UNIVERSITI TEKNIKAL MALAYSIA MELAKA

THE EFFECT OF CUTTING PARAMETER TO THE SURFACE FINISH OF AISI D2 TOOL STEEL IN DRY DRILLING PROCESS

This report is submitted in accordance with the requirement of Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Manufacturing Engineering Technology (Process and Technology) with Honours

by

SITI HAJAR BINTI DIN
B071210397
930323-01-6774

FACULTY OF ENGINEERING TECHNOLOGY

2015

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **The Effect of Cutting Parameter to The Surface Finish of AISI D2 Tool Steel in Dry Drilling Process**

SESI PENGAJIAN: **2015/2016 Semester 1**

Saya**SITI HAJAR BINTI DIN**

mengakumembenarkanLaporan PSM inidisimpan di PerpustakaanUniversitiTeknikal Malaysia Melaka (UTeM) dengansyarat-syaratkegunaansepertiberikut:

1. Laporan PSM adalah hak milik Universiti Teknikal Malaysia Melaka dan penulis.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja dengan izin penulis.
3. Perpustakaan dibenarkan membuat salinan laporan PSM ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. **Silatandakan (✓)

☐ SULIT (Mengandungimaklumat TERHAD yang telahditentukanolehorganisasi/badan di mana penyelidikandijalankan)

☐ TERHAD (Mengandungimaklumat yang berdarjahkeselamatanataukepentingan Malaysia sebagaimana yang termaktubdalam AKTA RAHSIA RASMI 1972)

☐ TIDAK TERHAD

Disahkanoleh:

(TANDATANGAN PENULIS)

(TANDATANGAN PENYELIA)

AlamatTetap:

No. 178 Blok 5 FeldaKeratong 7,

26700 MuadzamShah,

Pahang.

Cop Rasmi:

**Jika Laporan PSM ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh laporan PSM ini perlu dikelaskan sebagai SULIT atau TERHAD.

DECLARATION

I hereby, declared this report entitled "The effect of Cutting Parameter to The Surface Finish of AISI D2 Tool Steel in Dry Drilling Process" is the results of my own research except as cited in references.

Signature : ………………………......

Name : <u>**SITI HAJAR BINTI DIN**</u>

Date : ………………………......

APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Engineering Technology (Process and Technology) (Hons.). The member of the supervisory is as follow:

……………………………….

(Mr. Mohd Hairizal bin Osman)

ABSTRACT

In this paper the drilling of AISI D2 tool steel also called D2 steel using CNC machine of drilling operation with tool use high speed steel in different type of coating is reported. Taguchi method is used for optimizing the cutting parameter for surface finish in dry drilling operation. Dry drilling is a drilling operation where is the cutting fluid also called coolant doesn't used in this process. A number of experiments will be conducted using the L_9 orthogonal array on CNC milling machine. This drilling process will be performed on AISI D2 steel block using HSS Tin coated, HSS TiCN coated and HSS uncoated under dry drilling conditions. The measure results will be collected and analyzed with the help of the commercial software package MINITAB 16. Analysis of variance (ANOVA) is used to determine the most significant control factors affecting the surface finish.

ABSTRAK

Dalam kertas ini penggerudian alat AISI D2 keluli juga dipanggil D2 keluli menggunakan mesin CNC operasi penggerudian dengan penggunaan alat keluli kelajuan tinggi dalam jenis yang berbeza lapisan dilaporkan. Kaedah Taguchi digunakan untuk mengoptimumkan parameter pemotongan untuk kemasan permukaan dalam operasi penggerudian kering. Penggerudian kering ialah operasi penggerudian di mana cecair pemotongan juga dikenali sebagai penyejuk tidak digunakan dalam proses ini. Beberapa eksperimen akan dijalankan menggunakan L9 tata susunan ortogon pada mesin pengilangan CNC. Proses penggerudian akan dilakukan pada AISI D2 keluli blok menggunakan HSS Tin bersalut, HSS TiCN bersalut dan tidakbersalut HSS di bawah keadaan penggerudian kering. Keputusan langkah akan dikumpul dan dianalisis dengan bantuan pakej perisian komersial MINITAB 16. Analisis varians (ANOVA) digunakan untuk menentukan faktor-faktor kawalan yang paling utama yang menjejaskan kemasan permukaan.

DEDICATIONS

A special appreciation, I dedicate this thesis to my mother Habsah Binti Mohamed, my late father Din Bin Basiran and all.

