UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF NEW CLAMPING METHOD FOR WATERJET MACHINE

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

by

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DECLARATION

I hereby, declared this report entitled "Development of New Clamping Method Waterjet Machine" 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 in Manufacturing (Process and Technology) with Honours. The member of the supervisory is as follow:

………………………………

(Dr. Norfariza Binti Ab. Wahab)

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ABSTRAK

Mesin jet air biasanya digunakan dalam industri. Mesin ini boleh beroperasi pada pelbagai jenis reka bentuk dan bahan sesuatu produk. Kebiasaanya, terdapat dua jenis mesin jet air iaitu mesin jet air dan mesin jet air kasar. Objektif kajian ini adalah untuk menghasilkan cara baru pengapit untuk mesin jet air. Kajian ini tertumpu dalam menghasilkan cara dan reka bentuk baru pengapit untuk mesin jet air. Tambahan lagi, saya teruskan dengan memilih bahan yang sesuai yang boleh digunakan dalam menghasilkan pengapit jet air ini. Akhir sekali, untuk mengenal pasti kemampuan pengapit ini dalam memegang bahan kerja yang mempunyai ketebalan dan saiz yang pelbagai. Kesimpulan, saya dapat menghasilkan cara baru untuk mesin jet air untuk memenuhi kehendak industri.

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ABSTRACT

Water-jet machine is commonly used in industry. This kind of machine can be operates in many types of design and material of product. Generally, there are two types of water-jet machining which is Water-jet Machining (WJM) and Abrasive Water-jet Machining (AWJM). The objective of this study is to develop a new method water-jet clamping for water jet machine. This work is focused on to produce and design a new clamping method for waterjet machine. Moreover, we proceed to choose suitable material can be uses to produce waterjet clamping. Furthermore, we have to analyze the efficiency of the clamp to hold the workpiece. Finally, to determine the capability of the clamp to hold various of thickness and the size of the workpiece. It is expected that the water-jet clamping can afford to clamp the workpiece in various of thickness and size of the workpiece. In conclusion, through this project we have to produce a new clamping method for water-jet which is to fulfill industry requirement.

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DEDICATION

I dedicate this thesis to my parent who have always been my side and understand and help me whenever I needed. They had motivated me to become a successful person and being achieve my own life goals. They also have inspired and support me from my back continuously while I sad and happy. Besides that, my siblings also encourage me to improve my ability and skill in my career and as the elder brother I have big responsible to my family.

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TABLE OF CONTENTS

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LIST OF TABLES

1

© Universiti Teknikal Malaysia Melaka

LIST OF FIGURES

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CHAPTER 1

INTRODUCTION

1.1 Background of study

Clamps serve two primary functions. First, they must hold the workpiece against its locators. Second, the clamps must prevent movement of the workpiece. The locators, not the clamps, should resist the primary cutting forces generated by the operation.

Holding the workpiece against locators. Clamps are not intended to resist the primary cutting forces. The only purpose of clamps is to maintain the position of the workpiece against the locators and resist the secondary cutting forces. The secondary cutting forces are those generated as the cutter leaves the workpiece. In drilling, for example, the primary cutting forces are usually directed down and radially about the axis of the drill. The secondary forces are the forces that tend to lift the part as the drill breaks through the opposite side of the part. So, the clamps selected for an application need only be strong enough to hold the workpiece against the locators and resist the secondary cutting forces.

Holding securely under vibration, loading, and stress. The next factors in selecting a clamp are the vibration and stress expected in the operation. Cam clamps, for example, although good for some operations, are not the best choice when excessive vibration can loosen them. It is also a good idea to add a safety margin to the estimated forces acting on a clamp.

Preventing damage to the workpiece. The clamp chosen must also be one that does not damage the workpiece. Damage occurs in many ways. The main concerns are part distortion and marring. Too much clamping force can warp or bend the workpiece. Surface damage is often caused by clamps with hardened or non-rotating contact surfaces. Use clamps with rotating contact pads or with softer

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contact material to reduce this problem. The best clamp for an application is one that can adequately hold the workpiece without surface damage.

