**.** Surface roughness which is often is used to determine and evaluate the quality of a product, is one of the major quality attributes of a turned product. In order to obtain a better surface roughness, the proper setting of cutting parameters is crucial before the process takes place. Cutting parameters is very important to produce a good surface finish (surface roughness). Surface roughness and tool wear are influenced by cutting process conditions. This study was undertaken to investigate and evaluate the effect of different cutting parameters (cutting speed, feed rate and depth of cut) on surface roughness using the full factorial design of experiment when turning hardened ASSAB steel 760. The initial tool wear form was also investigated of cutting insert CNMG120408 NM4 WPP20. The experimental results indicate the proposed mathematical model suggested could describe the performance indicators within the limits of the factors being investigated. The feed is the most significant factor that influences the surface roughness. The secondary contribution follows by the interaction of feed and depth of cut that influences the surface roughness. The results and effects of cutting conditions factors and factors interactions on surface roughness are also presented in graphical form.

ABSTRAK

Keperluan untuk memiliki toleransi lebih jitu dan lebih baik kekasaran permukaan produk telah mendorong industri pemotongan logam untuk terus meningkatkan proses pemotongan logam. Kekasaran permukaan yang sering digunakan untuk menentukan dan menilai kualiti produk. Ia merupakan salah satu faktor utama dari produk mesin larik. Dalam rangka untuk mendapatkan kekasaran permukaan yang lebih baik, tatacara yang sesuai dari parameter pemotongan sangat penting sebelum proses pemotongan berlangsung. Parameter pemotongan sangat penting untuk menghasilkan permukaan akhir yang baik (kekasaran permukaan). Kekasaran permukaan dan kehausan mata alat yang dipengaruhi oleh keadaan proses pemotongan. Kajian ini dilakukan untuk menyiasat dan menilai pengaruh parameter pemotongan yang berbeza (kelajuan pemotongan, kelajuan suapan dan kedalaman pemotongan) pada kekasaran permukaan dengan menggunakan eksperimen faktorial penuh ketika melarik ASSAB 760. Bentuk awal kehausan mata alat juga diselidiki terhadap mata alat pemotongan CNMG120408 NM4 WPP20. Keputusan kajian menunjukkan model matematik yang dicadangkan menyarankan boleh menggambarkan penunjuk prestasi dalam batas-batas faktor yang diteliti. Kadar suapan adalah faktor yang paling ketara yang mempengaruhi kekasaran permukaan. Sumbangan kedua seterusnya oleh interaksi antara kadar suapan dan kedalaman pemotongan yang mempengaruhi kekasaran permukaan.Hasil keputusan dan kesan dari factor parameter pemotongan dan interaksi antara factor pada kekasaran permukaan juga dipersembahkan dalam bentuk grafik

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LIST OF ABBREVIATIONS AND SYMBOLS

D, d	-	Diameter
γ	-	Rake Angle
CS	-	Cutting Speed
DOC	-	Depth of Cut
f	-	Feed Rate
l	-	Tool Overhang Length
Ra	-	Mean Roughness
Ry	-	Maximum Peak
Rz	-	Ten-point Mean Roughness
Sm	-	Mean Spacing
t_m	-	Machining times
ANOVA	-	Analysis of Variance
RPM	-	Revolution per Minutes
DOE	-	Design of Experiment
RSM	-	Response Surface Methodology
α	-	Significance Level
CCD	-	Central Composite Design
F_t	-	Tangential force
F_f	-	Feed force
F_r	-	Radial force
V_c	-	Cutting speed
$Ø_c$	-	Shear angle

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CHAPTER 1

INTRODUCTION

1.1 Background

The challenge of modern machining industries is mainly focused on the achievement of high quality, in terms of work piece dimensional accuracy, surface finish, high production rate, less wear on the cutting tools, economy of machining in terms of cost saving and increase the performance of the product with reduced environmental impact. Surface roughness plays an important role in many areas and is a factor of great importance in the evaluation of machining accuracy. Full Factorial Design of Experiment method is a statistical tool, adopted experimentally to investigate the influence on surface roughness by cutting parameters such as cutting speed, feed and depth of cut. Many researchers developed many mathematical models to optimize the cutting parameters to get lowest surface roughness by turning process. The variation in the material hardness, alloying elements present in the work piece material and other factors also affects the surface finish and tool wear. Turning has emerged as a viable alternative to grinding for finish machining of hardened steels. A major factor leading to the use of hard turning in place of grinding has been the development of cubic boron nitride (CBN) cutting tools, which enable machining of high-strength materials with a geometrically define cutting edge.

