UNIVERSITI TEKNIKAL MALAYSIA MELAKA

OPTIMIZATION OF DRILLING PARAMETER ON SURFACE ROUGHNESS IN WET DRILLING PROCESS AISI D2 TOOL STEEL

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

by

SITI NURFARHANA BINTI SIDEK
B071310843
921128-10-5714

FACULTY OF ENGINEERING TECHNOLOGY
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BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **Optimization of drilling parameter on surface roughness in drilling process AISI D2 Tool Steel**

SESI PENGAJIAN: **2016/17 Semester 1**

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DECLARATION

I hereby, declared this report entitled "Optimization of Drilling Parameter on Surface Roughness in Wet Drilling Process AISI D2 Tool Steel" is the results of my own research except as cited in references.

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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 member of the supervisory is as follow:

………………………………

(En Mohd Hairizal Bin Osman)

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ABSTRAK

Projek ini di jalankan untuk menentukan parameter optimum dalam mengkaji kekasaran permukaan pada bahan keluli blok AISI D2 dengan menggunakan proses penggerudian basah. Proses pemesinan di jalankan dengan menggunakan mesin kawalan berangka terkomputer dengan kehadiran penyejuk. Tujuan projek ini adalah untuk menentukan parameter yang optimum untuk proses penggerudian pada blok keluli AISI D2 dengan menggunakan kaedah Taguchi. Parameter bagi kadar suapan adalah 136 mm/min, 206 mm/min and 291 mm/min dan kelajuan pengumpar pula adalah 723 RPM, 825 RPM and 940 RPM. Sementara itu, jenis salutan pada mata gerudi yang digunakan adalah keluli laju tinggi bersalut Nitrida Titanium (TiN), Karbon Nitrida Titanium (TiCN) dan Aluminium Nitrida Titanium (TiAlN). Ortogon L_9 dipilih untuk kajian ini melibatkan tiga faktor pada tiga peringkat. Pengkaji kekasaran permukaan akan di gunakan untuk menganalisa kecantikan permukaan pada blok keluli AISI D2. Data yang dikumpul akan dianalisa dengan menggunakan perisian Minitab 17. Akhir sekali, ujian pengesahan akan dijalankan untuk menentukan kesahihan parameter yang diramal.

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ABSTRACT

This project was carried out to determine the significant factor of surface roughness on AISI D2 Tool Steel in wet drilling process. The machining process were performed on the CNC Milling Machine DMC 635 V Ecoline. This project is run under wet drilling condition so the drilling process have use a coolant. The aim of this project is to optimize the parameter for the drilling process of AISI D2 Tool Steel on surface roughness utilizing the Taguchi Method. The parameter for the feed rate are 136 mm/min, 206 mm/min and 291 mm/min. The selected of spindle speed parameter for the wet drilling process are 723 rpm, 825 rpm and 940 rpm. And the last parameter that will be considered in this project is types of drilling tool which is High Speed Steel (HSS) coated with Titanium Nitride (TiN), High Speed Steel (HSS) coated with Titanium Carbon Nitride (TiCN) and High Speed Steel (HSS) coated with Titanium Aluminium Nitride (TiAlN). There are L9 of orthogonal array choosen which is include the 3 level and 3 factor. The surface roughness will be test by using Surface Roughness Tester Mitutoyo SJ-410. The value of S/N ratio and the value of mean surface roughness will be obtained from the Taguchi method in Minitab software. Lastly, the conformation test will be conducted to illustrate the validity of the result.

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DEDICATION

To my beloved parents, Encik Sidek Bin Abdul Rahman and Puan Rosidah Binti Dolah. This is for you and thank you for all your sacrifice.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

Al	-	Auminium
ANOVA	-	Analysis of Variance
CNC	-	Computer Numerical Control
C	-	Carbon
Co		Cobalt
Cr	-	Chromium
Fe	-	Ferum
HSS	-	High Speed Steel
JTKP	-	Jabatan Teknologi Kejuruteraan Pembuatan
Mn	-	Manganese
Ra	-	Mean Roughness
RPM	-	Revolution per Minutes
Rq	-	Root Mean Square
Ra	-	Mean Roughness
RPM	-	Revolution per Minutes
Si	-	Silicon
Ti	-	Titanium
N	-	Nitride
TiN	-	Titanium Nitride
TiCN	-	Titanium Carbon Nitride
TiAlN	-	Titanium Aluminium Nitride
V	-	Vanadium

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CHAPTER 1

INTRODUCTION

1.0 Introduction

Chapter one will cover about the introduction that presentation comprises of the project background, problem statement, objectives and project scope.

