UNIVERSITI TEKNIKAL MALAYSIA MELAKA

OPTIMIZATION OF DRILLING PARAMETERS ON SURFACE ROUGHNESS IN DRY DRILLING PROCESS OF AISI D2 TOOL STEEL

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

by

NUR AMIRA BINTI SHUHAIMI

B071310817

910906-07-5918

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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 Manufacturing Engineering Technology (Process and Technology) with Honours. The member of the supervisory is as follow:

……

(Mr. Mohd Hairizal Bin Osman)

ABSTRAK

AISI D2 alat keluli adalah bahan yang digunakan secara meluas dalam industri pembuatan. Kajian ini adalah tentang kaedah pengoptimuman parameter penggerudian dalam penggerudian kering ke atas AISI D2 keluli yang digunakan untuk mencapai parameter yang minimum pada kekasaran permukaan. Parameter penggerudian yang digunakan adalah kadar suapan, kelajuan pengumpar dan jenis bahan alat penggerudian. Beberapa eksperimen akan dijalankan berdasarkan teknik tatasusun Taguchi L_9 Ortogon pada mesin pengisar CNC. Hasilnya akan dikumpulkan dan dibandingkan dengan hasil yang perolehi daripada perisian MINITAB 17. Analisis varians (ANOVA) digunakan untuk menentukan faktor-faktor kawalan yang paling penting yang memberi kesan kekasaran permukaan.

ABSTRACT

AISI D2 Tool Steel is a material that widely used in manufacturing industries. This paper is about an optimization method of the drilling parameters in dry drilling of AISI D2 steel that use in order to achieve minimum parameter on surface roughness. The parameter of drilling that use is feed rate, spindle speed and type of drilling tools material. A number of experiments will be conducted based on the Taguchi's L_9 Orthogonal Array technique on CNC milling machine. The result will be collected and compared to the result that obtain from MINITAB 17 software. Analysis of Variance (ANOVA) is used to determine the most significant control factors affecting the surface roughness.

DEDICATION

As a token of appreciation, I dedicate this thesis to both of my parents, Mr. Shuhaimi Bin Aziz and Mrs. Noorhayati Binti Hashim.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

AISI	-	American Iron and Steel Institute
Al	-	Aluminium
ANOVA	-	Analysis of Variance
C	-	Carbon
°C	-	Degree Celcius
CNC	-	Computer Numerical Control
Co	-	Cobalt
Cu	-	Copper
Cr	-	Chromium
CVD	-	Chemical Vapour Deposition
DOE	-	Design of Experiments
Fe	-	Ferum
HSS	-	High Speed Steel
JTKP	-	Jabatan Teknologi Kejuruteraan Pembuatan
min	-	minit
mm	-	millimeter
Mn	-	Manganese
Mo	-	Molybdeum
N	-	Nitride
Ni	-	Nickel
OA	-	Orthogonal Array
P	-	Phosphorus
PVD	-	Physical Vapour Deposition
Ra	-	Mean Roughness
Ry	-	Maximum Peak f Roughness
Rt	-	Maximum Peak-to-Valley Roughness
Rz	-	Ten Point of Mean Roughness
RPM	-	Revolution per Minutes
S	-	Sulphur
S/N	-	Signal to Noise

Si	-	Silicon
Ti	-	Titanium
TiN	-	Titanium Nitride
TiCN	-	Titanium Carbon Nitride
TiAlN	-	Titanium Aluminium Nitride
V	-	Vanadium

CHAPTER 1
INTRODUCTION

1.0 Introduction

Inside this chapter one is an explanation about the introductions of the project. It consists of the project background, problem statement, objectives and project scope.

1.1 Project Background

Industry is a sector of production that produces goods or services that will generate the national growth. One of industry that generates growth is manufacturing industry. These industries have become a key sector for production and labour during industrial revolution. For industrial production, the raw material will be changed into finished goods on large scale which will make a lot of profit for the country.

Drilling is one of cutting operations that widely applied in manufacture industries. These processes use a drill bit or known as cutting tools to cut or broaden a hole of circular in substanial materials. Drilling can be assumed as a complex operation because the cutting velocity needs to be zero at the midpoint of the drill and the removal of material happen around the chisel edge that occurs by extrusion which makes the material move radially away from centre. The material removal on the cutting edge occurs by shear in the same way as turning and milling tools with the cutting speed and distance from the drill centre. (Staff, 2010) This drilling process is either in dry or wet condition.

