Faculty of Mechanical and Manufacturing Engineering Technology

EFFECT OF SINGLE SELF CONTAINED DUAL VACUUM CLAMPING ON ACRYLICS END MILLING PERFORMANCE

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ABSTRACT

Clamping in workshop practice usually use tools and holding devices such as a vice to clamp the workpiece. Hence, thin wall components have always been a challenging problem due to the low stiffness of work parts during machining. Therefore, the right selection of vice is important to obtain the desired performance due to machining. In this study aims to relate the research literature review by providing the new experimental results based on a measurement of the process consist of the response of machining parameters in terms of thrust force and surface roughness. Experiments were carried out on acrylic towards endmill machining with chosen cutting parameters. Furthermore, the analysis was carried out in achieving thrust force by a dynamometer and good surface roughness for the influence of process parameters on the suction vacuum clamp during machining. Cutting tool 2 flutes of 3mm diameter were chosen in these experiments to study the superior surface quality to the acrylic material at the velocity of cutting tool speed during machining in surface roughness analysis. The result shows that vacuum clamping has better surface roughness result with the average of surface analysis is 0.585μm for continuously pressure (CP) method and 0.663μm for remain pressure (RP) method. As a conclusion, all the various result and data is taken from experiments conducted against vacuum clamping to the machining performances.

ABSTRAK

Pengepit dalam amalan bengkel biasanya menggunakan alat dan pemegang peranti seperti vise untuk mengepit bahan kerja. Oleh itu, komponen yang berketebalan nipis sentiasa menjadi masalah yang mencabar kerana ketahanan yang rendah pada bahagian bahan kerja semasa pemesinan. Oleh itu, pemilihan vise yang betul adalah penting untuk mendapatkan prestasi yang diingini ketika pemesinan. Dalam kajian ini bertujuan untuk mengaitkan kajian kesusasteraan sebelum ini dengan memberikan hasil eksperimen yang terkini berdasarkan respon proses pengukuran parameter yang sistematik dari segi daya pemotongan dan kekasaran permukaan. Eksperimen dijalankan pada akrilik terhadap pemesinan *'endmill'* dengan pemotongan parameter yang dipilih. Tambahan pula, analisis telah dijalankan untuk mencapai daya pemotongan oleh dinamometer dan kekasaran permukaan yang baik bagi mengkaji pengaruh proses parameter pada sedutan pengapit vakum semasa pemesinan. Alat pemotongan 2 flutes diameter 3mm telah dipilih dalam eksperimen ini untuk mengkaji kualiti permukaan pada bahan akrilik pada kelajuan halaju alat pemotong semasa pemesinan dalam ujian kekasaran permukaan. Hasilnya menunjukkan bahawa pengepit vakum mempunyai hasil kekasaran permukaan yang lebih baik dengan menghasilkan analisis purata permukaan 0.585μm untuk kaedah tekanan masuk (CP) dan 0.663μm kaedah tanpa tekanan (RP). Sebagai kesimpulan, semua pelbagai hasil dan data diambil dari eksperimen yang dijalankan terhadap pengepit vakum dari persembahan pemesinan.

DEDICATION

To my beloved parents

Mohd Apandi bin Abdul Rahman

Wan Noor Aini Bt Wan Ahmad

To my beloved siblings

Muhamad Shahin Fathi Bin Mohd Apandi

Nur Sharah Salsabila Bt Mohd Apandi

Muhamad Syamil Sabil Bin Mohd Apandi

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LIST OF SYMBOLS

Vc	-	Cutting speed
S	-	Spindle speed
D	-	Tool Diameter
CNC	-	Computer Numerical Control
FPT	-	Feed per tooth
N	-	Number of tooth of flute
F	-	Feed rate
CP	-	Continuously Pressure
RP	-	Remain Pressure

CHAPTER 1

INTRODUCTION

1.1 Introduction

Generally, the manufacturing process is the process of machining especially for sheet metal parts. In machining, there are various axis been operated to improve the undesired workpiece shape by produce the required shape using a cutting tool device. This problem can be done by a manual process or machining but it has to use clamp devices to hold the workpiece before machining is operated. Other than that, in this project have calibrated with industry Kurnia Al Rizq from Johor. Technical part and all details vacuum clamper system is come from them while all the vacuum clamper testing experiment were obtained by this project. This chapter will discuss about the overall of flow of the project consists of project background, problem statement, objectives, project scope and project significance.

