QUALITY IMPROVEMENT OF Al MACHINING UNDER CNC AUTOMATED COOLANT SUPPLY

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This report is submitted in accordance with requirement of the University Teknikal Malaysia Melaka (UTeM) for Bachelor Degree of Manufacturing Engineering

by

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Saya **AISYAH BINTI JAMRI (951111-04-5548)**

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APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of Universiti Teknikal Malaysia Melaka as a partial fulfillment of the requirement for Degree of Manufacturing Engineering (Hons). The member of the supervisory committee are as follow:

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(Dr. Fairul Azni Bin Jafar)

ABSTRACT

In the manufacturing nowadays there are many methods that have been introduced due to the improvement of the coolant supply used in manufacturing industry. For example, dry cooling technique, high pressure cooling technique, wet cooling technique, mist cooling technique and minimal quality lubricant technique. The dry machining and wet machining both give a bad impact to the industrial workplace. Thus, the technique of minimum quantity lubricant (MQL) technique is introduced to overcome these problem. Therefore, the idea of this project is come from the MQL method that use minimal quantity of the cutting fluid but the coolant supply is to be controlled by using Programmable Logic Control (PLC) which is able to control the duration time for coolant supply during the machining process. The PLC program should be constructed where the duration of the coolant supply must be insert and controlled by the ladder diagram which have been controlled by using the nozzle. The experiment are conducted for flooded and non flooded coolant using the same interval time. The flooded experiment required in order to measure the quantity of the coolant supply during the machining process while the analysis is performed to obtain the optimum duration of coolant supply during the machining process by referring to the workpiece surface quality and the weary of the machining tool. The non flooded technique is used to obtain the optimum feed rate, spindle speed and the depth of cut. The performance of each interval time of coolant supply is analyzed through in term of surface roughness of the workpiece. Therefore, result of this experiment show that the make use of the automated cooling technique is proven for large improvement compared to the conventional cooling supply such as dry cooling technique and the wet cooling technique. Furthermore, the optimum cutting parameter of the spindle speed, feed rate and the depth of cut are also defined.

ABSTRAK

Dalam pembuatan pada masa kini terdapat banyak kaedah yang telah diperkenalkan kerana peningkatan bekalan penyejuk yang digunakan dalam industri perkilangan. Sebagai contoh, teknik penyejukan kering, teknik penyejukan tekanan tinggi, teknik penyejukan basah, teknik penyejukan kabus dan teknik pelincir berkualiti rendah. Pemesinan kering dan pemesinan basah memberi impak buruk kepada tempat kerja industri. Oleh itu, teknik minimum pelincir kuantiti (MQL) teknik diperkenalkan untuk mengatasi masalah ini. Oleh itu, idea projek ini datang dari kaedah MQL yang menggunakan kuantiti minimum cecair pemotongan tetapi bekalan penyejuk dikawal dengan menggunakan Kawalan Logik Programmable (PLC) yang dapat mengawal tempoh masa untuk bekalan penyejuk semasa proses pemesinan. Program PLC perlu dibina di mana tempoh bekalan penyejuk mesti dimasukkan dan dikawal oleh gambarajah tangga yang telah dikawal dengan menggunakan muncung. Percubaan dilakukan untuk penyejuk banjir dan tidak dibanjiri menggunakan waktu selang yang sama. Eksperimen dibanjiri diperlukan untuk mengukur kuantiti bekalan penyejuk semasa proses pemesinan sementara analisis dilakukan untuk mendapatkan tempoh optimum bekalan penyejuk semasa proses pemesinan dengan merujuk kepada kualiti permukaan bahan kerja dan lekapan alat pemesinan. Teknik yang tidak dibanjiri digunakan untuk mendapatkan kadar suapan optimum, kelajuan gelendong dan kedalaman potongan. Prestasi setiap masa selang bekalan penyejuk dianalisis melalui segi kekasaran permukaan bahan kerja. Oleh itu, hasil percubaan ini menunjukkan bahawa penggunaan teknik penyejukan automatik terbukti untuk peningkatan yang lebih besar berbanding bekalan penyejukan konvensional seperti teknik penyejukan kering dan teknik penyejukan basah. Selain itu, parameter memotong optimum kelajuan gelendong, kadar suapan dan kedalaman potongan juga ditentukan.

