UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT AND OPTIMIZATION OF PORTABLE VACUUM CLAMPING

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

by

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I hereby, declared this report entitled Development and Optimization of Portable Vacuum Clamping 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 Manufacturing Engineering Technology (Process And Technology) with Honours. The member of the supervisory is as follow:

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(Dr. Norfariza Binti Ab Wahab)

ABSTRACT

Manufacturing and workshop practices have become important in the industrial environment to produce products for the service of mankind. Clamping on milling machine usually use tools and holding device such as vise, magnetic and vacuum to clamp the workpiece. On this thesis, it is focused on clamping by using vacuum concepts. The purpose of this project is to develop and optimize the portable vacuum clamping. The method is to develop a concept design by using CATIA V5 and optimize it to apply the vacuum clamping method on the milling machine. Then, the development and fabrication of this product by using advance machining which was DMG Mori 5 Axis CNC milling machine. After this product was done fabricated, a selected test was undergo on the vacuum clamping to evaluate and experiment the result of the product. The result shows that vacuum clamping has better surface roughness result which is total of 1.696μm and the result for recommended depth of cut was 0.2mm. As a conclusion, all the various result of the analysis was taken and vacuum clamping can be able to apply and used for teaching purpose but there also some of limitation and suggestion that need to works out on future research.

ABSTRAK

Amalan pembuatan dan bengkel telah menjadi penting dalam persekitaran perindustrian untuk menghasilkan produk untuk perkhidmatan manusia. Pengapit pada mesin penggilingan biasanya menggunakan alat dan memegang peranti seperti ragum, magnetik dan vakum untuk mengapit benda kerja. Pada tesis ini, ia memberi tumpuan kepada pengapit dengan menggunakan konsep vakum. Tujuan projek ini adalah untuk membangunkan dan mengoptimumkan pengapit vakum mudah alih. Kaedah ini adalah untuk membangunkan reka bentuk konsep dengan menggunakan CATIA V5 dan mengoptimumkannya untuk menggunakan kaedah pengapit vakum pada mesin penggilingan. Kemudian, pembangunan dan fabrikasi produk ini dengan menggunakan pemesinan awal yang merupakan mesin penggilingan DMG Mori 5 Axis CNC. Selepas produk ini dibuat, satu ujian terpilih menjalani pengapit vakum untuk menilai dan mencuba keputusan produk. Hasilnya menunjukkan bahawa pengapit vakum mempunyai hasil kekasaran permukaan yang lebih baik iaitu jumlah 1.696μm dan keputusan untuk kedalaman yang dicadangkan adalah 0.2mm. Sebagai kesimpulan, semua pelbagai hasil analisa telah diambil dan pengapit vakum boleh digunakan dan digunakan untuk tujuan pengajaran tetapi terdapat juga beberapa batasan dan cadangan yang perlu dilakukan untuk penyelidikan masa depan.

DEDICATION

As a token of appreciation, I dedicate this thesis to both of my parents, Mr. **Abdul Rahman Bin Hj Sidek** and Mrs. **Huzaimah Bt Abdul Rashid** whose word of encouragement and always give positive vibes whenever me in depress and not to forget all my siblings that always support and give encouragement to proceed with thesis. I also dedicate my dissertation to all my friends that support and contributed some of the ideas for this research. Thank you for everything. Lot of love my family-rangers.

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Besides, not to forget technician who always help me solve some of the problem while doing my thesis who are Mr Azimin, Mr Zulkifli, Mr Hisyam, Mr Basri and all JTKP technician.

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CHAPTER 1
INTRODUCTION

1.1 Background

A vacuum is the state in a space which is free of matter. In practice, we already call it a vacuum when the air pressure in a space is less than that of the atmosphere.

Vacuum clamping is one of the new clamping method in recent years. Vacuum clamping systems can used in the wood, plastics and non-ferrous metals industries for quick, simple machining. They can be compatible with CNC machine tools or conventional machines. Vacuum technology is used in connection with special handling systems for example in order to fix an aluminium plates and machine it from all sides. This increases productivity and cost-effectiveness. The fixing does not cause any damage to the workpiece and no laborious. The latest clamping systems allow attachments of the various sizes and shapes to be exchange in a very short time, thus facilitating flexible handling of a wide range of workpiece shapes.

