UNIVERSITI TEKNIKAL MALAYSIA MELAKA

INVESTIGATION ON DESIGNED JIG FOR NOZZLE POSITIONING OF AUTOMATED COOLANT SUPPLY SYSTEM

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

by

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DECLARATION

I hereby, declared this report entitled "Investigation on Designed Jig for Nozzle Positioning of Automated Coolant Supply System" is the results of my own research except as cited in reference.

Signature :

Author's Name : SITI NURSYAFIQAH BINTI MOHAMED TALMIZI

Date : 28th August 2020

APPROVAL

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

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ABSTRAK

Haba yang tinggi daripada geseran menyebabkan mata alat menjadi tumpul dan menghasilkan kemasan yang kurang elok pada alat kerja. Oleh itu, sistem penyejuk diperkenalkan untuk mengurangkan haba pada alat kerja, mengurangkan haus pada mata alat dan memperbaiki kemasan pada alat. Namun yang demikian, penyejuk juga mengakibatkan pencemaran pada persekitaran dan memberi kesan kepada kesihatan. Sebuah sistem pembekal penyejuk automatik telah dimajukan untuk mengurangkan pencemaran dan masalah kesihatan dengan menggunakan sistem pembekal penyejuk automatik. Sistem tersebut perlu diuji dari segi kedudukan injap untuk mendapatkan prestasi yang optimum. Sebuah aci dibina kerana kajian terdahulu tidak menggunakan aci dan hanya menganggarkan kedudukan injap sahaja tanpa memperolehinya secara tepat. Lantaran itu sistem penyejuk ini perlu diperbaharui dengan memajukan aci untuk memegang injap dengan lebih tepat. Pertama, aci dilukis dan dianalisa menggunakan simulasi untuk menguji tekanan dan regangan pada aci yang telah dilukis. Aci direka menggunakan perisian rekabentuk 'SolidWork'. Dimensi dan spesifikasi rekabentuk aci tersebut diilhamkan daripada kajian terdahulu. Rekabentuk aci ini mengambil kira sudut posisi untuk setiap 15°, jarak semburan yang boleh dilaraskan dan juga sudut kecenderungan semburan. Bagi membuktikan projek ini, tiga daya yang berbeza telah dirancang untuk dikenakan pada lokasi yang berbeza pada rekabentuk aci untuk menguji tekanan dan regangan yang maksimum yang dapat ditahan oleh rekabentuk aci. Selepas itu, kesemua daya dikenakan pada rekabentuk aci dalam masa serentak. Keputusan daripada simulasi menunjukkan rekabentuk aci yang dilukis dapat menahan daya yang dikenakan ke atas rekabentuk aci tanpa mengubah bentuk aci tersebut. Oleh itu, aci tersebut boleh dimajukan dan digunakan semasa pemesinan alat kerja menggunakan sistem pembekal penyejuk automatik yang telah dimajukan.

ABSTRACT

The increasing heat due to friction causes the cutter becomes blunt and poor surface finish on the workpiece. Therefore, coolant system is introduced to remove excess heat at the workpiece, decrease tool wear and improved surface. Nevertheless, the coolant causes pollution to the environment and causes health problems to the workers. An automatic coolant supply system has been developed to reduce the pollution and health problem by using the automatic coolant supply system. In order to obtain an optimum performance, the system needs to be tested in term of nozzle positioning. A jig is designed as the previous research is used without any application of jig; therefore the nozzle positioning is only estimated and not accurately obtained. That is why the coolant system needs to be improved by developing a jig to accurately hold the nozzle. The jig is first designed and then analyzed through simulation to test on the stress and strain of the designed jig. A jig is design using SolidWork design software. The dimension and specifications of the designed jig is inspired from previous study. The design of the jig is considering the positioning angle for every 15°, adjustable spraying distance as well as inclination angle of the spraying in order to identify the best angle for the nozzle positioning, as well as inclination angle and the nozzle distance from the workpiece. To justify the project, 3 different forces designed to be acted on different locations on the designed jig to test the maximum stress and strain that the designed jig can withstand. Then, all 3 forces are acted simultaneously on the designed jig. The result from the simulation shows that the designed jig can withstand the load acted on it without facing deformation. Therefore, the designed jig can be developed and used during machining workpiece using the previously developed automatic coolant supply system.

