Faculty of Mechanical and Manufacturing Engineering Technology

WATERJET ANTI-SINK PRODUCT FILTER FOR TINY PART

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

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ABSTRACT

Abrasive Waterjet Machining (AWJM) is one of the most advanced manufacturing technologies recently. Waterjet is a computerized technology that can cut most materials, no matter how brittle, into any two dimensional shape. Waterjet cutting is a clear, cold process that does not heat, harden, or distort metals. In this project, new accessories for waterjet machine is designed and fabricated to solve the cutting process problem which small dimensional of part that need by customer. The purpose of build this anti-sink filter product is to avoid cutting part from fall into the tank especially small cutting part that can through the gap of every pieces of the waterjet table. The design of the product was visualized by using Solidwork software. The manufacturing process will be conducted to produce the new accessories of the filter product. The processes involved in fabricating the product is grinding, bending, drilling and welding. Therefore, the material that been used in this project is flat and angle bar of mild steel and steel net and also certain ready part of joining component. Coating also been used to cover the metal material from any corrosion occurs. In a nutshell, after the product was fabricated, the filter has been run some testing for certain material to ensure the filter can catch the small cutting part and gives no effect to the filter due to exposure to the pressure of the water jet. The objective of this project are achieved. So, in future I hope this project can have continuous improvement such as make this product by the polymer material by using 3D printed or maybe can have some additional jig or fixture that can combine together with this filter.

ABSTRAK

Abrasive Waterjet Machining (AWJM) adalah salah satu teknologi pembuatan yang paling maju baru-baru ini. Jet air adalah teknologi berkomputer yang boleh memotong kebanyakan bahan, tidak kira berapa rapuh kepada dua bentuk dimensi. pemotongan jet air adalah jelas, proses pemotongannya tidak panas atau keras. Tujuan membina produk penapis anti-tenggelam ini adalah untuk mengelakkan bahan pemotongan dari terjatuh ke dalam tangki terutama bahan yang berdimensi kecil dimana ia boleh melepasi jurang setiap keping meja jet air itu. Reka bentuk produk ini digambarkan dengan menggunakan perisian Solidwork. Proses yang terlibat dalam membuat produk ini seperti pengisaran, membongkok, penggerudian dan kimpalan. Oleh itu, bahan yang digunakan dalam projek ini adalah keluli lembut rata dan sudut keluli lembut dan jaring keluli dan juga beberapa komponen penyambungan. Salutan juga telah digunakan untuk menampung bahan logam dari mana-mana hakisan berlaku. Secara ringkas, selepas produk itu direka, penapis telah menjalani beberapa ujian untuk bahan tertentu untuk memastikan penapis boleh menangkap hasil pemotongan bahan yang kecil dan tidak memberi kesan kepada penapis disebabkan oleh pendedahan kepada tekanan jet air. Jadi, pada masa akan datang saya berharap projek ini boleh mempunyai penambahbaikan yang berterusan seperti pembuatan semula penapis ini dari bahan polimer dengan menggunakan pencetak 3D atau mungkin ade jig tambahan atau lekapan yang boleh digabungkan bersama-sama dengan penapis ini.

DEDICATION

This thesis I devoted to my beloved parents, family and friends. Those who have been there to support me on an ongoing basis, compliment me and show me the most appropriate pat to pursue. I'll never stop by thanking my parents for everything you do.

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AWJM	-	Abrasive Waterjet Machine
MPa	-	Megapascal
μm	-	micrometer
ksi	-	kilo square inch
m/s	-	meter per seconds
mm	-	milimeter
psi	-	Per square inch
UHP	-	Ultrahigh Pressure
AWJ	-	Abrasive Waterjet
gPm	-	Gallon per minute
HP	-	Horse power
UTeM	-	Universiti Teknikal Malaysia Melaka
FTKMP	-	Fakulti Teknologi Kejuruteraan Mekanikal dan Pembuatan

CHAPTER 1

INTRODUCTION

1.1 Introduction

AWJM is a non-conventional mechanical cutting method that incorporates abrasive particles such as garnet and silicon carbide into high-speed waterjet to erode material from the surface material. In 1983, AWJM was established as a commercial system. Due to its different advantages over other state-of - the-art technologies such as no high temperature irregularities in the workpiece, small cutting process high machining flexibility to cut nearly any material and high flexibility to cut any direction. Hard machining materials such as composites, ceramics and titanium alloys are widely used where conventional machining is not always applied technically or economically, as well as cutting patterns on different materials.

In this field of waterjet machine, something which had been cut part is very important to the operator or the user of this machine because any part that has cut up is necessary for owned or obtained to produce and complete the product perfectly, especially small parts because all time the period of this abrasive waterjet machine are developed, the probability of the small parts that have been cut to sink into the tank are higher and it cannot be took back until the waterjet machine comes to the maintenance time. That time, the small cutting parts that has sunk into the tank can be take back. But, based on research that have been made, the period of the maintenance for this abrasive waterjet machine are 2 years per maintenance, and that time the parts that can be take is useless.