1.2 Problem Statement

The term machinability refers to the ease with which a metal can be machined to an acceptable surface finish. Materials with good machinability require little power to cut, can be cut quickly, easily obtain a good finish, and do not wear the tooling much; such materials are said to be free machining. The factors that typically improve a material's performance often degrade its machinability. Therefore, to manufacture components economically, engineers are challenged to find ways to improve machinability without harming performance.

Machinability can be difficult to predict because machining has so many variables. In most cases, the strength and toughness of a material are the primary factor. Strong, tough materials are usually more difficult to machine simply because greater force is required to cut them. Other important factors include the chemical composition, thermal conductivity and microstructure of the material, the cutting tool geometry, and the machining process parameters.

This present investigation is undertaken to determining the performance of machining ASSAB 760 steel hardened (399HB) with cutting tool coated carbide (CNMG120408 NM4 WPP20). Surface roughness as the numerical dependent response and initial form of tool wear as the categorical dependent response.

1.3 Objective Of Study

This study is carried out as to evaluate the effect of cutting conditions on surface roughness and tool wear when hard turning steel hardened to (399 HB). Expectation of this study will consist of:

i) To evaluate the effects of different process conditions on hard turning performance.

ii) To develop a mathematical model for predicting the surface roughness of hard turned part by using the design of experiment approach.

iii) To observed the initial tool wear and the form of the chips produced during the hard turning operation.

1.4 Significance of The Study

Hard turning material is developing rapidly with the new technology that offers many potential benefits to the industries. Hard turning has been increasingly used and slowly replacing the grinding operation in producing component with the near same result in terms of surface finish. The proper selection of machining parameters during hard turning material affected the outcome such as surface roughness for the material itself and cutting tool wear. This experimental data and result will be expected to know the effect on surface roughness when hard turning using coated carbide tool and the type of initial form tool wear.

1.5 Scope Of The Study

The scopes of this experiment are as follows:

(i) The performance was primarily evaluated in terms of surface roughness. The chip form and the initial tool wear were also be observed.

(ii) Work piece material used is ASSAB 760 steel hardened to 399HB.

(iii) Process conditions investigated are cutting speed, feed and depth of cut.

(iv) Dry cutting machining conditions used.

1.6 Overview of The Methodology

The following methodology used as guidance to achieve the study objectives.

(i) Based on the previous literature review and recommendation for manufacturer

(ii) Select the proper cutting condition and discuss with supervisor.

(iii) Planning and design a reliable design of experiment.

(iv) Design experiment consist of::

- Surface roughness measurement using stylus instrument.
- Initial form tool wear observation using optical microscope.

(v) Data analysis and validation.

- Evaluate the effect of cutting parameter on the surface roughness
- Determine the effect of cutting parameter on the cutting tool initial form wear
- Develop a mathematical model between the cutting parameter and surface roughness

(vi) Data analysis and validation consist of:

- Evaluate the effect of cutting speed on the surface roughness.
- Evaluate the initial form tool wear affected by cutting condition.
- Determine the suitable cutting condition affected surface roughness.

- Determine the interaction between cutting condition and surface roughness.
- Determine the effect of cutting condition on cutting tool edge on a fixed length.

1.7 Thesis Organization

This thesis is divided into six chapters. First chapter gives an overview of the study. Chapter 2 in organized to summarize the literature reviews of the relevant topic to give clear picture and guidance towards achieving the objective. In Chapter 3 the experiment setup, method and techniques used to conduct the experiment are explained. All the experiment data and result presented in Chapter 4. Chapter 5 will discuss the results obtained and comparison will be made from previous research. The conclusion and recommendations will be on Chapter 6