1.2 Project background

A milling machine is the flexible conventional machine tools with extensive metal cutting capabilities. Milling includes various types of operations and machines, based on the scale from small individual parts to large and heavy grinding operations. This is one of the most usually used processes for specialized parts machining with accurate and tolerance. Many complicated operations such as indexing, straddle milling and gang milling can be done on milling machines. Milling is additionally a machining process utilizing a rotary cutter to remove material from the workpiece by moving the cutter into the workpiece in a certain direction. The cutter can withal be held at an angle relative to the axis of the

implement. In technology nowdays, machines have the capability to machine up to five axes compared conventional clamping.

With the unique features of vacuum clamps, it can increase the productivity and efficiency of material clamper on machine milling. These vacuum clamps usually use pneumatic suction to hold materials or workpieces during machining. Vacuum clamping systems are used for wood, plastics and non-ferrous metals. Vacuum clamper compatible with CNC machine tools. Here vacuum technology is used in connection with special handling systems. Then, the sliding force of the workpiece depends on its surface structure, the pressure differential and the area on which the vacuum acts. Vacuum clamper can increase productivity and cost-effectiveness. The fixing does not cause any damage to the workpiece, and no laborious, time-consuming aligning of the workpiece is required

Portable vacuum clamping was developed by Bachelor of FTK student's cohort 3, and then continued for this final year project as dual vacuum clamper. Among the objectives of this project is to improve the holding mechanism and functionality of a vacuum clamper. The mechanism of previous clamping has change in terms of design from round shape to square block, material of surfaces mounted block from metal material to the lightweight delrin material. While irregularities in the workpiece surface are compensated for by the sealing cord change to silicon rubber. Aside, method of vacuum clamper also was improved which direct continuously pressure from compressor to two method vacuum clamper which is continoulsy pressure and remain pressure.

The previously designed portable vacuum clamp has been preserved in spiral round shape. The portable vacuum clamper is continuously pressure which direct air pressure from compressor. Besides that, this portable vacuum clamp was designed with has grooves and one suction points on its upper side. By inserting the sealing cord, one or more fields can be

defined for the desired workpiece size. Suction points are interconnected. Lateral grooves or fastening holes allow the vacuum clamping plate to be fastened to a baseplate.

1.3 Problem statement

This project is focusing on effect of single self-contained dual vacuum clamper on acrylic end mill process. Based on the previous research of vacuum clamper, it found that the vacuum system is not suitable as the portable because heavy and not efficiency to setup because too much step to setup on macine which using tool devices on the left and the right base plate clamping. Then, that need to carry vacuum pump everywhere when needed in operation. To overcome this problem, the dual vacuum clamping system was improve by previous clamping with design and develop top and bottom side clamper by delrin material without vacuum pump to become portable. This new develop vacuum clamper also is lightweight and more efficiency to setup.

Irregularities in the workpiece surface are compensated for by the sealing cord on portable vacuum clamping is not suitable to clamp for soft material. Sealing cord by previous clamping was imporoved to silicon rubber on dual vacuum clamper to become more elastic and can clamp various material compared to previous clamper which only can clamp metal material. Advantages of silicon rubber is it can grip the workpiece according to various surface roughness material.

