Faculty of Manufacturing Engineering

DIFFERENTIATION ANALYSIS OF SURFACE INTEGRITY AND WEAR MECHANISM AISI 1045 MACHINABILITY ASSESMENT UNDER WET AND DRY CONDITION

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Master of Manufacturing Engineering
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DEDICATION

This project is dedicated to my beloved wife Norazreen binti Tumiran and my children Haiqal Danish and Nuraleesya Damia for being great pillars of support.

ABSTRACT

Dry and wet machining are two conditions that applied in the machining operation CNC turning machine. Dry machining operations performed without coolant, whereas the wet machining using coolant the same brand in the industry, FUCH eco-cool. Both process gain advantages and disadvantages in term of feasibility, surface roughness, surface integrity and wear performance during machining. This research focuses on evaluating the machinability of Carbon Steel AISI 1045 under dry and wet conditions and to compare the two methods. The cutting tool used in this research is a coated carbide cutting tool. Surface roughness and wear characteristics on cutting tool are observed within the range of 35 m/min to 53 m/min cutting speeds and feed rates 0.15 and 0.5 mm/rev, variable feed rates and constant depth of cut of 1mm. Comparisons will be made through three measurement equipment or test equipment, it is a surface roughness, optical microscope and scanning electron microscope (SEM). The test machine is used to measure tool wear, surface roughness and surface integrity of the specimen. Through the tests, the comparison between wet and dry machining can be performed and evaluated. The whole experiment will be conducted at Faculty of Engineering Technology, UTeM by using the latest equipment and a reliable experimental result.

ABSTRAK

Pemesinan basah dan kering merupakan dua keadaan yang diaplikasi dalam operasi pemesinan CNC pelarik. Operasi pemesinan kering dilakukan tanpa sebarang bahan penyejuk, manakala pemesinan basah menggunakan bahan penyejuk sama seperti di industri iaitu jenama FUCH eco-cool. Kedua-dua proses terdapat kelebihan dan kekurangannya tersendiri, iaitu, dari segi kemudahan, kekasaran permukaan dan pembentukan kehausan. Kajian ini menumpukan untuk menilai keboleh mesinan Carbon Steel AISI 1045 di dalam keadaan kering dan basah serta membandingkan terhadap kedua-dua kaedah tersebut. Mata alat yang digunakan dalam kajian ini ialah mata pemotong carbide bersadur. Kekasaran permukaan dan ciri-ciri kehausan akan diperhatikan dalam kelajuan pemotongan 35 m/min to 53 m/min kelajuan pemotongan, kadar suapan 0.15 dan 0.5 mm/putaran dan kedalaman pemotongan yang tetap 1mm. Perbandingan akan dilakukan melalui tiga peralatan pengukuran atau peralatan ujian, ianya adalah mesin surface roughness, optical microscope dan juga scanning electron microscope (SEM). Mesin ujian ini digunakan untuk mengukur kehausan mata alat, kekasaran permukaan dan juga integriti permukaan specimen. Melalui ujian yang dilakukan, perbandingan antara pemesinan basah dan kering dapat dilakukan dan dinilai. Keseluruhan eksperimen akan dilakukan di Fakulti Teknologi Kejuruteraan, UTeM dengan menggunakan peralatan yang terkini dan keputusan ujikaji yang boleh dipercayai.

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CHAPTER 1

INTRODUCTION

1.1 Background of the Study

Carbon steel AISI 1045 is widely used for all industrial applications requiring more wears resistance and strength. Typical applications of Carbon steel AISI 1045 for machine part, machine tool and motor engine. AISI 1045 steel is characterized by good weldability, good machinability and high strength and impact properties in either the normalized or hot rolled condition. The general properties of carbon steel AISI 1045 are medium carbon and also medium tensile steel supplied as a forged or normalized. This steel also shows a good strength, toughness and wears resistance. Some techniques have been developed so that carbon steel AISI 1045 can be machined, formed and welded with relative ease. Medium carbon steels include grades with carbon contents ranging from 0.25% to 0.60% of the steel mass (Odusote et al., 2012). Carbon steels AISI 1045 also have good machining characteristics, one of the more popular and also can be formed into turned ground and polished bars that can be machined unsymmetrically with limited distortion.

1.2 Problem Statement

Despite the advantages of this carbon steel AISI 1045 for producing machined part, machine tool and motor engine, there are some difficulties to machine this material especially when the cutting parameter is not applied correctly. In any machining process, the most critical criterion is to produce the parts as many as possible with the minimum

usage of cutting tool. Apart from that, the criterion of surface finish and dimensional accuracy are also important. Mostly, industry prefers to machine the material with minimum cost for their economical sustainability. There are needs to produce high volumes of product with optimization of machining processes for the achievement of high responsiveness of production.

The problem arises when the cutting parameter is not applied correctly while doing machining. The absence of cutting fluid will lead to economic benefits by way of saving lubricant cost and workpiece, and also the tool machine cleaning cycle time. Then, the adhesion and friction between tool and chip tend to be higher in dry machining process. These situations will cause higher temperature, higher tool wear rates and consequently, shorter tool lives (Alabi et al., 2010). However using coolant will provide hazard to environment and health problem can be caused by the long term exposure to the cutting fluids and by the inappropriate way while handling with the cutting fluids. So, this study investigates which techniques are better to machine carbon steel AISI 1045 whether at dry or wet condition.