Improving load/unload speed. The speed of the clamps is also important to the work holder's efficiency. A clamp with a slow clamping action, such as a screw clamp, sometimes eliminates any profit potential of the work holder. The speed of clamping and unclamping is usually the most-important factor in keeping loading/unloading time to a minimum.

The main goal of this project is to development a new waterjet clamping that suitable for water-jet machining uses in JTKP Laboratory. The design of this product is depending on the learning purpose and to make it has a good potential in commercialize it to the industry sector. This product is one the requirement from JTKP Machining Technology Laboratory to increase the quality in using the waterjet machining.

1.2 Problem Statement

There are several problems in manage the workpiece during the cutting process. One of them is the workpiece fall into the catcher tank after the cutting process especially for small part event the tab had been set in the CNC program. The tab supposedly to hold the part but in the term of the size of the part is small and the properties of part such as brittle, the tab do not function properly. The operator has to monitor the cutting session to make sure there are no part get into the catcher tank.

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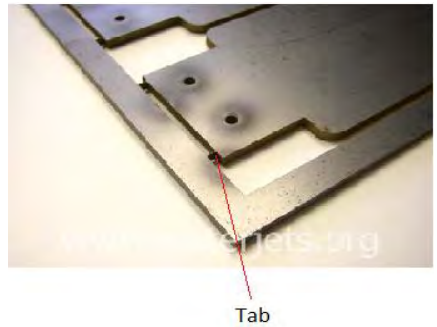

Figure 1.1: Tab at the part after water-jet process

.

(http://waterjets.org/archive/about-waterjets/overview-of-waterjets/waterjet-glossary/)

Besides that, the other problems are the movement of the nozzle. The movement of the nozzle need to be consider to prevent the nozzle hit the clamping and the workpiece. If the clamping is to huge, the probability the nozzle being hit the clamp is high. This situation had caused many difficulties in operating the waterjet machine because it have to make many consideration in design of the part.

Figure 1.2:The nozzle hit the clamp

(http://www.instructables.com/id/Etching-Aluminum-With-a-Waterjet/step3/Hardware-OMAX-60120-Waterjet/)

Moreover, the workpiece is misalignment during the cutting process cause of the vibration and bouncing of the water from catcher tank that make the workpiece move from the original position. This issue had reduced the quality of cutting and the accuracy, so, the dimensional of the part is not follow the actual

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design. Before this, the workpiece is just hold by placed the loader at the edges of the workpiece but this method in not efficient.

1.3 Objective

The objectives of this project are as follow:

1. To produce a new design and clamping method for waterjet machine.
2. To choose suitable material can be uses to produce waterjet clamping.
3. To analyze the efficiency of the clamp to hold the workpiece.
4. To determine the capability of the clamp to hold various of thickness and the size of the workpiece.

1.4 Project Scope

The project scope has similar meaning with objective which is mean the project scope is depend on the objective:

1. There is requirement for laboratory and lesson session for safety issues.
2. The design is based on the laboratory and lesson purpose.
3. The material selection is depend on the condition and can be used to all of waterjet machine.
4. Determine the accuracy of the dimension of the part after had run cutting process.
5. The capability of the clamp is depend on the thickness of the workpiece to hold.

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CHAPTER 2

LITERATURE REVIEW

2.1 Introduction of Machining Process

Machining is defined as a process, in which the metal is eliminate in the shape of chips by means of single or multiple wedge-shaped cutting tools. The machining process involves physical phenomena that are very complex to describe accurately using traditional mathematical models because of the principle of the process itself; this is the main purpose why there are no such models accessible. Chandrasekaran et al. (2010).

In machining, the process of cutting is divide into two segment where is contact process cutting and non-contact process cutting. Contact process means that there is direct contact between tools and workpiece during cutting process. The cutting tools remove the metal in physical contact. Meanwhile, the non-contact process is the contact is indirect between the cutting tools and workpiece which is there is no physical contact but the cutting tool still remove the material.