ACKNOWLEDGMENTS

Alhamdulillah, I would like to thanks to Allah S.W.T, the Most Merciful, and all praises to Allah for His blessing in completing this thesis. Special appreciation to my supervisor, Mr. Mohd Hairizal Bin Osman for supervised and guiding me throughout the experimental and thesis works.

I would like to express my appreciation Mr. Muhammad Syafik Bin Jumali, Mr Syahrul Azwan Bin Sundi @ Suandi and all the technicians that help towards my study. Sincere thanks to my beloved family and friends for their moral support and kindness. Unforgotten to those who directly or indirectly contributed in this research.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLE

LIST OF SYMBOLS AND ABBREVIATIONS

C	-	Carbon
CNC	-	Computer Numerical Control
Co	-	Cobalt
Cr	-	Chromium
Fe	-	Ferum
HSS	-	High Speed Steel
JTKP	-	Jabatan Teknologi Kejuruteraan Pembuatan
Ra	-	Mean Roughness
Ry	-	Maximum Peak f Roughness
Rz	-	Ten Point of Mean Roughness
RPM	-	Revolution per Minutes

CHAPTER 1
INTRODUCTION

1.0 Introduction

In the chapter one is an explanation about the introduction consists of the project background, problem statement, objectives and project scope.

1.1 Project Background

Drilling is a cutting process that uses a drill bit to cut or enlarge a hole of circular (thin slice that can be looked at) in solid materials. Holes usually are used for device that made up of smaller parts with fasteners for the design purposes such as weight reduction or access to the inside parts or for appearance. Other processes for producing holes are punching and different advanced machining processes.

During a dry drilling condition, the cutting fluid doesn't use during the machining process. Depending on the type of machining operation, the cutting fluid needed may be a coolant, oil/grease, or both. Because the machine-tool operator is usually close together to cutting fluids, the health effects of operator contact with fluids should be the first (or most important) concern.

Usually (in the past), cutting fluids have been widely used in machining operations in efforts to increase cooling and slipperiness, and as a result improve tool life, reduce process (quality of changing over time or at a different places), etc. However, over the last ten years, it has become seen/obvious that fluid-related decisions have all too often been based upon industrial old stories rather than knowledge-based (having to do with measuring things with numbers) evidence.

In this project, CNC machine is used to drill AISI D2 tool steel under dry drilling condition. High speed steel (HSS) with the diameter 10mm is used. There are three types of HSS coated material that used which is HSS TiN, HSS TiCN and HSS uncoated. Taguchi method design of experiment is used to determine the optimum cutting parameter for surface finish of AISI D2 tool steel. The surface roughness of the hole will be tested using surface roughness measuring tester. Minitab 17 software is used to analyze and arrange the data of experiment.

Quality is one of the important aspects in drilling industries. In machining, surface quality is one of the most commonly customer needs in which the major indication of surface quality on machined parts is surface roughness. Surface roughness is mainly a result of process limits/guidelines such as tool geometry (nose radius, edge geometry, rake angle, etc.). There are many things to explore when choosing from manufacturing processes for your metal product(s). There are many factors that the ability of a processing operation to produce a specific surface roughness depends on. For example, in surface grinding, the final surface depends on the speed of the wheel, the speed of the go through, the rate of feed, the grit size, bonding material and state of dress of the wheel, the amount and type of lubrication at the point of cutting, and the mechanical properties of the workpiece being ground. A small change in any of the above factors can affect the final surface that is produced.

1.2 Problem Statement

AISI D2 is one of the most popular high-chromium and high-carbon steels of D series and it is characterized by its high compressive strength and wear resistance, good through-hardening properties, high stability in hardening and good resistance to tempering-back. Cold work tool steels of Series D, also known as die steels, are high alloy steels Fe-Cr-C-base. This alloy has the ability to preserve its desirable mechanical properties intact upon cycling over a range of temperatures, which can be an advantage for applications including, piercing and blanking dies, punches, shear blades, spinning tools, slitting cutters, as well as variety of higher-end wood working tools (V.Sistaet al. 2011, Wuu-Ling Pan et al. 1998, K.H.Prabhudev 1992) Despite good mechanical properties of D2 steel, the lifetime of pieces and accessories fabricated with this alloy is negatively affected by the increase in the severity of operating conditions due to continuing evolution of industrial processes and corrosive operation environments (Ramírez et. al, 2012). Since the properties of material D2 steel make it hard to cut or machining, the above statements provide a niche or a trend in directing this study by providing a guideline in drawing out the objectives of this research.

1.3 Objectives

This project is a study on cutting parameter in dry drilling conditions using computer numerical control (CNC) machine. Discoveries whereupon will be qualified into surface roughness estimation parameters or all the more precisely the arithmetical mean deviation (Ra). Though, there are objectives of this project:

1. To study the surface roughness of AISI D2 tool steel in dry drilling condition by using various type of cutting tools.