DEDICATION

My respected father, Mohamed Talmizi Bin Mohamed Yusoff

My beloved mother, Rohana Binti Mat Yaacob

My adored siblings, Nabilah, Nazirah and Naqiuddin

For endless support, cooperation, encouragement and understanding

Thank You from the bottom of my heart and Love You forever

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LIST OF ABBREVIATIONS

CNC	-	Computer Numerical Control
MQL	-	Minimal Quantity Lubrication
PLC	-	Programmable Logic Control
ACS	-	Automated Coolant System
3D	-	3 Dimension
ABS	-	Acrylonitrile Butadiene Styrene

LIST OF SYSMBOLS

ml	-	Milliliter
min	-	Minute
l	-	Liter
kPa	-	Kilo Pascal
rpm	-	Revolution Per Minute
mm	-	Millimeter
Ra	-	Surface Roughness
°	-	Degree
kg	-	kilogram
GPa	-	Giga Pascal
MPa	-	Mega Pascal
W	-	Watt
C	-	Celsius
J	-	Joule
N	-	Newton

CHAPTER 1
INTRODUCTION

In this chapter, Computer Numerical Control (CNC) machining is explained briefly which includes 3 different techniques of coolant system. Problem statement that brings to the introduction of Automated Coolant Supply system is also discussed in this chapter. Objectives and scopes throughout this project are explained.

1.1 Background

Nowadays, current manufacturing industry stresses more on producing low price, high efficiency and great quality of product. To increase the flexibility of the machine in handling various materials, CNC concept was used to develop a CNC machining. CNC milling machine is the machine which removes material by drilling in the form of small chips to create the desired shape and introduce it wisely into the production environment. Milling is the process by which the cutting tool is moved to the workpiece and removed by controlling the cutting feed, cutting speed, spindle speed, feed rate, axial cutting depth and radial cutting depth. The increase in heat due to friction and energy loss can make the cutter becomes blunt and affecting high power consumption and poor surface finishing. Dhar and Kamruzzaman (2007) stated that the increase in temperature leads to accelerated wear and surface quality degradation. Mia and Dhar (2015) added that when coolant is used, it will decrease tool wear, sustained tool life, improved surface finish and reduce cutting temperature. Therefore, coolant system is important to keep a system from overheating and to remove excess heat at the workpieces.

Commonly used coolant are cutting oils and cutting fluid. Cutting fluid can avoid the interface between cutting tool and the chip of the workpiece as it can prevent heat friction at the interface. 85% of cutting fluids used around the world is petroleum-based oils. Though cutting fluids brings benefits to the machining process, it also has downfall which create negative effects on health and environment. Shashidhara & Jayaram (2010) indicated that about 80% of all employees ' work-related infections were due to contact with cutting liquids. Based on Ozcelik et al. (2011), continuous used of poisonous and non-biodegradable cutting fluids can cause severe health problems like respiratory infections, lung cancer, dermatological and inherent diseases. Special treatment need to be taken in action to extracted the hazardous chemicals in cutting fluids before it is disposed. Inappropriate storage and disposal of cutting fluids will bring undesirable impact on the environment.

Considering the bad impact cutting fluids to health and environment, various methods are used to minimize the usage of cutting fluids such as minimal quantity lubrication (MQL), dry machining and conventional flood lubrication (wet cooling). These methods are evaluated regarding the tool wear, temperature deviation, surface roughness, depth of cut and the amount of coolant system.