Material removal may occur with chip formation or even no chip formation may take place. For example, in Abrasive Water-jet Machining are of microscopic size and in case of Electrochemical machining material removal occurs due to electrochemical dissolution at atomic level. There may not be a physical tool present. For example, in laser jet machining, machining is carried out by laser beam. However, in Electrochemical machining there is a physical tool that is very much required for machining. Mostly, non-contact process does not required use mechanical energy domains to provide machining.

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2.1.1 Conventional Machining Process

Conventional machining is generally regarded as using manually controlled machines. The tool moves around the work by mechanical controls that are manually controlled. Conventional also known as traditional machining process consists of several type of machining process namely turning, milling, drilling, grinding and boring.(Mohd Adnan et al., 2013)

Generally, macroscopic chip formation by shear formation. There may be a physical tool present. For example, a cutting tool in a Lathe Machine. Cutting tool is harder than workpiece at room temperature as well as under machining conditions. Material removal takes place due to application of cutting forces energy domain can be classified as mechanical. Conventional involve the direct contact of tool and workpiece.

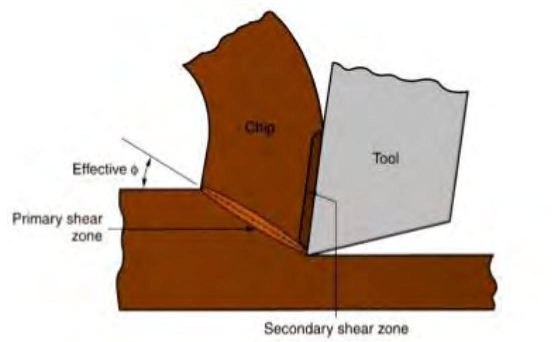

Figure 2.1:Formation of shear deformation

(http://www.slideshare.net/palanivendhan/metal-cutting-38254541)

2.1.2 Advanced Machining Process

Non-traditional 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 tool as it needs to be used for traditional manufacturing processes.

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Extremely hard and brittle materials are difficult to machine by traditional machining processes such as turning, drilling, shaping and milling. Non-traditional machining processes, also called advanced manufacturing processes, are employed where traditional machining processes are not feasible, satisfactory or economical due to special reasons as outlined below.

• Very hard fragile materials difficult to clamp for traditional machining

• When the work piece is too flexible or slender

• When the shape of the part is too complex

Several types of non-traditional machining processes have been developed to meet extra required machining conditions. When these processes are employed properly, they offer many advantages over non-traditional machining processes. The common non-traditional machining processes are described in this section.

Electrical Discharge Machining (EDM)

Electrical discharge machining (EDM) is one of the most widely used non-traditional machining processes. The main attraction of EDM over traditional machining processes such as metal cutting using different tools and grinding is that this technique utilises thermoelectric process to erode undesired materials from the work piece by a series of discrete electrical sparks between the work piece and the electrode. A picture of EDM machine in operation is shown in Figure 2.2.

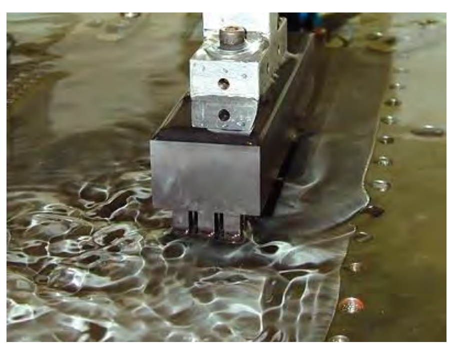

Figure 2.2:Electrical Discharge Machining (Die Sinking)

(http://www.sme.org/MEMagazine/Article.aspx?id=49910&taxid=1459)

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Figure 2.3:Electrical Discharge Machining (Wire Cut)

(http://www.njpt.com/wire-edm.html)

The traditional machining processes rely on harder tool or abrasive material to remove the softer material whereas non-traditional machining processes such as EDM uses electrical spark or thermal energy to erode unwanted material in order to create desired shape. So, the hardness of the material is no longer a dominating factor for EDM process. A schematic of an EDM process is shown in Figure 2.3, where the tool and the workpiece are immersed in a dielectric fluid.