Additionally, experiment outcome by previous clamping project was focuses on surface roughness and various depth of cut only by 3 different thickness of mild steel testing on the vacuum clamper experiment testing. Meanwhile, in this project was improved to more emphasis of experiment analysis in terms of surface roughness and thrust force to two method vacuum clamper with continuously pressure and remain pressure towards constant parameter end mill process. In milling process, thrust force analysis are related using

dynamometer kistler type 9257BA to the axes of motion of the machine. An end milling process consists of a cylindrical cutter that has multiple cutting edges on both its periphery and its tip, permitting end cutting and peripheral cutting. These cutting edges or flutes are usually made helical to reduce the impact that occurs when each flute engages the workpiece. Lastly, surface roughness analysis data was maintain likely previous research vacuum clamper project to measure the quality surface of material testing when using vacuum clamper on machining performances.

1.4 Objective

In this objective are optimize the output of experiment to prove in result as follows:

i. To develop an experiment of new design dual vacuum clamping during the machining process.

ii. To analyse the thrust force of the dual vacuum clamper that presents as a function of machining performance on acrylic sheet in 15 minutes.

iii. To analyse the average surface roughness as function of machining performances after finished machining.

1.5 Scopes of work

The research project will focus primarily on the dual vacuum clamping by two methods consist of continuously pressure and remain pressure towards machining performances to observe the thrust forces on the acrylic effect through end mill process. After that, to measure the surface acrylic to observe the roughness of material sheet which using dual vacuum clamper towards machining performances. Thrust force will be measured using dynamometer type 9257BA while surface roughness will be calibrating by feed

direction on the surface roughness Mitutoyo SJ-410. All the experimental will be using constant parameter on the CNC machine within 15minutes. Both methods will be testing in same process by different method to analyze the effect of single self-contained dual vacuum clamper towards machining performances. This system is using multiple parts to generate the air suction on the vacuum clamper which generated from pneumatic solenoid valve, vacuum distributoe to vacuum pressure and reservoir as extra storage to keep the pressure when pressure is removed. From that, it wants to compared and prove the functionality and sustainability of dual vacuum clamper can be undergoing in machining performances as experimental testing in project.

1.6 Project significance

The purpose of this project is to improve the clamping levels and accurately clamping can hold the various workpiece. A workpiece has a different shape, curve, thickness, and properties. The dual vacuum clamping system is to reduce the probability effect of clamping on the workpiece during the machining process is run in speed rate. The novelty of this clamping based on a minimum and maximum force can be reached to clamp the workpiece by sensor detected on dynamometer during an end mill machining process with support by reservoir as extra storage when clamping in OFF mode. Lastly, the target of this project is to help the industrial manufacturing and manufacturing practice to enhance the diversity of more technology clamping functions in reducing their time and energy to set up and toggle axial movements in a work that is taking time.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction of clamping

Low rigidity thin-wall components are commonly used in aeronautics, automobiles, plastic molding and electronics applications. (Ganesh, Selladurai and Shanmugam, 2008) The thin sections elastically deform during machining of thin-walled parts under the action of thrust forces. The limited surface cannot put the workpiece to cut or drill in one side single clamping. This requires the operator to load and adjust the clamping vice repeatedly to each process refer on axis direction. (Wahab, Haris, et al., 2018) Therefore, to maintain the dimensional accuracy and to impart desired surface finish it is quite difficult. The current techniques of conventional clamping are not a suitable method to apply on the thin-wall parts machining for the future because the requirement of components on the clamping systems are rising when the complexity thickness is not constant. (Klotz, Zanger and Schulze, 2014). This is a common problem in the machining of thin-wall components (Bolar and Joshi, 2017).

A good clamping system is basic to use on the correct machining of parts. In particular, for the vacuum clamping systems, it is fundamental to ensure that the clamping forces generated are sufficient to support the parts while being machined. The identification of clamping surfaces and the clamping design has focused on clamping force on a given workpiece. (Cecil, 2001).

Literature research work on various aspects of vacuum clamping experimental, consist of the design and optimization of vacuum clamper, vacuum suction, thin-wall milling process, various surface quality, and depth of cut on experimental work piece during machining process. This chapter will explain all the findings obtained from many literature studies, which may be from articles, internet, journals and books on topics related to this study. This section covers the discovery of history of clamping in machining processes, method of clamping, material selection of holding mechanism and machining parameters effects.