Faculty of Mechanical and Manufacturing Engineering Technology

FABRICATION OF BOTTOM MODULAR NOZZLE FOR ABRASIVE WATERJET MACHINE BY USING HIGH CARBON STEEL

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Bachelor of Manufacturing Engineering Technology (Process & Technology)

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

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TAJUK: Fabrication Of Bottom Modular Nozzle For Waterjet Machine By Using High Carbon Steel

SESI PENGAJIAN: **2018/19 Semester 1**

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ABSTRACT

Inside an abrasive jet machining, the nozzle is one of the most important segments. The wear and tear properties and features of the nozzle occur due to the high pressure of the water and the abrasive grain passing through the nozzle during the cutting process. When the defect in this nozzle occurs, it will indirectly impact the deterioration of the predation result and thereby induce unauthorized changes to the workpiece itself. To improve nozzle life, using high carbon steel material. It will be processed and formed using the EDM Wirecut machine, the lathe machine, and the cylindrical grinding machine. Then it will be given heat treatment where it will be heated at high temperature and then cooled to increase the strength of the substance. After the nozzle is completed, it will undergo trial testing to see the results and will collect the data results of cutting the mild steel with different thickness. Then the nozzle and the surface cutting will be investigated to see the corrosion effect that occurs.

ABSTRAK

Di dalam pemesinan jet air yang kasar, muncung adalah salah satu segmen yang paling penting. Sifat dan ciri-ciri muncung yang mudah haus dan terhakis berlaku kerana disebabkan tekanan yang tinggi daripada air dan bijiran yang kasar yang melalui muncung tersebut semasa proses memotong berlaku. Apabila kecacatan pada muncung ini berlaku, ia secara tidak langsung akan membawa kesan kepada kemerosotan hasil pretasi memotong dan di samping itu menyebabkan perubahan yang tidak diingini kepada bahan kerja itu sendiri. Untuk meningkatkan kehidupan muncung, dengan menggunakan bahan keras iaitu keluli karbon tinggi. Ia akan diproses dan dibentuk menggunakan mesin "EDM Wirecut", mesin larik, dan mesin "Cylindrical Grinding". Kemudian ianya akan diberi rawatan haba dimana ia akan dipanaskan pada suhu tinggi dan kemudiannya disejukkan untuk meningkatkan kekuatan bahan tersebut. Selepas muncung siap, ia akan melalui ujian percubaan untuk melihat keberhasilan dan akan dikutip maklumat berkaitan hasil memotong keluli lembut yang berbeza ketebalan. Kemudian muncung dan permukaan dipotong akan dikaji untuk melihat kesan hakisan yang berlaku.

DEDICATION

To my parents, Mr. Jamal Mohamed and Madam Norliza Ahmad I will never finish express thank you for everything you do. I dedicated this report to a family which encourages and supports towards my studies and joyful experience. Also, thanks to my friends because help me to go through my studies. And last but least, my supervisor, Mr. Abd Khahar Bin Nordin, thanks for teaching and encourage me to become a better person in life. May Allah bless all of them.

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In the name of Allah, the most Gracious and most Compassionate.

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LIST OF ABBREVIATIONS AND SYMBOLS

AWJM	-	Abrasive Water Jet Machining
AWJ	-	Abrasive Water Jet
EDM	-	Electrical Discharge Machining
HCS	-	High Carbon Steel
HSS	-	High-Speed Steel
Mm	-	Millimeter
psi	-	Pounds per Square
MPs	-	Meter per Second
Mpa	-	Megapascal
Ksi	-	Kilopound per square inch
hp	-	Horsepower
kw	-	Kilowatt
FTK	-	Fakulti Teknologi Kejuruteraan
%	-	Percent

CHAPTER 1

INTRODUCTION

1.0 Introduction

To disintegrate, dissolve or eliminate an aim material will be using the abrasive water jet machine. It is a machining that will produce the high-pressure water to quicken rough particles which is abrasive and the water for the cutting process. This blend of water, abrasive grain, and the air is fit for slicing the materials from very soft material workpiece to metal, stone, and furthermore pottery. The high-pressure water is quickened completely through a fine hole towards delivering a high-speed stream of water. The section of this stream all through a mixing chamber makes an incomplete vacuum by venturi impact, in addition, to entrains rough particles that are blended at that point quickened in the high-speed water stream inside the nozzle. (Nanduri, Taggart, & Kim, 2002)