Chemical Machining (CM)

Chemical machining (CM) is the controlled dissolution of workpiece material (etching) by means of a strong chemical reagent (etchant). In CM material is removed from selected areas of workpiece by immersing it in a chemical reagents or etchants; such as acids and alkaline solutions. Material is removed by microscopic electrochemical cell action, as occurs in corrosion or chemical dissolution of a metal. This controlled chemical dissolution will simultaneously etch all exposed surfaces even though the penetration rates of the material removal may be only 0.0025–0.1 mm/min. The basic process takes many forms: chemical

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milling of pockets, contours, overall metal removal, chemical blanking for etching through thin sheets; photochemical machining (pcm) for etching by using of photosensitive resists in microelectronics; chemical or electrochemical polishing where weak chemical reagents are used (sometimes with remote electric assist) for polishing or deburring and chemical jet machining where a single chemically active jet is used. A schematic of chemical machining process is shown in Figure 2.4.

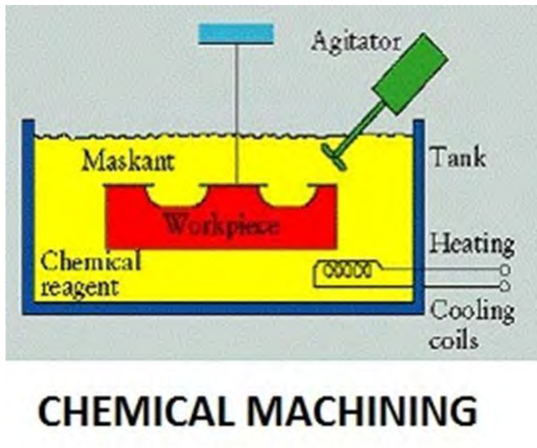

Figure 2.4:Illustration of Chemical Machining.

(http://ecetmech.blogspot.my/2015/09/unconventional-machining-process.html)

Electrochemical Machining (ECM)

Introduction Electrochemical machining (ECM) is a metal-removal process based on the principle of reverse electroplating. In this process, particles travel from the anodic material (workpiece) toward the cathodic material (machining tool). A current of electrolyte fluid carries away the deplated material before it has a chance to reach the machining tool. The cavity produced is the female mating image of the tool shape.

Similar to EDM, the workpiece hardness is not a factor, making ECM suitable for machining difficult-to –machine materials. Difficult shapes can be made by this process on materials regardless of their hardness. The ECM tool is positioned very close to the workpiece and a low voltage, high amperage DC

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current is passed between the workpiece and electrode. Some of the shapes made by ECM process is shown in Figure 2.5.

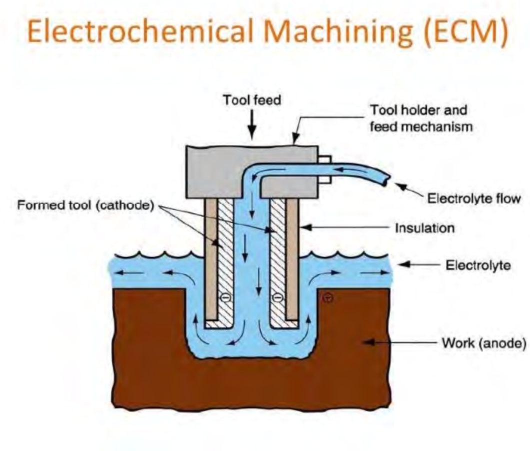

Figure 2.5:Illustration Electrochemical Machining

(http://www.slideshare.net/todkarmahesh/electrochemicalmicromachiningemm)

Ultrasonic Machining (USM)

USM is mechanical material removal process or an abrasive process used to erode holes or cavities on hard or brittle workpiece by using shaped tools, high frequency mechanical motion and an abrasive slurry. USM offers a solution to the expanding need for machining brittle materials such as single crystals, glasses and polycrystalline ceramics, and increasing complex operations to provide intricate shapes and workpiece profiles. It is therefore used extensively in machining hard and brittle materials that are difficult to machine by traditional manufacturing processes. The hard particles in slurry are accelerated toward the surface of the workpiece by a tool oscillating at a frequency up to 100 KHz - through repeated abrasions, the tool machines a cavity of a cross section identical to its own. A schematic representation of USM is shown in Figure 2.6.