1.1 Background

Drilling is one of the most imperative machining processes. Approximately 75% of all metal cutting process involves drilling operation (Al Fredo 2016). In automotive engine production, costing of drilling hole is among the highest (Mohan et al. 2005). Drilling is most commonly used machining processes to produce holes in many industrial components. It is also the operation that generating the circular hole in the work-piece by using a rotating cutter called drill. Other processes for producing holes are punching and different advanced machining processes. This project is conducting on a CNC milling machine that produces holes at a specified rate of parameters in presence of coolant. During in drilling condition, the cutting fluids have use during the machining process. Depending on the type of machining operation, the cutting fluid needed may be a coolant, oil or grease. Coolant is utilized to grease up the machined surface and too reduce heat from the tool and the work piece (Bingham 2010). Taguchi method design of experiment is used to find the optimum parameter for the drilling process. Quality is an important aspects of the drilling industry (Mishra et al. 2015).

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1.2 Problem Statement

Manufacturers around the world are always exploring innovative procedure to process high strength material such as AISI D2 Tool Steel which was a high carbon and high chromium tool steel that utilized as part of high duty cutting tools, measuring instruments and gauges, where excellent wear resistance required (Ali et. al 2014).

AISI D2 Tool Steel is related of hard to cut or machining and the effect on the surface roughness. Many researchers have been focused on determining the best drilling process. Since drilling process is one from the most important process in industry, several researchers were studied in order to optimize the quality in this process (Mohan et al. 2005).

1.3 Objective

The objective of this project are:

- To study the significant factor of surface roughness of AISI D2 tool steel in drilling process.
- To optimize parameter for the drilling process of AISI D2 tool steel.

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1.4 Work Scope

- There are three (3) types of drill bit with the same diameter of 11mm will be used for drilling process. There are High Speed Steel (HSS) coated by Titanium Nitrite (TiN), Titanium Carbon Nitrite (TiCN) and Titanium Aluminium Nitirite (TiAlN).
- Material that used is AISI D2 tool steel with the dimension of 200mm x 200 mm x 13mm. 3 drill bit will be used for each type of coating where each of it produce 6 holes for the same parameters.
- It will be conduct using Computer Numeric Control (CNC) Milling Machine to produce holes.
- Design layout using Taguchi's L9 orthogonal array technique and Analysis of Variance (ANOVA).
- Surface Roughness Tester will be used to measure the hole surface.
- Cutting fluid used during the machining operation. The experiment is run under wet drilling condition so the drilling process have use coolant or lubricant.

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CHAPTER 2
LITERATURE REVIEW

2.0 Introduction

In this chapter will show basically about the literature review of this project. This chapter also discuss about the journals were make as references and good example from other sources.

2.1 Tool Steel

Tool steels serve primarily of making tools used in manufacturing and in the trades for the working and forming of metals, wood, plastic and other industrial materials. Tools must withstand high specific loads, often concentrated at exposed areas, may have to operate at evelated or rapidly changing temperaturs and continual contact with abrasive types of work material and are often subjected to shocks or may have to perform under other varieties of adverse conditions. Nevertheless, when should not suffer major damage, untimely wear resulting in the dulling of the edges or be susceptible to detrimental metallurgical changes (Kundor et al. 2016).

Tools for less demanding uses such as ordinary hand tools including the hammers, chisels, files and else are often made of standard AISI steels that are not considered as belonging to any tool steel categories. The steel for the types of tools must be used in a heat treated state, generally hardened and tempered, to provide the properties needed for the particular application. The adaptability to heat treatment

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with a minimum of harmful effects, which dependably results in the intended beneficial changes in material properties. It is still antoher requirement that tools steels must satisfy (Kundor et al. 2016).