During a dry drilling condition, the cutting fluid won't be used at all whereas wet condition, cutting fluid will be used. Types of cutting fluid or medium cooling that always used are coolant, oil/grease, or both. Nowadays, there is increasing interest in performing machine processes in dry conditions. This is because to reduces the cost to produce a lot of products, ease of chip to remove, able to recyclability and prevent from pollute the environment. (Tasdelen, Wikblom, and Ekered, 2008).

As for this project, dry drilling process will be used with drill bit (High Speed Steel) that coated with TiN (Titanium Nitride), TiCN (Titanium Carbon Nitride) and TiAlN (Titanium Aluminium Nitride). As for the material, AISI D2 Tool Steel is used. D2 is a high Carbon and high Chromium alloy which has outstanding strength, wear and corrosion resistance, and deep hardening characteristics which is ideal for maximum production runs. Besides, this material is widely used in manufacturing industries for cutting, punching, stamping tools, shear blades, thread rolling dies, cold extrusion dies, drawing and bending tools, flanging and straightening rolls, fine cutting tools, deep drawing tools, plastic moulds for abrasive polymers and much more. The elements that contain inside AISI D2 Tool Steel like C=1.6%, Si=0.34%, Mn=0.39%, Cr=11.55%, Mo=0.81%, V=0.84%, P=0.025% and S=0.01%. (*Tool Steel*, 2014)

This project will come out with an optimization procedure of drilling parameters (feed rate, spindle speed and type of drilling tools material) in dry drilling process for AISI D2 Tool Steel in order to obtain the minimum parameter on surface roughness. The layout of this experimental will be layed out by Taguchi's L_9 Orthogonal Array technique and also ANOVA (Analysis of Variance).

1.2 Problem Statement

AISI D2 Tool Steel is well known with high Chromium and high Carbon Steels of D series that widely used in manufacturing and machining operations. This is because of its outstanding strength and wear resistance, excellent hardening properties, great for stability in hardening and great resistance to tempering-back is better than other tool steel make it hard to cut or machining and the effect on the surface roughness after the machining process is done on it. Due to their capability to maintain their mechanical ability over a range of temperatures makes them become demanding materials for modern industrial such as punches, piercing and blanking dies, spinning tools, shear blades, slitting cutters as well as higher end wood working tools.

Drilling process usually used coolant as a medium cooling that prevent the device from overheating. But, now the interest in performing operations in dry machining is increasing due to its advantange in producing a higher productivity in a lesser time along with quality or feature improvement beside of improving the cutting that conducts on the product. (Orra and Choudhury, 2016). Besides that, this dry processes also can reduce the cost of production, recyclability, and prevent from polluting the environment that can cause an environmental hazard and contaminate the health of people around there. (Kalpakjian, Technology, and Schmid, 2013).

1.3 Objectives

This project is a study on cutting parameter in dry drilling conditions using Computer Numerical Control (CNC) machine. Here are objectives of this research:

i. To study the significant factor of surface roughness of AISI D2 tool steel in drilling process.

ii. To find the optimum parameter in dry drilling process on AISI D2 tool steel.

1.4 Work Scope

i. To evaluate the parameter set up which is feed rate, spindle speed and type of drilling tools material on a surface roughness, by using a dry drilling process.

ii. Three type of HSS coated drill bit with diameter of 11mm that used for this project is TiN, TiCN and TiAIN.

iii. Material that used is AISI D2 Tool Steel with the dimension of 200mmx 200mmx13mm.

iv. Design layout using Taguchi's L_9 Orthogonal Array Technique and ANOVA (Analysis of Variance).

v. Each one of coated drill bit is used to drill for 6 holes in the same 3 levels of parameter.

CHAPTER 2
LITERATURE REVIEW

2.0 Introduction

In chapter two, literature review is a text of the works of others people which can pave the way for a better research. It really helps in giving a relevance research for a particular topic. So, this chapter is consist of drilling process, cutting tools for drilling process, D2 tool steel, surface roughness and statistical analysis.