AWJM has far above the ground machining versatility plus high flexibility. It is used for cutting an extensive variety of materials. This method is especially very appropriate and also suitable for very soft, brittle plus fibrous materials. This innovation is less delicate to material properties since it does not cause babble. This machinery is generally widely used compared to other non-conventional machinery since of its clear advantages. This method is not going to use much heat generation so the machined surface is at no cost from heat affected zone plus residual stresses. The major disadvantage of this process is, it creates loud noise than a messy working surrounding. (Shah & Patel, 2012)

In the field of abrasive waterjet machining, the nozzle is one of the predominantly critical segments of the machining procedure. Each one of the materials has a divergent property which exhibits the ability of the nozzle toward dragging out its life cycle. Normally, the materials used to make this are tungsten carbide, silicon carbide, boron carbide, tungsten carbide-cobalt and in addition additionally composite carbide. Promptly accessible are different kinds of the nozzle with disparate lengths and widths. (Syazwani, Mebrahitom, & Azmir, 2016)

The nozzle is the most limited lived segment and also basically critical in abrasive waterjet machining, as it will in a straight line affect the performance, precision, functioning in addition to financial matters of the abrasive waterjet machining process. In any case, wear of the nozzle likewise will lead toward the debasement of the nature of the cut surfaces and in addition causes the undesirable changes in the geometry of the workpieces. At that point, the nozzle wear is the impact of the procedure of material disposal as the two surfaces are in sliding contact. (Gupta, 2012)

During the abrasive waterjet machining, the nozzle wear is a typical inconvenience. To handle the issue, a lot of analysts and furthermore producers attempt to solve it. In addition, to enhance the spout life, current nozzle utilizing a tungsten carbide-based material has been made to decrease and lower the wear rate in the product. By utilizing delicate rough materials generally spouts made of hard materials, for example, high carbon steel can decrease the wear too. (Syazwani et al., 2016)

1.1 Project Background

Abrasive Water Jet Machining (AWJM) nowadays has been used in this world because of the convenience of cutting a workpiece in the industrial. The importance of this project is to create the new design of a waterjet nozzle which contains bottom modular. This is to handle the problem that found in the AWJM which is the nozzle is the shortest-lived component. So, this project can overcome the erosion that always makes the nozzle cannot be used for a long time. The nozzle will be produced by using high carbon steel and then going to harden it by heat treatment to become high-speed steel.

1.2 Problem Statement

The nozzle is the most limited lived segment and also basically critical in abrasive waterjet machining because of the erosion and the wear resistant. The factor of the wear resistant and erosion at the nozzle includes abrasive because of type, shape, and size. The orifice diameter and water pressure input into the nozzle also can be the main factor for the problem. The parameter of the nozzle shape will be influenced wear includes the bore diameter, nozzle length.

Beside of that, wear of the nozzle going to prompt the debasement of the nature of the cut surfaces in a roundabout way causes the bothersome changes in the geometry of the workpieces. Other than that, the erosion at the taper also the factor the nozzle cannot use for a long time. And last but not least, the material itself use for the current nozzle also has brittle properties.

1.3 Objective

In order to finish the Final Year Project, there are some objectives that must be accomplished. The objectives are:

i. To fabricate the new design of water jet nozzle bottom modular by using high carbon steel.

ii. To study the erosion of the surface cutting edge material.

iii. To study the erosion of high carbon steel water jet nozzle.

1.4 Work Scope

In this Final Year Project, the experiment will be conducted at the FTK Manufacturing Process Laboratory by using the Abrasive Water Jet Machine (AWJM) use is modeled Mach2 1313b with 80 mesh of the abrasive size. Meanwhile, the nozzle will be produced are using High Carbon Steel. The software will go to use for this AWJM is Flow Master Software while the catcher tank content is tap water. The workpieces materials are aluminum and mild steel.