So, the development of this product which is this filter (catcher) can avoid these issues occur again, the small parts can be cut by using this abrasive waterjet machine and if the parts fell down, it will not sink into the tank, but it will be stuck into the filter or catcher. So that, the operator will be more confident to make a cutting process for the small or tiny parts by using this abrasive waterjet machine.

In any case, the development of the separate tank compartment are done. Features of catch tank for an abrasive water jet machine is assembly in order to facilitate the recovery of spent abrasives and kerf material from the abrasive water jet machine's operation. The catch tank contains detachable wear plates that disperse remaining energy from the abrasive water jet by sacrificially wearing so that damage to the tank is decreased and catcher damages also can be avoided by the effect of the water jet. The catcher spaced upper level of the tank and it is separated over the tank bottom and splits the tank in a high compartment which receives the water jet abrasive and the low compartment which is flushed permanently to remove spent abrasives and kerf material from the tank. (Tan, 1992)

1.2 Background

Waterjet machine is an industrial cutting machine capable of cutting a wide variety of materials using a very high-pressure jet of water, or a mixture of water and an abrasive substance. The term abrasive jet refers specifically to the use of a mixture of water and abrasive to cut hard materials such as metal or granite, while the terms pure waterjet and water-only cutting refer to waterjet cutting without the use of added abrasives, often used for softer materials such as wood or rubber. This waterjet machine can make cutting process for big or small part or stock part cause of the base for the cutting place are bigger compared to other machine.

1.3 Problem Statement

Issues that often arise when using waterjet machine is small pieces of cut will fall into tank. This is because of the base table of the abrasive waterjet machine are made into the thin beam shape that will not affect from the cutting water. So, it will make the product need reproduce again. Finally, it will waste the time where we need to make new drawing and machining setup for the only part which was fall into the tank.

1.4 Objective

This proposal is to study develop a new design of part product where it can solve the problem in waterjet machining outcome which is:

i. To design and develop the anti-sink filter product
ii. To avoid the cutting part from fall into the tank that cannot be retrieved.
iii. Save cost and time for the reproducibility of the cutting part.

1.5 Scope

This project is focus on the material and design that need be use where it will place on the table of the abrasive waterjet machine water, and half of the body of the product which is the filter part or catcher will sunk into the tank. So that, the material of this product need to be anti-corrode material and the design also will have less effect when cutting water and abrasive from the machine are operates.

1.6 Conclusion

This product (tiny part anti-sink filter) is created as a waterjet machine part which it is very useful to the machine operator especially student where it will avoid from any cutting part of material sink into the tank that cannot be take. So, this product will not make the operator waiting and waste their more time to make another drawing part and also setup again the waterjet machine to cut the only part that fall into the water. Furthermore, it can decrease the probability of uncompleted project on time and waste of raw material.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this chapter, the article that has been searched and selected which related to the title of the project will be discussed. Some analysis have been carried out in others from the primary stage of the project to guarantee the relevance of this research. The main source of information is research journals, reference books, and online conference article. This section will also include the Abrasive Waterjet Machine history, the AWJM principle, and the properties of machining.

2.2 Abrasive Waterjet Machining

AWJM is a non-conventional mechanical cutting method that incorporates abrasive particles such as garnet and silicon carbide into high-speed waterjet to erode material from the surface material. In 1983, AWJM was established as a commercial system. Due to its different advantages over other state-of - the-art technologies such as no high temperature irregularities in the workpiece, small cutting process high machining flexibility to cut nearly any material and high flexibility to cut any direction. Hard machining materials such as composites, ceramics and titanium alloys are widely used where conventional machining is not always applied technically or economically, as well as cutting patterns on different materials.

Abrasive waterjets are versatile devices for the removal of a wide range of equipment with neither heat nor mechanical distortion. In a high-speed waterjet with a pressure of 400 MPa, the process uses the trained abrasives. The use of higher pressure at 600 MPa (to reduce water and abrasive substances) is new. A mixing tube of approximately 0.38 mm is used to mix waterjet (75 microns) and the abrasives (mesh 220 and finer). The current AWJM process is thus restricted. (Hashish, 2005)