Minimal Quantity Lubrication (MQL) as shown in Figure 1.1 is an environmental friendly and economically beneficial method as stated by Jayal et al. (2009). MQL method used aerosol concept which are mixing small amount of cutting fluids and air, then sprayed on the cutting zone using nozzle as (Varadharajan et al. 1999) indicated. The usage of MQL method can reduce significant amount of cutting fluids consumption, minimizes cost, improved machining operation performances as well as reducing negative impact towards environment. MQL method delivers better performance rather than dry or wet machining. This is supported by Li & Lin (2012) that MQL effectively improve tool lifetime and lessen surface roughness.

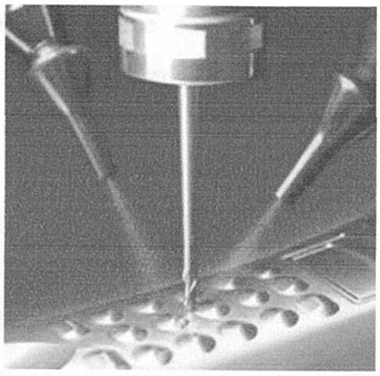

Figure 1.1: Minimal Quantity Lubrication (MQL) (Source : http://www.fuji-bc.com/english/e_mql/minimum_quantity_Lubrication.html)

Dry machining shown in Figure 1.2 is a machining process that involved none coolant application during CNC milling nor drilling process. Dry machining is controlled by the machine speed and carbide coated tool. Over the time, the tool become tougher because of the carbide's characteristics and reduces tool wear. This method has no contamination towards environment and risks to health as there are no cutting fluids used. However, the tool will become overheat as stated by Diniz et al. (2002), the high friction between tool and workpiece increased the temperature as well as causing oxidation and abrasion.

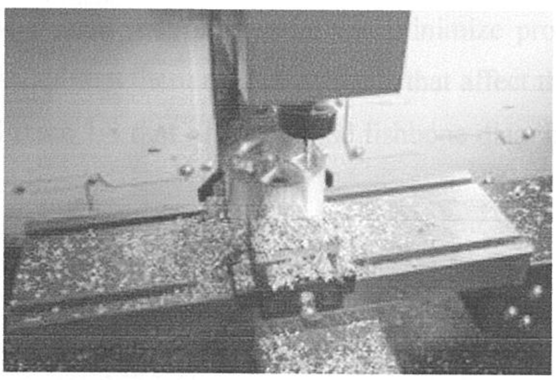

Figure 1.2: Dry Machining (Source : http://coolclean.com/2013/05/14/dry-machining/)

Conventional flood lubrication (wet cooling) as shown in Figure 1.3 is commonly used method in CNC machine as it provides a steady flow of cutting fluids to the workpiece which causes heat reduction, removing the chip away from the workpiece and supplies lubrication to avoid corrosion. However, Imran et al. (2013) found that excessive or large amount of cutting fluids directly supplied to the workpiece can affect the workpieces' surface roughness. Moreover, conventional flood lubrication causes abundant waste of cutting fluids that leads to higher expenditures.

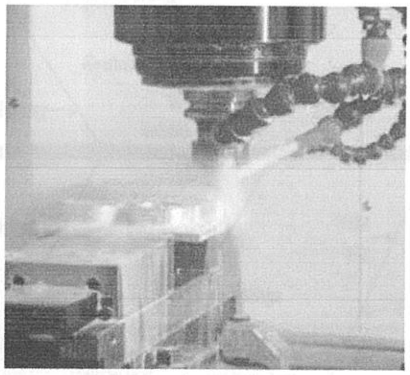

Figure 1.3: Conventional Flood Lubrication (Wet Cooling)
(Source : https://en.wikipedia.org/wiki/Cutting_fluid)

Between these three methods, Minimal Quantity Lubrication (MQL) application is used as the based and references of this project. As highlighted by Unist (2012), after the execution of MQL concept, Ford saw a decreasing of 13% in overall costs. It has something to do with the fact that MQL used cutting fluid in the form of mist compared to flooding the workpiece. Indirectly, MQL can reduce wastage and minimize production costs. However, Upandhay et al. (2012) stated that there are many issues that affect the surface roughness of a workpiece as shown in Figure 1.4 that illustrated the fishbone diagram for cause and effect in MQL assisted machining.