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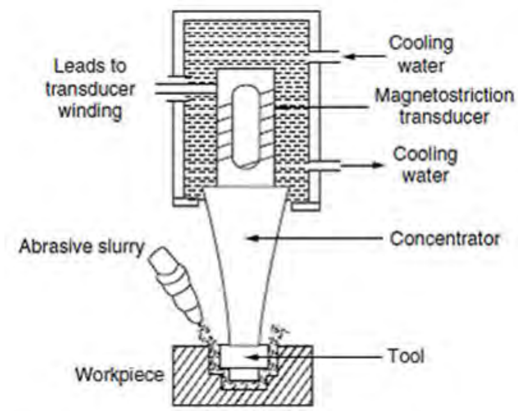

Figure 2.6:Illustration of Ultrasonic Machining

(http://www.mechscience.com/ultrasonic-machining-process-usm-concept-of-ultrasonic-machining-process-usm/)

USM is primarily targeted for the machining of hard and brittle materials (dielectric or conductive) such as boron carbide, ceramics, titanium carbides, rubies, quartz etc. USM is a versatile machining process as far as properties of materials are concerned. This process is able to effectively machine all materials whether they are electrically conductive or insulator.

Laser–Beam Machining (LBM)

Laser-beam machining is a thermal material-removal process that utilizes a high-energy, coherent light beam to melt and vaporize particles on the surface of metallic and non-metallic workpieces. Lasers can be used to cut, drill, weld and mark. LBM is particularly suitable for making accurately placed holes. A schematic of laser beam machining is shown in Figure 2.7.

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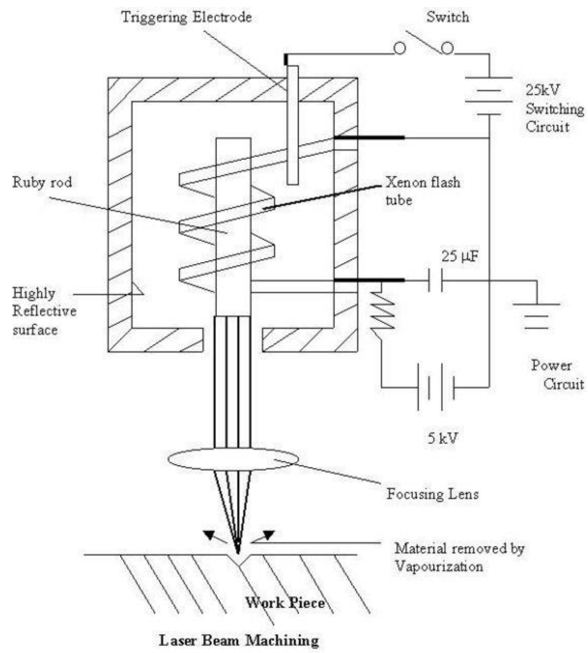

Figure 2.7:Illustration of Laser Beam Machining

(http://mechanicalbuzz.com/laser-beam-machining-process-applications-advantages-disadvantages-1000.html)

Different types of lasers are available for manufacturing operations which are as follows:

• CO2 (pulsed or continuous wave): It is a gas laser that emits light in the infrared region. It can provide up to 25 kW in continuous-wave mode.

• Nd:YAG: Neodymium-doped Yttrium-Aluminum-Garnet (Y3Al5 O12) laser is a solid-state laser which can deliver light through a fibre-optic cable. It can provide up to 50 kW power in pulsed mode and 1 kW in continuous-wave mode.

Water Jet Machining

Water jet cutting can reduce the costs and speed up the processes by eliminating or reducing expensive secondary machining process. Since no heat is applied on the materials, cut edges are clean with minimal burr. Problems such as cracked edge defects, crystalisation, hardening, reduced wealdability and

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