2.1 Drilling

Drilling is one of the traditional machining processes that up to now still consider as the most important metal cutting operations which involve with 33% of all cutting operations. Even the modern cutting process excessively upgrades, the traditional drilling method still be used as one of the universal processes. (Garg et al., 2015) This process is used to cut or broaden the size of circular cross section of the holes in materials. The drill bit will be urged on the work piece and will rotate at rates of hundreds to thousands of revolution per minute (rpm). (Patel and Verma, 2015)

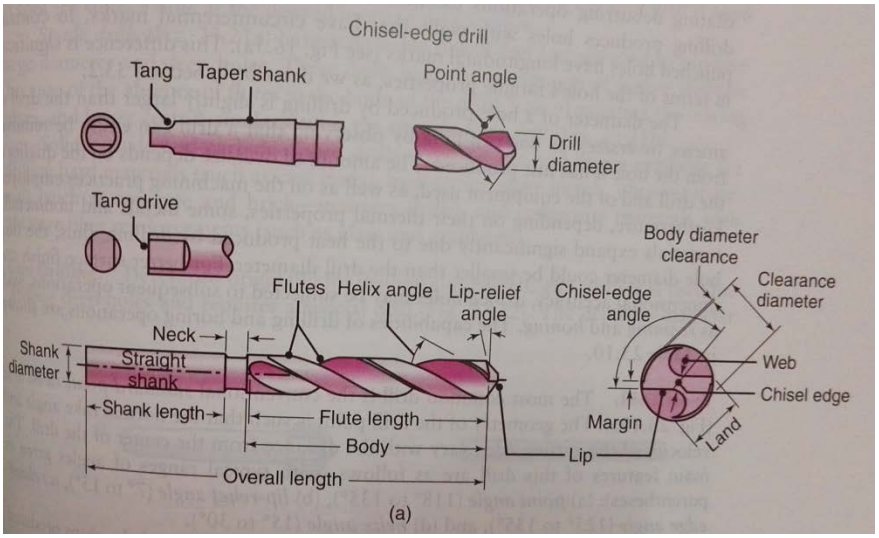
However, it also known as complex cutting processes that can simulate the action of a two twist drill with two dimensional models need to be considered because it can influence the feed velocity on the cutting geometry at the drill point. The simulation action of the drill point can develop the chip formation and indentation model. From the work material, the total torque and thrust can be predict include cutting condition, drill geometry and an empirical factor for the process.

This process is mostly used for the final step in the manufacturing of mechanical parts and it considered as economic importance (Li, Hegde, and Shih, 2007) and (Sharman, Amarasinghe, and Ridgway, 2008). Several literatures and studies show that drilling is one of the most times consuming metal removal process (36% of all machine hours) when compared to turning and milling which accounts for 25% and 26% machining hours respectively. When compared to other machining processes like turning and milling, the cutting tool in drilling process have to perform under severe conditions as the machining region is situated deep within the workpiece and hence it is still viewed as one of the challenging machining processes in spite of the widespread research work carried out. (Mathew and L., 2016)

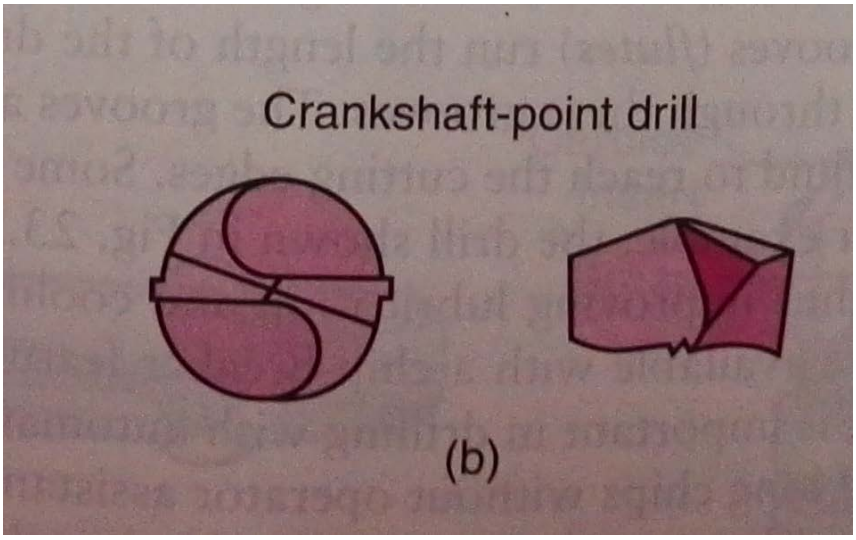
Nowadays, the drilling process is very important especially in making small hole. This small drilling hole is widely used in industries especially in producing precision products spanning from the manufacturing of fuel injection nozzles, printed circuit boards, Micro Electro-Mechanical System (MEMS) packaging, orifices in air bearings, and vent holes. Besides that, this process also used in aerospace industries in order to make a condenser tubes in turbines and holes in turbine blades. (Prasanna et al. 2014) It commonly use up to 50% in machining operations due to its new control systems where it has many advantages like reduce the cycle time, device breakage and cost, and also product quality improvements. (Sheng & Tomizuka 2006; Haber et al. 2010). According to Authors, the drilling performance such as metal removal rate, thrust force, torque and tool life can be forecast based on the process parameters like drill diameter, cutting speed and feed rate.