DEDICATION

This narrative report is lovely dedicate my beloved father, Jamri bin Ahmad my appreciated mother, Lipah bin Marsidi my adored sister , Atiqah binti Jamri for giving me moral support, money, cooperation, encouragement and also understandings . Furthermore, this report also dedicated to the sporting technician which is En Hanafiah, Pn Aisyah, and En Taufiq that willingly help me and guide me to use all the equipment at the faculty lab.Thank You So Much & Love You All Forever

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TABLE OF CONTENT

LIST OF FIGURE

LIST OF TABLE

CHAPTER 1
INTRODUCTION

In this chapter, the project on quality improvement of Aluminium under CNC automatic coolant supply system that include the Programmable Logic Control (PLC) in machining operation is discussed. Next, the conventional method is replace by the automated system of the coolant system at the machine. Moreover, the aims and specified objectives of the project, the scope and the problem statements have been discussed in this chapter.

1.1 Background

From the observation, the most of the industrial manufacturing are seeking for the low production cost, high finishing of the workpiece and surely high efficiency of the machining process. The machining process will produce friction that will lead to the high heat between the workpiece and the machining tool. Furthermore, the surface roughness is increase, whilst dimensional sensitiveness of workpiece is decrease due to generated friction (Cakir et al., 2007) (Boswell and Chandrantilleke, 2009). Cakir et al. (2007) stated that there are some approaches to protect cutting tool from heat. There are many ways such as the uses of coolant are to cool the cutting tool and the workpiece as well as to lubricant them. Furthermore, the coolant is very important for CNC machining to decrease the temperature on the cutting zone

so that the tool life will become longer, high accuracy and lastly the surface quality of the machine workpiece in good condition are achieved. The coolant also can flush away the chip formation during the machining operation, so that the cutting tool will be less weary.

There are four problems occurs at the CNC machining when using the conventional coolant method which is high coolant recycle frequency, increase the production cost and waste, the machine coolant easily contaminated and harmful for the health and environment. The analysis will be focused on the effect of the coolant to the tool wear, depth of cut and the feed rate while using the conventional flooded lubricant compare to the minimal quantity lubricant (MQL).

1.1.1 Dry Machining

Dry machining is a process of metal removal without using coolant. There are many advantages of using the dry machining such as able to complete eliminate the harmful cutting fluid, reduce production cost on the cutting fluid, able to achieve high surface finish with high speed, and the operation time will be reduce. The Engineer (2016) state that Dry machining is becoming more prevalent, in milling especially. In drilling, coolant is required because the tool has prolonged exposure to the material and fluid is essential to evacuate the chips. And dry machining in turning is rare as the cutting edge is constantly in contact with the workpiece, so without some cooling, the cutting edge will eventually fail. Milling is the main beneficiary.

1.1.2 Conventional Wet Lubricant (Wet Cooling)

Conventional wet lubricant used the flooded coolant system during the machining process. From which is better: dry or wet machining? (Andrei Petrilin,2016) stated that cooling mixture Cooling mixture, cutting lubricant, cutting fluid and coolant are common terms that refer to a liquid applied for both cooling and lubricating the tool/workpiece interface while machining. All cutting generates unwelcome friction at that interface. The presence of coolant ensures that the friction between the two surfaces is reduced and lubrication significantly enhances the metal-removal process. The disadvantage of conventional wet lubricant were stated by how it works - dry and near - dry machining (2007). Everybody in the business has used flooded coolant practically forever and knows that it works. They are probably also aware that it has its drawbacks, including The cost of buying, maintaining and disposing of cutting fluid, which is estimated to account for 7 to 17 percent of the cost of machining parts, The need to clean parts after machining and to remove as much fluid as possible from chips before recycling, and Health problems from handling or working around conventional coolants include skin irritation or allergic reactions, asthma, bronchitis and other respiratory difficulties. It's possible that long-term exposure to some coolant additives could lead to cancer.

1.1.3 Minimal Quantity Lubricant Method (MQL)

MQL will decrease the amount of machining fluid to solve the problems from the conventional method. (Xia Ji, 2014) Minimum quantity lubrication (MQL) machining has achieved noticeable attention in both academic and industry research areas due to its minimum costs and maximum environmental protection. This paper (Xia Ji, 2014) focuses on the analysis of the effects of MQL parameters such as the flow rate of lubricant and the air-oil mixture ratio on cutting performances in terms of cutting force, cutting temperature, and residual stress. Additionally, the cutting performances in MQL machining are also

compared with the dry and flood cooling machining. The reduction of the cutting force and cutting temperature is the results from the uses of the cutting fluid. For MQL machining, there is a maximum effective flow rate of lubricant and it is influenced by the cutting speed. When the flow rate of lubricant is beyond the maximum effective value, the air-oil mixture ratio will no longer affect the cutting performances in machining. This research can support the process planning in achieving the desired residual stress profile by strategically adjusting the MQL parameters. Benefits and challenges of minimum quantity lubricant propose that when properly applied, whether externally or through the tool, MQL can lead to improved surface finish and increased tool life (Emily Probst, 2016). It also has a positive impact on emissions and waste, boosting a facility's overall health, safety and environmental profile.