2. To investigate the optimum parameter in dry drilling of AISI D2 tool steel.

1.4 Project Scope

The effect of a surface roughness will be based on the control parameter set up.The research is conducted as shown in Table 1.1. Based on the Table 1.1, D2 steel with the dimension of 100 mm×100 mm×10 mm is used as a workpiece material. There are three type of parameter set up which is feed rate (136 mm/min, 206.25 mm/min, 291 mm/min), spindle speed (680 rpm, 825 rpm, 970 rpm) and type of drilling tools material (HSS Tin coated, HSS TiCN coated, HSS uncoated. During this experiment, the drilling process doesn't use any coolant or lubricant. In other words, the experiment is running under dry drilling condition.

Table 1.1: The Machining Conditioning

Work Condition	Description
Workpiece	D2 steel, Square shape (100×100×10mm)
Spindle Speed	680 to 970 RPM
Feed Rate	136 to 291 mm/min
Coolant/lubricant	The drilling process doesn't used any coolant or lubricant (dry drilling condition)
Drilling Tools	HSS Tin coated, HSS TiCN coated and HSS uncoated
Tool Diameter	10mm

CHAPTER 2
LITERATURE REVIEW

2.0 Introduction

In chapter two, literature review is a text of a scholarly paper, which includes the current knowledge including substantive findings, as well as theoretical contributions to a particular topic. This chapter consists of drilling process, cutting tools for drilling process, D2 tool steel, surface roughness and statistical analysis.

2.1 Drilling Process

The manufacturing process used in this project is high speed machining in dry drilling condition where lubricant and coolant doesn't used in the drilling process.

2.1.1 High Speed Drilling

High speed machining is now acknowledged to be one of the key manufacturing technologies to ensure high productivity and throughput. The meaning of high speed drilling is the drilling process is at high speed. The high speed of the drilling process is changing from time to time. Some manufacturer defines high speed drill as drilling at spindle speed fast enough for penetration rates that are three to ten times greater than those considered conventional (American Machinist, 2011). Table 2.1 below shows the differentiation between the types of speeds.

Table 2.1: Differentiation Between The Type of Speed (Kalpakjian and Schmid, 2010)

Type of Speed	Speed (m/min)
High speed	600-1,800
Very high speed	1,800-18,000
Ultra high speed	18,000

2.1.2 Drilling

Drilling is a cylindrical hole opening process on a workpiece with cutting tools. Drilling can be applied to various workpieces and materials. A higher degree of tolerance accuracy may not be necessary at the hole for the bolt, screw and other components. However, at the critical holes such as wedge hole or mould pins tolerance accuracy becomes important (Krar et. al, 1998).

In the drilling processes chip disposability is considerably important. As the hole gets deeper, control of the process and disposability of the chip become difficult; this affects the surface and hole quality adversely. The difficult conditions arising during deep hole drilling bring certain requests relevant with cutting tool, machining center and auxiliary equipment. Manufacturing sector constitutes a major part of the annual income of the countries. When this is taken into consideration, it is very well understood how important are the contributions of these processes and the used cutting tools on the economy (Halamoglu.T, 2003). Figure 2.1 shows the drilling process on the workpiece.