1.3 Objectives

The objectives of this study are:

a) To identify the effects of cutting speeds and feed rate on tool wear and surface integrity during machining AISI 1045 at dry and wet condition.

b) To analyze type of wear mechanisms, surface roughness and surface profile on AISI 1045 at dry and wet conditions.

c) To compare the performance of tool wears and surface integrity under dry and wet condition.

1.4 Scope of Study

This project is about investigating the surface integrity and tool wear on carbon steel AISI 1045 during turning operation using carbide cutting tools and compare between wet and dry cutting. This study have been done on the Computer Numerical Control (CNC) turning machine in the room temperatures for each condition the AISI 1045 carbon steel have been machined at different spindle speed, feed rate and constant depth of cut. The cutting tool used in this experiment is coated carbide cutting tool. Surface roughness tester, microscope and Scanning Electron Microscope (SEM) have been used to measure and identify the surface roughness, tool wear and the surface integrity. This study should be determine the surface integrity of the material after completing the machining operations. The factors that influence the surface integrity, tool wear and the surface roughness have been identified after the material have been machined.

1.5 Significance of Study

The study has been conducted and focussed into machining carbon steel AISI 1045 and aim to differentiate through the use of coolants and without coolant, which is dry and wet cutting. This study presents the suitable parameters that produce fine surface finish and minimum tool wear. The study conducted serve to be advantageous to the manufacturing industry such as oil and gas, automotive components and tools and die industries. The data obtained from this study can be used as reference for manufacturing industries for product optimization as well as to reduce production costs. This study also can provide input regarding the suitability of the industry in which the machining tool purchase cost and the implications for dry cutting.

1.6 Gantt Chart

Gant chartt experimental evaluation on machinability of AISI 1045 under dry and wet condition can be referred in Appendix A, so that it can be conducted efficiently.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Developing countries have awakened to fact that fabrication and processing of machine parts is a key to the technology that brings economic growth. The gross domestic product of the countries is tied to their manufacturing capacities. Hence the richest nations are those with powerful and flourishing manufacturing industries. Alabi et al., (2006) claim that machining; especially on the lathe is most important aspect of manufacturing process. Surface roughness plays an important role in product quality and manufacturing processes planning, which is also a technical requirement. Khidhir et al., (2009) found that cutting speed have a significant influence on the surface roughness produced. Atul et al., (2011) also found that the effect of turning processes parameters is independent variables.

Surface finish is responsible for its functionality, reliability, and lubrication. According to (Hari et al., 2004), the process parameter that may effect during turning process are cutting tool (geometry and cutting tool parameter), workpiece base parameter (composition, structure and hardness), cutting parameter (cutting speed, feed rate, depth of cut), wet cutting and dry cutting. A significant improvement of the productivity and efficiency can be obtained by processes parameter optimization that identifies the region of processes control factor (Lee et al., 2010 cited in Montgomery, 2001).

2.2 Lathe Machine

Turning is one of the most important and widely used machining operations, which are carried out on lathe (Kumar et al., 2012). Turning is a form of machining that is a material removal process and can create variety of features and produces smooth finish on cylindrical surfaces (Saini et al., 2014). The removal material process of turning is by a relative motion between a single point of cutting tool and rotating cylindrical workpiece. In a direction that is parallel to the axis of rotation, the cutting tool will fed linearly on the workpiece (Quazi et al., 2013). Figure 2.1 shows the conventional turning machine that can be used for turning process.

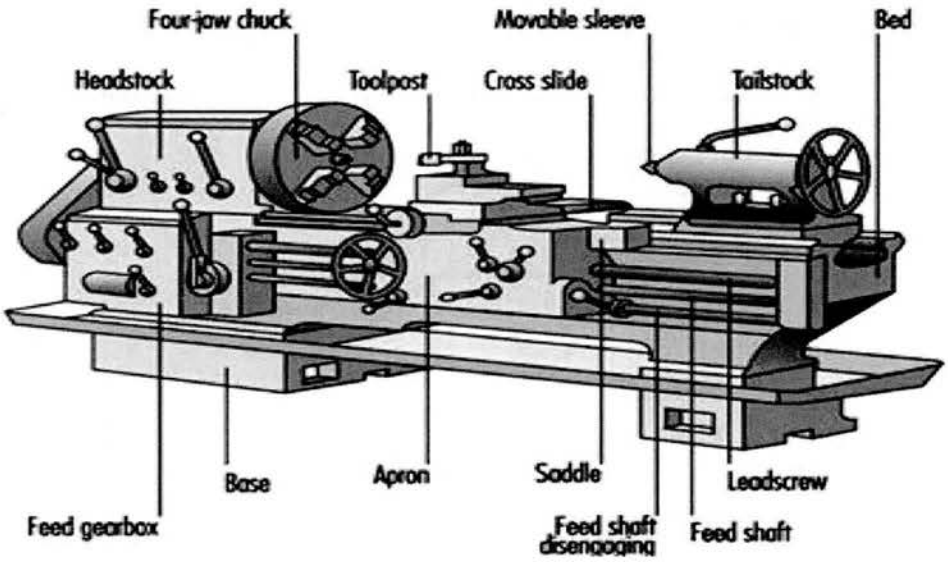

Figure 2.1: Typical parts in lathe machine (Hou, 2012)

Turning process requires a lathe which is the turning table, fixture, cutting tool and workpiece. Turning process produces solids of revolution in high tolerance because of the specialized nature of the operation (Hou, 2012). The operation of turning is using only a single point of cutting tool. This has been one of the popular and oldest method of metal cutting.