Tool steels mut posses certain properties to a higher than ordinary degree to make them adaptable for uses that require the ability to sustain heavy loads and perform dependably even under adverse conditions. The extend and the types of loads, the characteristic of the require the ability to sustain heavy loads and perform dependably even under adverse conditions. Tool steels are generally heat treated to make them adaptable to the indended use by enchacing the desirable properties, the behavior of the steel during heat treatment is of prime importance. The behavior of the steel comprises, in the respect both the resistance to harmful effects and the attainment of the desirable properties (Kundor et al. 2016).

2.1.1 AISI D2 Tool Steel

Cold work tool steels consists othe high chromium steel, high carbon or group D steels. It was generally used for tools operating under conditions of severe abrasion and wear or as an another alternative to oil hardening tool steel grades when enduring runs are required (Fred H. Colvin 2013). Type AISI D2 tool steel is the most usually used steel among to the group D steels (Takacs & Farkas 2014).

As the result of its special annealed structure, developed and tested over a period of several years, AISI D2 tool steel is the ideal grade for maximum production runs. It machninability is superior to any of the similar types of tool steel (Takacs & Farkas 2014).

AISI D2 tool steel is an air hardening, high-carbon, high chromium tool steel and high compressive strength. It has high wear and abrasion resistant properties. AISI D2 tool steel shows little distortion on correct hardening. AISI D2 tool steel is available from stock in hot rolled rounds,

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squares and flat, metric sizes and bright drawn rounds in imperial (Magic 2014).

2.1.2 Composition of Tool Steel

The AISI again provides a useful grading system in their T and M series for high speed steels. The alloying elements added to the Fe-C system to create high speed steels include tungsten, molybdenum, chromium and, for specific applications, cobalt (Kundor et al. 2016).

Tungsten and molybdenum behave in the same manner by promoting red hardness and wear resistance. It is noted that the cutting performance of the steels increases in a linear manner as the percentage of either element increases. Molybdenum may be used to replace tungsten at the rate of around 1wt. % for every 1.6-2.0 wt. % of tungsten (Kundor et al. 2016).

Addition of 4% chromium is made to all high speed steels with the prime purpose of promoting depth hardening. The chromium in annealed steel is present in the form of carbide which dissolves into the austenite during the hardening cycle and hence becomes one of the primary sources of martensite in the quenched and tempered tool. Chromium is the absence of large quantities of retained austenite sharply retards the rate of softening in these steels, but in itself does not produce a true secondary hardening peak (Kundor et al. 2016).

This element is always present to a minimum of 1 wt. % and generally up to 2 wt. % or 3 wt. %. It can be higher in very highly alloyed grades. Vanadium forms extremely stable carbides such as VC or V_4C_3, which are virtually insoluble at normal hardening temperatures, and thus create a very effective means of limiting grain growth. The fact that the austenitizing temperatures encountered in the treatment of all high speed steels approaches the solidus means that the retention of these complex vanadium carbides

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dispersed in the austenite matrix as it approaches the melting point restricts grain growth, which would otherwise be quite disastrous (Kundor et al. 2016).

Cobalt is optional as an alloy addition, being present in only a few of the super grades up to about 10 wt. % maximum, although few special steels have higher additions. The addition of cobalt can raise the hardness by as much as 60HV, depending on the specific grade of steel. Its prime purpose is to promote red hardness, which it does, however, at the expense of impact strength (Kundor et al. 2016).

As in all tool steels, carbon is essential to the hardenability of steel. Also, it is evident that, as the wearing properties and high hot hardness depend on the presence of massive amounts of complex alloy carbides, carbon is of prime importance. The Figure 1 shows that the carbon content of the eutectoid is reduced to a very marked extent by additions of W, Mo and Cr and therefore we expect in most high speed steels the actual eutectoid composition to be around 0.4 wt. % of carbon. The usual carbon range for high speed steels is 0.65-1.5 wt. %, of which about 30 wt. % is dissolved in the matrix. The hardness on the finished product increases rapidly up to about 1.0 wt. % carbon. The higher carbon grades show a fairly marked fall off in ductility (Kundor et al. 2016). Figure 2.1 shows graph the alloying elements bertween Eutectoid composition.

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