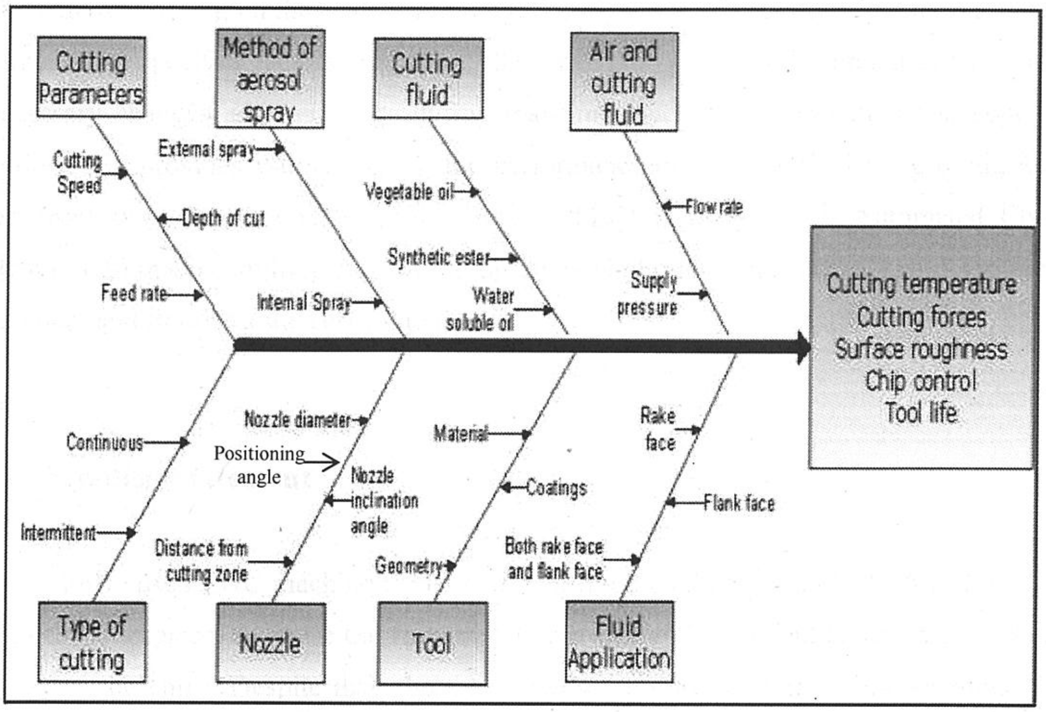

Figure 1.4 Fishbone Diagram

(Source: Upandhay et al. 2012)

Based on Figure 1.4, there are many factors that affect the surface finish of a workpiece such as cutting parameters, cutting fluid, type of cutting, nozzle and many others. Out of other main causes, nozzle factor is mainly focused in this report. Although research regarding the effects of nozzle diameter and distance from cutting zone on the surface roughness had been conducted by previous works of researchers, as far as it is concern, research work regarding the positioning (angle and distance) of nozzle has not been actively studied yet. In this project, nozzle inclination angle, nozzle distance from cutting zone, nozzle positioning angle (nozzle spraying form left, right, front or back of the cutting zone) is focused by developing a jig to obtain a better cutting performance (surface roughness, temperature, force and so on) on the workpiece. It is believe that different parameters of nozzle inclination angle, nozzle distance from cutting zone and nozzle positioning angle gives different effects on the workpiece. After all, the quality of the workpiece is what matters most in machining.

The goal in conducting this project is to develop a jig for nozzle positioning of Automated Coolant Supply (ACS) system. The jig design undergoes stress and strain analysis