UNIVERSITI TEKNIKAL MALAYSIA MELAKA

OPTIMIZATION OF DRILLING PARAMETERS ON DIAMETER ACCURACY IN WET DRILLING PROCESS OF AISI D2 TOOL STEEL

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

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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 Engineering Technology (Department of Manufacturing Engineering Technology) (Hons.). The Project supervisor is as follow:

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Mr. Mohd Hairizal Bin Osman

(Project Supervisor)

ABSTRACT

The aim of this project is utilize the Taguchi method as one of Design of Experiment (DOE) to investigate the diameter accuracy in the wet drilling process using of AISI D2 Tool steel. By using CNC machine of drilling operation with tool use High Speed Steel in different type of coating is reported. This research was carried out to describe about optimization of drilling parameters which are feed rate, spindle speed and type of drill bit to achieve optimal diameter accuracy. The value of hole diameter accuracy will be test by using Coordinate Measuring Machine. The types of drill bit with diameter of 11mm to be used such as High Speed Steel coated with Titanium Nitride (TiN), High Speed Steel coated with Titanium Carbon Nitride (TiCN) and High Speed Steel coated with Titanium Aluminium Nitride (TiAlN). A number of experiments layouts will be conducted using the L_9 Orthogonal Array. Taguchi method is used for optimizing the cutting parameter for diameter accuracy in wet drilling operation can be determined. Analysis of variance (ANOVA) is used to determine the most significant control factors affecting the diameter accuracy. Confirmation test were done with the optimal levels of parameter are carried out in order to verify the effectiveness of the Taguchi optimization method.

ABSTRAK

Tujuan projek ini adalah dengan menggunakan kaedah Taguchi sebagai salah satu Reka bentuk Eksperimen untuk menyiasat diameter ketepatan dalam proses penggerudian basah dengan menggunakan AISI D2 alat keluli. Dengan menggunakan mesin kawalan berangka terkomputer operasi penggerudian dengan penggunaan alat keluli kelajuan tinggi dalam jenis yang berbeza lapisan. Kajian ini telah dijalankan untuk menerangkan tentang pengoptimuman parameter penggerudian di mana kadar suapan, kelajuan pengumpar dan jenis bit gerudi untuk mencapai diameter ketepatan yang optimum. Nilai lubang diameter ketepatan di uji dengan menggunakan mesin mengukur koordinat. Jenis-jenis bit gerudi dengan diameter 11mm untuk digunkan seperti HSS disalut dengan Titanium Nitride (TiN), HSS disalut dengan Titanium Karbon Nitride (TiCN) dan HSS bersalut dengan Titanium Aluminium Nitride (TiAlN). Beberapa eksperimen susun atur yang dijalankan menggunakan pelbagai ortogon L_9. Dengan menggunakan Kaedah Taguchi dapat menentukan optimum parameter pemotongan untuk diameter ketepatan dalam operasi penggerudian basah. Menggunakan perisian Minitab Analisis varians (ANOVA) digunakan untuk menentukan faktor-faktor kawalan yang paling penting yang mempengaruhi diameter ketepatan. Ujian pengesahan telah dilakukan dengan tahap optimum parameter dijalankan untuk mengesahkan keberkesanan kaedah pengoptimuman Taguchi.

DEDICATIONS

A special appreciation, I dedicate this thesis to my beloved father En.Mohtar @ Zamri Bin Hj Muda, my late mother Yusni Yusoff. Also special thanks to my supervisor En Mohd Hairizal Bin Osman, for the constructive guidance, supportive values and encouragement in fulfilling my aspiration in completing this project. To my sibling's sister, brother and my friend, the work and success will never be achieved without all of you.

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LIST OF SYMBOLS AND ABBREVIATIONS

AISI	-	American Iron and Steel Institute
C	-	Carbon
°C	-	Celsius
D	-	Diameter
CNC	-	Computer Numerical Control
Co	-	Cobalt
Cr	-	Chromium
Si	-	Silicon
Mg	-	Manganese
Mo	-	Molybdenum
V	-	Vanadium
Fe	-	Ferum
PVD	-	Physical Vapour Deposition
HSS	-	High Speed Steel
TiN	-	Titanium Nitride
TiCN	-	Titanium Carbon Nitride
TiAlN	-	Titanium Aluminium Nitride
JTKP	-	Jabatan Teknologi Kejuruteraan Pembuatan
CMM	-	Coordinate Measuring Machine
Mm/min	-	Millimeter per minute

S/N	-	Signal to Noise
RPM	-	Revolution per Minutes
RM	-	Ringgit Malaysia
µm	-	Micro meter
mm	-	Millimeter
kg	-	Kilogram
MQF	-	Minimum quantity of fluid
ANOVA	-	Analysis of variance
DOE	-	Design of Experiment
CAM	-	Computer-aided manufacturing
CAD	-	Computer-aided drawing

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 follow by the project scope. The entire sub-topic relates with each other to ensure the readers of this report can understand on how the project process flow. This project will describe about the optimization of drilling parameters on diameter accuracy in wet drilling process of AISI D2 tool steel. Several tests will be conduct with different parameter, different types of drill tools and the material use to drill on AISI D2 tool steel. Taguchi method will be used to analyze this project. By doing the analysis, the best parameter for the drilling process that produce the best holes diameter accuracy can be determine.

1.1 Project Background

In the manufacturing technology industry, there are many challenges were faced because the new technology build in this modern age. The challenges faced by the industry in terms of dimensional accuracy and precision especially for hardened material. (J.A.Arsecularatne, 2005). The quality of the machined parts and increase the productivity are the examples of the main challenges in this industry. Modern cutting tools such as drilling tool allow cutting process at high speed and increase the volume of the product produce. In this project will be focus on the optimization parameter for drilling process with coolant for holes diameter accuracy based on the Taguchi method.