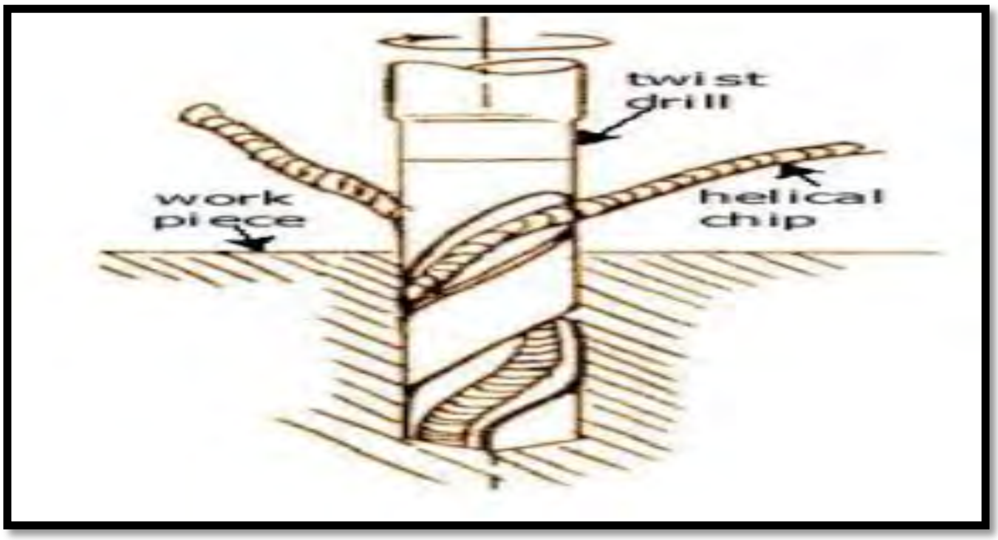

Figure 2.1 : Process of Gray Scale Transformation

Although long spiral chips usually result from drilling, adjustment of the feed rate can result in chips with a range of many different shapes and sizes. Material of work piece can also change the range of different chip shapes and sizes generally, the hole diameters produced by drilling are slightly larger than the drill diameter (oversize). The amount of oversize depends on the quality of the drill and also the equipment that used as well as the machinist skill. (Sretenović et. al, 2014)

2.1.3 Dry Drilling

Based on Kalpakjian and Schmid (2010), cutting fluids (as well as other metalworking fluids used in manufacturing operations) may undergo chemical changes as they are used repeatedly over time. These changes may be due to environmental effects or to contamination from various sources, including metal chips, fine particles produced during machining, and tramp oil (from leaks in hydraulic systems, oils on sliding members of machines, and lubricating systems for the machine tools). The changes involve the growth of microbes (bacteria, molds and yeast), particularly in the presence of water, becoming an environmental hazard and also adversely affecting the characteristics and effectiveness of the cutting fluids.

In 2002, over two billion gallons of cutting fluids were used by North American manufacturers. Traditionally, cutting fluids have been widely used in machining operations in efforts to increase cooling and lubricity, and as a result enhance tool life, reduce process variability, etc. However, over the last decade, it has become apparent that fluid-related decisions have all too frequently been based upon industrial folklore rather than knowledge-based quantitative evidence. Recently there has been a change in this situation, in part driven by the fact that costs associated with fluid use often constitute between 7% and 17% of total production costs, as compared to 4% for tooling costs (King et al., 2001).

Cutting fluids have seen extensive use and have commonly been viewed as a required addition to high productivity and high quality machining operations. Cutting fluid related costs and health concerns associated with exposure to cutting fluid mist and a growing desire to achieve environmental sustainability in manufacturing have caused industry and academia to re-examine the role of these fluids and quantify their benefits.

In addition to the environmental challenges of managing a used cutting fluid waste stream, cutting fluids also introduce several health/safety concerns. The National Institute for Occupational Safety and Health (NIOSH) estimates that 1.2 million workers involved in machining, forming, and other metalworking operations are exposed to metalworking fluids annually (NIOSH, 1998). Dermal exposure to these fluids represents a health concern, as does the inhalation of airborne fluid particulate. The application of cutting fluids within a machining operation often produces an airborne mist, and medical evidence has linked worker exposure to cutting fluid mist with respiratory ailments and several types of cancer (Mackerer, 1989; Thorne et al., 1996). This makes the use of cutting fluids a health issue with the potential of both long- and short-term consequences.

2.2 Cutting Tools for Dry Drilling

This project used high speed steel (HSS) as a cutting tools. There are three type of HSS used:

a) HSS Uncoated
b) HSS TiN Coated
c) HSS TiCN Coated

2.2.1 High Speed Steel (HSS)

Sutton tools, the brand of high speed steel uncoated is used for this project. The type of this drill tools is jobber drill bright with diameter 10mm. The specification of this drill tools is shown as follows in Table 2.3.

Table 2.2: The Specification of HSS Drill Bit (Sutton, 2015)

Specification	Description
Angle Point	118^0
Consumer Material	Wood, Chipboard, Hard Wood, Mdf, Pallet, Plywood, Sandwich Construction, Soft Wood, Window Frame, Wood & Nails, Metal, Aluminium, Copper / Brass, Metal Pipe, Sheet Metal, Steel, Masonry, Plasterboard, Specialty, PVC Plastic
Coolant	External
Depth of Cut	5Xd
Tool Surface Finish	Brt
Helix Angle	R30
Industrial Materials	P - Steel, N - Non-Ferrous Metals
Tools by Trade	Automotive, Cabinet Making, Carpenter, Electrician, Fitter & Turner, General Contractor, Maintenance Repair, Mechanic, Metal Worker, Plasterer, Plumber, Woodworker
Power Tools	Hammer Drill, Pedestal Drill, Power Drill
Shank Form	A
Tool Material	HSS