From the three application method by using the MQL method is the best method compare to the dry machining and the conventional wet machining. Therefore in order to complete this project the MQL method will be used. The MQL method gives many advantage to improve the machining operation. The programmable logic controller (PLC) will be used to perform the duration that will be minimized the quantity of the coolant. The aim of this project is to improve the aluminium under CNC automated coolant supply to replace the conventional coolant method.

1.2 Motivation

The aim of this project is about the quality improvement of Aluminium under CNC automated coolant supply system. Therefore, the improvement of the coolant system at the CNC milling machining should be improved by the series of analysis. For the conventional machining, the continues coolant supply that lead to problems such as a large amount of coolant, but only small amount of coolant play their role. Furthermore, from this situation may lead to large amount of the coolant required and directly cause will increase the production cost. Due to these problems the MQL will be applied by using the PLC system to the CNC

machining. The PLC system able to apply the time-base coolant supply, thus the coolant supply to the CNC machining as well as the production cost will reduce. Therefore, the MQL will improve the coolant supply at the CNC machining.

1.3 Problem Statement

Most of the industrial in the world use the CNC machining that can facilitate low process cost, low process time, better surface quality and contribute lower waste. The uses of coolant at the CNC machining to reduce the friction between the workpiece and the cutting tools as well as cool the workpiece and wash away the chips. However there are four major problems that occurs with the use of the wet cooling method. Therefore, the development of the PLC control based on the coolant supply become important. The long use of machining fluid may lead to the decrease in coolant quality. Also, the production cost will increase when the efficiency of the machining coolant is getting lower. Therefore, there are only 10% to 15% of the coolant that play their own role, while the rest of coolant will become waste. Moreover, the cost for recycle machining coolant will be increase due to contaminated or expired of the machining coolant. High recycle of the machining coolant also can affect the quality of the machining coolant itself. The high use of coolant at the CNC machining also able to effect the health of the operator. Thus, in order to reduce the production cost, lower the coolant recycle frequency, reduce the environmental affect and minimize the uses of coolant, the PLC control based on the coolant supply is introduce to eliminate the problems on the CNC machining.

1.4 Objective

The objective of this Quality Improvement of Aluminium under CNC Automated Coolant Supply System project is to know the best interval time for the coolant supply at the milling machine .

i. To analyse the performance of the develop system in term of surface roughness and tool wear to identify the best interval time for coolant supply.
ii. To study the quantity of the coolant that can affect the surface roughness of the workpiece and the weary of the machining tool.

1.5 Scope

The scope of this project are :

i. The Programmable Logic Control (PLC) will be use in the operation system.
ii. The CNC milling machine will be used
iii. The used of the tool with 10mm high speed steel
iv. There are setting of several of fixed variables include such as 250mm/s feed rate, 1500rpm of the spindle speed and the cutting depth of the workpiece was 0.5mm.

1.6 Report Structure

The whole of this report consist of five key chapter which is introduction as chapter 1, literature review as chapter 2, methodology as chapter 3, discussion as chapter 4 and lastly for conclusion as chapter 5. For the chapter 1, all the discussion include the introduction or preview for the whole chapter. Therefore, the content on this chapter is the background, motivation, problems statement, objective, scope and the report structure. The guideline on this project is from the objective stated.

Next, for the chapter 2 which is literature review will covered the research that have been collected such as from newspaper, journal, and online information. Thus, this chapter will involve research fining related to this project. The benefit of using the PLC system at the CNC machining will be discuss in this chapter. The comparison between the five type of coolant method undergone and the best coolant system which is MQL has been selected to proceed this project.

For the chapter 3 that is methodology will discuss about the process flow of this project base on the problem statement and to achieve the objective of this project. The flow chart use to discuss about the process flow of this project such as flow chart of the process planning, detail design, and development. This method on explaining the flow of this project will improve the understanding of this project

Chapter 4 contains the software development which include the details of the ladder diagram. The testing on the loaded and unloaded system will be analyse as well as the tool wear, feed rate and the depth of cut.