In vacuum clamping, an underpressure is generated under the workpiece being clamped, i.e. a pressure is differential is created which presses the workpiece against the clamping plate.

There are a few advantages in using vacuum clamping such as high holding forces, low compressed air consumption and low operating method. With all these advantages, vacuum clamp could be the best clamping method for milling machine.

1.2 Problem Statement

In milling machine, fixtures system is very important to hold, support, and clamp workpiece during machining but there are several problem in using clamp in milling machine. Firstly there is no default shape material that can be apply as default vise for conventional milling machine. Second, there is no exact value of force for clamping material during machining. Too much force acting on workpiece may damage the workpiece especially for soft material. Beside that, there can cause incident for safety issue if wrongly control the machine. Colliding with the vise can cause damage to the cutting tools and also dangerous to the operator. Lastly, the time taken for initial setup each operation of milling machine . The clamping process alone take too much time in whole milling cutting process operation.

1.3 Objectives

The project objective that have been determined are:

1. To modify the vacuum clamping method for milling machine
2. To optimize the design of the vacuum clamping
3. To analyze the result of vaccum clamping in the term of surface roughness with current clamping jig.

1.4 Project Scope

Scopes for this project is based on objectives that have stated and there are the several scopes that will be carrying out :

1. Design of the improvement vacuum clamping is based on conventional milling machine at JTKP laboratory
2. Material that will be used for vacuum clamping are tool steel, mild steel, and aluminium

3. The result of surface roughness will be conducted to evaluate the result of vacuum clamping

CHAPTER 2
LITERATURE REVIEW

2.1 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 can help to giving a relevance research for a particular topic. This chapter is consist of machining process, milling process, clamping method and effect of cutting parameter

2.2 Machining Process

Machining is manufacturing process of removing the undesired or unwanted material from the workpiece or job or component to produce required shape using cutting tool. This can be done by manual process or by using machine called machine tool (Singh, 2006). Most of the engineering components such as gears, bearings, clutches, tools, screws and nuts required dimensional and form accuracy and good surface finish designed for serving their purposes. Machining process allocated into three process which is turning, milling and drilling. There are others process such as broaching, boring, sawing and shaping that involved under group of miscellaneous.

Turning process is a machining process and used to produce round parts in figure by on its own point cutting tool. Materials are detached by traversing in a route parallel to the axis of rotation of axis or along specified path to form complex rotational figure. The tool is served either linearly in parallel path or perpendicular to the axis of rotation (A.B.Chattopadhyay, 2011).

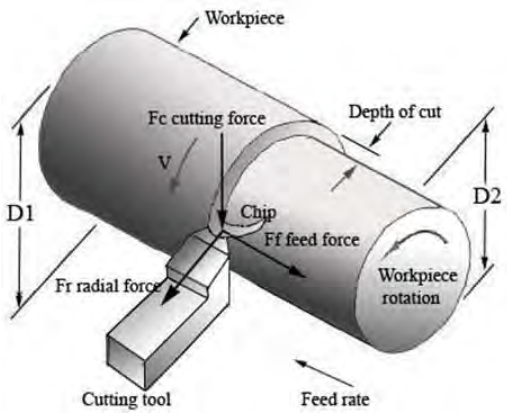

Figure 2.1 Turning process [retrieved from http://article.sciencepublishinggroup.com/html/10.11648.j.ijmea.20160403.12.html]

Milling is the method of machining horizontal, arched, or unequal edges by nourishing the workpiece in contrast to spinning cutter covering a figure of cutting sides. The typical mill contains mostly of motor-powered driven spindle, which stands and rotations the milling cutter, and reciprocating adjustable workbench, which stands and feeds the workpiece.

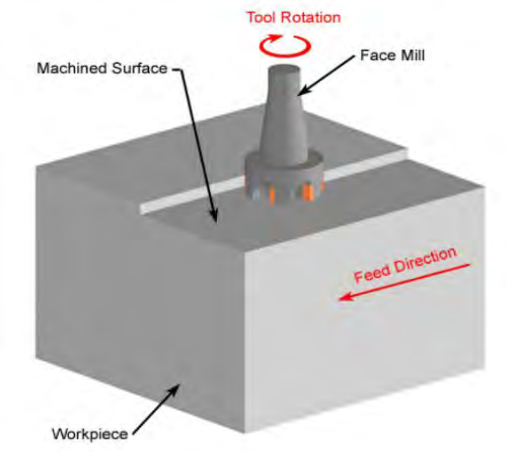

Figure 2.2 Milling process [retrieved from http://www.custompartnet.com/wu/milling]