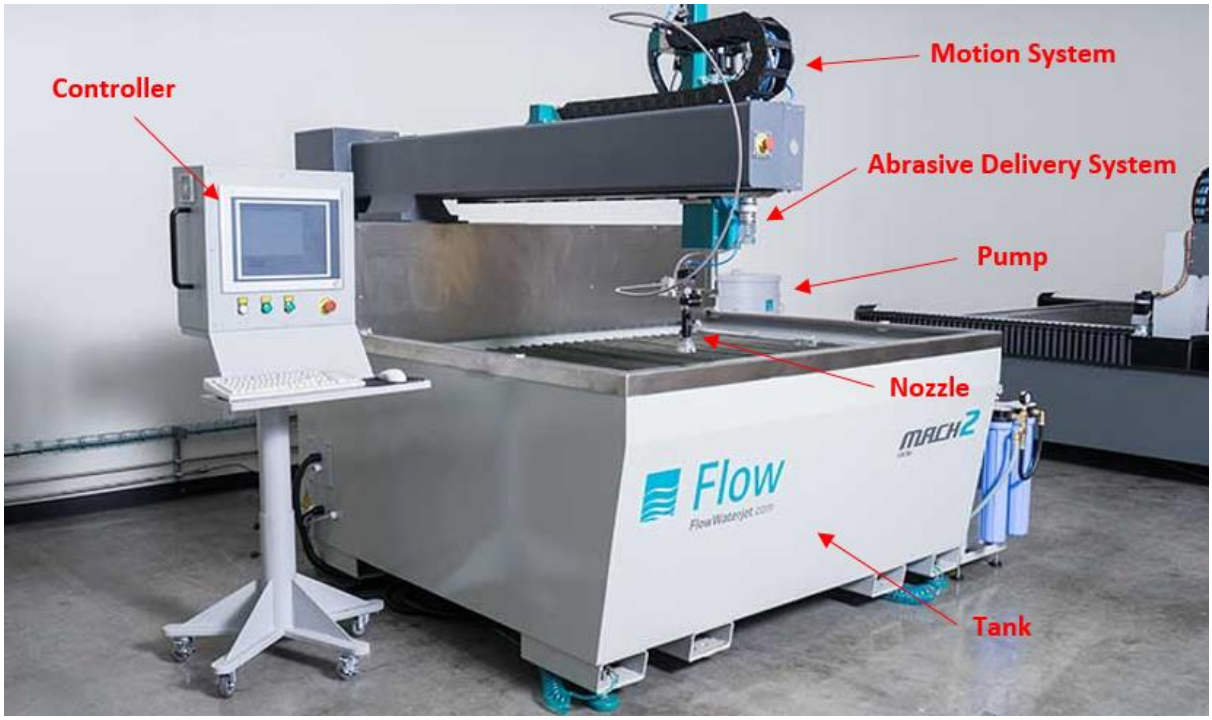

Figure 2. 1 : Component of abrasive waterjet machine.

Source: https://www.flowwaterjet.com/Machines/Mach-2b

Figure 2.1 illustrates the components of the AWJM schemas. As you can see, the performance of AWJM depends on many things relating to the technology itself and the features of the cutting material. Within these factors can be controlled in the cutting process by the characterization of the technology and operating variables themselves. The characterisation of the material on the other hand, because of the nature of the materials, may be difficult to control.

The abrasive machine with a waterjet is not very different from the main machine with waterjet machining. Usually, cutting polymers do not appear to be used in AWJM because the consistent increase in the jet prevents rough particles from mixing with the waterjet. The abrasive precision process is therefore more efficient.

2.2.1 Advantage of Abrasive Waterjet Machining

This abrasive waterjet machine technology is mainly used compared to other non-conventional technologies because of the advantages. The different materials such as metals, stone, composites, and ceramics were cut. This technique is suitable for material which is very soft, brittle and fibrous. By adding an abrasive particle that is water that does not erode the material, AWJM is different from pure waterjet. Thus, AWJM is more efficient than pure waterjet several times. There is not much heat generation in this process, so the surface is freely turned off from heat-affected areas. AWJM could be used to clean surfaces, especially in places that cannot be reached by ordinary methods, and their high wear resistance characterizes the final surface after cleaning by AWJM.

The workpiece is removed by the action of high velocity mixes with abrasive particles based on the material's principle corrosion. Compared with other licensing processes, the workpiece is not affected by heat. High-speed cutting and multi-cutting capability, high-efficiency cutting, the ability to cut complex shapes, even uneven surfaces, are very effective in tolerance, minimal heat formation and low-pressure deformation in part machines, and are some of the advantages offered by this process making it ideal for automation.. As a modern production process, abrasive waterjet

machining still needs to be sufficiently superior to achieve its full potential. (M. Korat, 2014).

2.2.2 Disadvantages of Abrasive Waterjet Machining

As other machining, there is also some limitation to abrasive waterjet machining. AWJM's application is not recommended for soft and flexible material machining. The abrasive cannot be recycled because its ability to cut and sharpness can be lost. When fine grains with a diameter less than 10μm are used, the nozzle will be blocked up. The abrasive jet's burning effect makes the abrasive waterjet nozzle's accuracy poorer. Periodically, a further cleaning operation has been performed on the machined part to get rid of grains sticking to the surface. In addition, excessive wear of the nozzle causes additional machining costs and the process will contaminate the environment. (Hassan et al 2008).

2.2.3 Fundamental of Abrasive Waterjet Machining

Abrasive waterjet machining also known as hydrodynamic machining. The water used in the workpiece as a saw and cuts a narrow drain. To cut hard and soft materials, high water pressure ranging from 60ksi to 200ksi is required.

Using intensifier technology, water is pumped with sufficient pressure at 2000 bar up to 4000 bar. Using hydraulic cylinders of the various cross-sections, it works on the basic principle of pressure amplification. The potential energy is converted into kinetic energy and yields a high-velocity jet at 1000 m/s when the water at the pressure is eliminated over the appropriate hole that usually has a diameter of about 0.2 mm to