The cutting tool is very importance for the drilling process. This is because the failure to choose the suitable drill types can cause to uncontrollable vibrations and raised the cutting force which at the end will resulting in nasty outcomes like rapid tool wear, poor quality surface, inability to get the required dimensional accuracy, unwanted burr formation at the front and back of holes, and excessive noise. (Ekici, Motorcu, and Uzun, 2017). As the twist drill rotates and penetrates into the workpiece, it produces both thrust force and torque. The cutting action by the lips and the web as well as the extrusion action of the web contributes to the thrust force. (Mathew and L., 2016). Therefore, the various angles have been accomplished on the

drill in order to make accurate holes, lessen the force and torque of drilling and increase the tool life. (Kalpakjian, Technology, and Schmid, 2013)



(a) Chisel-Edge Drill



(b) Crankshaft Drill

Figure 2.1: Two Common Types of Drills. (a) Chisel-edge drill. The function of the pair of margins is to provide a bearing surface for the drill against walls of the hole as it penetrates into the workpiece. (b) Crankshaft drill. These drill have good centering ability, and because chips tend to break up easily, this drills suitable for producing deep holes.

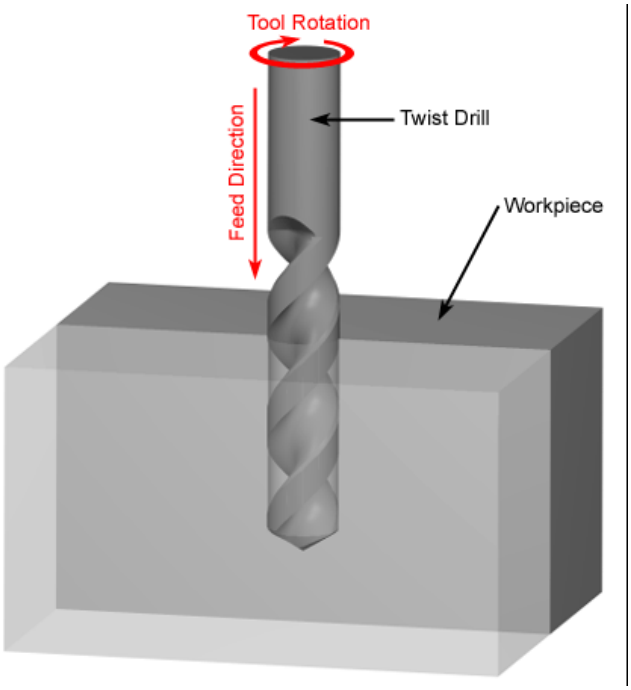


Figure 2.2 Drilling a workpiece

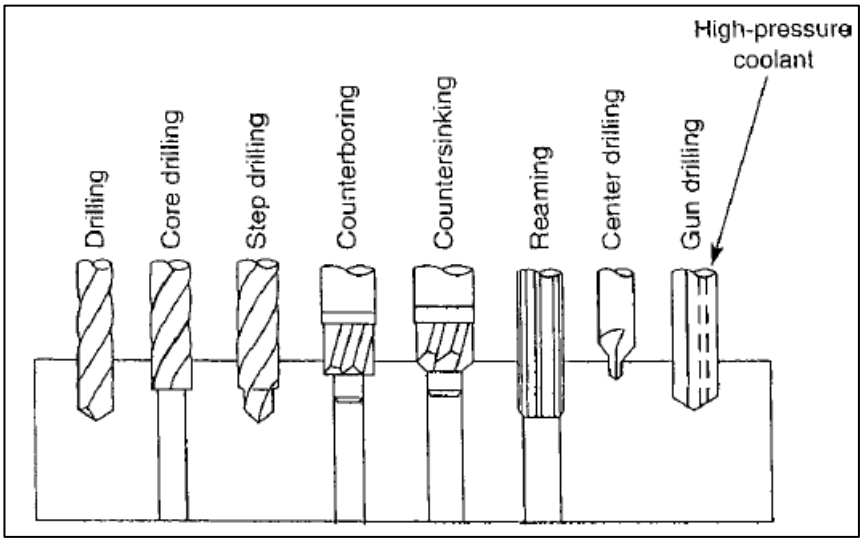


Figure 2.3: Another Types of Drilling

In Figure 2.2 shows the drilling process on a workpiece. As for Figure 2.3, it show types of drilling that used for machining.