Drilling is a process of creating a rounded hole by way of eliminating a volume of metal from the work by cutting instrument called drill. A drill is a rotating end-cutting instrument by single or additional cutting lips and typically one or more flutes for the passage of chips and the admission of cutting fluid. A drilling machine is a mechanism tool created for drilling holes in metals. It is one of the record important and versatile machine gears in a factory. In addition drilling curved holes, a lot of other processes can also be completed on the drilling machine such as counter- boring, countersinking, sharpening, reaming, and lapping (Singh, 2006).

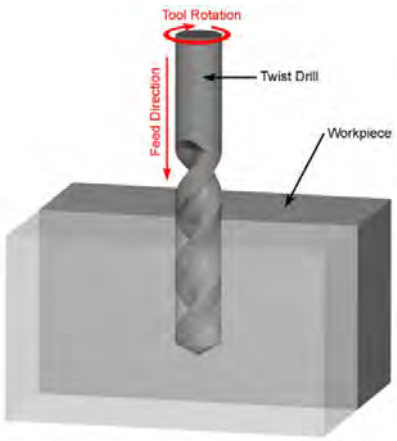

Figure 2.3 Drilling process [retrieved from http://www.custompartnet.com/wu/drilling]

2.2.1 Conventional machining process

Conventional Machining Methods frequently eliminate material in the technique of chips by put on forces on the workpiece through a section formed cutting device that is stiffer than the workpiece under machining situation.

Conventional machining needs a instrument that is tougher than the workpiece that is to be machine. This device penetrates into the workpiece intended for a certain depth of cut. A relative motion between the tool and workpiece is responsible for form and generation cutting to produce the required shape, dimensions, and surface quality. Such a machining arrangement includes all machining by cutting and mechanical abrasion processes. The absence of tool hardness or contact with the workpiece makes the process traditional (Hassan Abdel-Gawad El-Hofy, 2014).

2.2.2 Advanced machining process

Advanced manufacturing processes is defined as a group of processes that remove excess material by various techniques involving mechanical, thermal, electrical or chemical energy or combinations of these energies but do not use a sharp cutting tools as it needs to be used for traditional manufacturing processes.

The application of nontraditional machining (NTM) methods has paved the way for new developments in machining hard to-machine and advanced materials, both now and in the future. The use of these NTM processes is increasingly requested on the shop floor (Chakladar and Chakraborty, 2008).

Usages of non-traditional machining processes are rapidly increasing together with increases in demand and usage of high strength, temperature resistant and complex materials. Due to their advantages such as cutting speed, surface quality and economizing, they became a vital process of manufacturing. Because of the conflicting criteria, the selections of appropriate non-traditional machining process highly require usage of multi criteria decision making methods (Temuçin et al., 2013).

2.3 Milling Machine

Milling machines come in a wide variety of types such as universal, horizontal, vertical and drum. Each of these have their own unique features and used for various operations. In milling machine, there are many process parameters like spindle speed, feed rate, depth of cut, coolant, tool geometry etc. which affected on required quality parameters (Patel, 2015). The main advantage of the milling machine is that it can be used to perform literally any operation with a great degree of accuracy and hence it is an indispensable machine for any workshop.

Some advantages of this technique include lower machining forces, better penetration of lubricant into cutting zone, lower cutting temperature, higher tool life, higher machining accuracy, improvement of surface quality, burrs of lower height, and better chip formation (Janghorbanian et al., 2013)

2.3.1 Methods of Milling

There are various type of method that can be use in milling. Each of these method apply different specifications and functions. Given below are show a few of the most commonly used milling methods in the manufacturing industry.

- **Single piece milling** is method that used for milling single job work which is held on the milling machine. It is important to note that the piece has to be worked in a single machine cycle for it to be classified under this category of milling methods.
- **String milling** is quite similar to single piece milling but the only difference being that instead of single piece there are several parts which is simultaneously fixed and are worked upon.
- **Index milling** refers to a special kind of milling operation wherein the machine is set to perform identical operations on work piece. Each of these identical operations is performed one after the other by indexing the work piece into a new position. A very