Drilling is a cutting process that uses a drill bit to cut or enlarge a hole of circular in solid materials. Drilling can be described as a process where a multi-point tool is used to remove unwanted materials to produce desired holes. 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. There are many factors that can be influence the quality of the drilled holes. The most obvious are the cutting parameters which are cutting speed, feed rate and also cutting configurations consist of tool diameter, material and geometry. Other processes for producing holes are punching and different advanced machining processes. For this project, spindle speed, feed rate, and type of drill bit had been choose as the parameters that need to be observe.

The drilling process will conduct by three axis CNC milling machine. Using this machine, it will be more precise and easier to set the value of the selected parameter. During the machining process, the cutting fluid use for drilling condition. 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 important thing concern. 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, improved surface finish, and higher stock removal rate. The coolant type use in this project is Fuchs Lubricants (ECOCOOL 6210 IT).

In this project, CNC machine is used to drill AISI D2 tool steel under drilling condition. AISI group D are used widely in the manufacture of blanking and cold-forming dies, excellent wear resistance and deep hardening characteristics (Dewes, R.C, 2002). The material AISI D2 is hard material to be machined and is one of the most popular high-carbon and high chromium tool steel of this series. AISI D2 tool steel with hardness in the range of 55-62 HRC has a high strength, very high resistance to cracking and high resistance to softening and wear. The types of drill bit with diameter of 11mm to be used such as High Speed Steel coated with Titanium Nitride (TiN), High Speed Steel coated with Titanium Carbon Nitride (TiCN) and High Speed Steel coated with titanium Aluminium nitride (TiAlN).

Taguchi method design of experiment is used to determine the optimize cutting parameter for diameter accuracy of AISI D2 tool steel. Taguchi method will be used to analyze this project and based on the analysis the best parameter for drilling process with coolant that produce for diameter accuracy can be determine. The experiment layout will be design by used Minitab 17 software is used to analyze and arrange the data of experiment method with L_9 of Orthogonal Array. The diameter accuracy of the hole will be tested using Coordinates Measuring Machine (CMM) Zeiss Contura G2.

1.2 Problem Statement

The main problem that needs to be focus for this project is that the material of AISI D2 is hard material to be machined and 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. AISI D2 tool steel with hardness in the range of 55-62 HRC has a high strength, very high resistance to cracking and high resistance to softening and wear. Due to composition of chemical in this type of steel, it is really hard to machine. This is due to its typical composition which consists of 1.50% carbon(C), 0.3% silicon (Si), 0.4% manganese (Mg), 12.0% chromium (Cr), 0.8% molybdenum (Mo) and 0.9% vanadium (V). (V.Sista et al, 2011). Machinability of hard material through machining is hindered due to excessive wear of the cutting tool and differently in achieving desired quality of the machined surface. The strength of a part is of critical importance in the manufacturing industry, especially for precision assembly operation. (Ali, H.M, 2014). With high speed operation for AISI D2 tool steel, the cutting tools wear can be very much due to the mechanical stress and temperature increases. There will be presence of coolant during the drilling process.

1.3 Objectives

The objectives for this project are:

1. To study the significant factor affecting diameter accuracy in wet drilling process
2. To optimize the parameters of Computer Numerical Control (CNC) machine for drilling process.

1.4 Project Scope

In this project, there are several scopes to be considered in order to achieve the objectives. The following important elements that must be followed:

i. The material block to be machine is AISI D2 Tool Steel with size of 200mm × 200mm × 13mm is used as a workpiece material by using Computer Numerical Control (CNC) milling machine. There will be number of holes to be drilled are 54 holes. The drill bit used in this project are nine pieces which is three pieces for each type of drill bit coated and each one pieces of drill bit will produces 6 holes.

ii. There are 3 types of drill bit to be used which are High Speed Steel coated with Titanium Nitride (TiN), High Speed Steel coated with Titanium Carbon Nitride (TiCN) and High Speed Steel coated with Titanium Aluminium Nitride (TiAlN). The process to coating the drill bit used Physical Vapour Deposition (PVD) technique. The thickness of coating is in a range of 3-6µm. The diameter of each drilling bit is the same which is 11mm.

iii. Coordinates Measuring Machine (CMM) will be used to measure the accuracy of hole diameter and Minitab 17 software for the analysis process.

iv. During the drilling process, coolant must be used. The type of coolant use is Fuchs lubricants (Ecocool 6210 IT).

1.5 Project Requirement

The requirements of this project are:

a) The drilling process can't be done with conventional machine because it will be hard to maintain the values of parameter.
b) There must be presence of coolant during the drilling process.

CHAPTER 2
LITERATURE REVIEW

2.0 Introduction

In chapter two, literature review there will be explanation or discussion of the research background about related to the project. This chapter consists of drilling process, cutting tools for drilling process, AISI D2 tool steel, diameter accuracy and statistical analysis.

2.1 Drilling Process

Drilling is one of the most common and fundamental machining processes. It is most frequently performed in material removal and is used as a preliminary step for many operations, such as reaming, tapping and boring. Because of their importance in nearly all production operations, twist drills have been the subject of numerous investigations. The drilling machines are highly used in an industry for metal removal operation. Drilling is the cutting process of using a drill bit in a drill to cut or enlarge holes in solid materials, such as wood or metal. Different tools and methods are used for drilling depending on the type of material, the size of the hole, the number of holes, and the time to complete the operation. (A.Navanth, August 2013). The manufacturing process used in this project is high speed machining in drilling condition where lubricant and coolant used in the drilling process.