From this project, it will collect the data and compare with the data from the existing nozzle that AWJM use in FTK Laboratory. This project will explore the life tools of the nozzle for 30 hours. Indirectly, we can obtain the data cutting for data cutting mild steel for different thickness which is 2mm, 3mm, and 6mm with 5mm nozzle height and lastly to study the erosion of the nozzle by material high carbon steel.

1.5 Planning Project

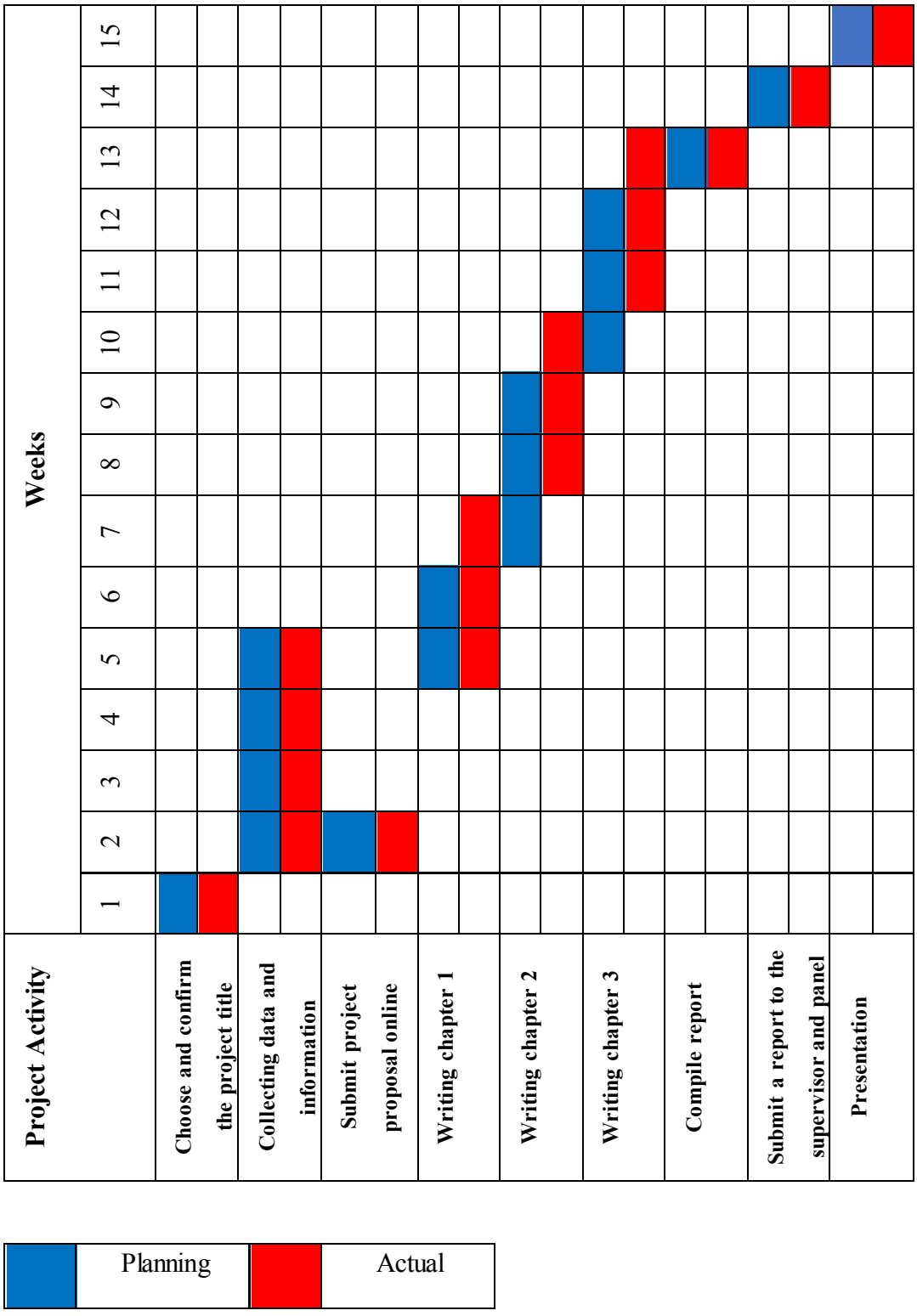

Table 1.1: Gantt chart PSM 1

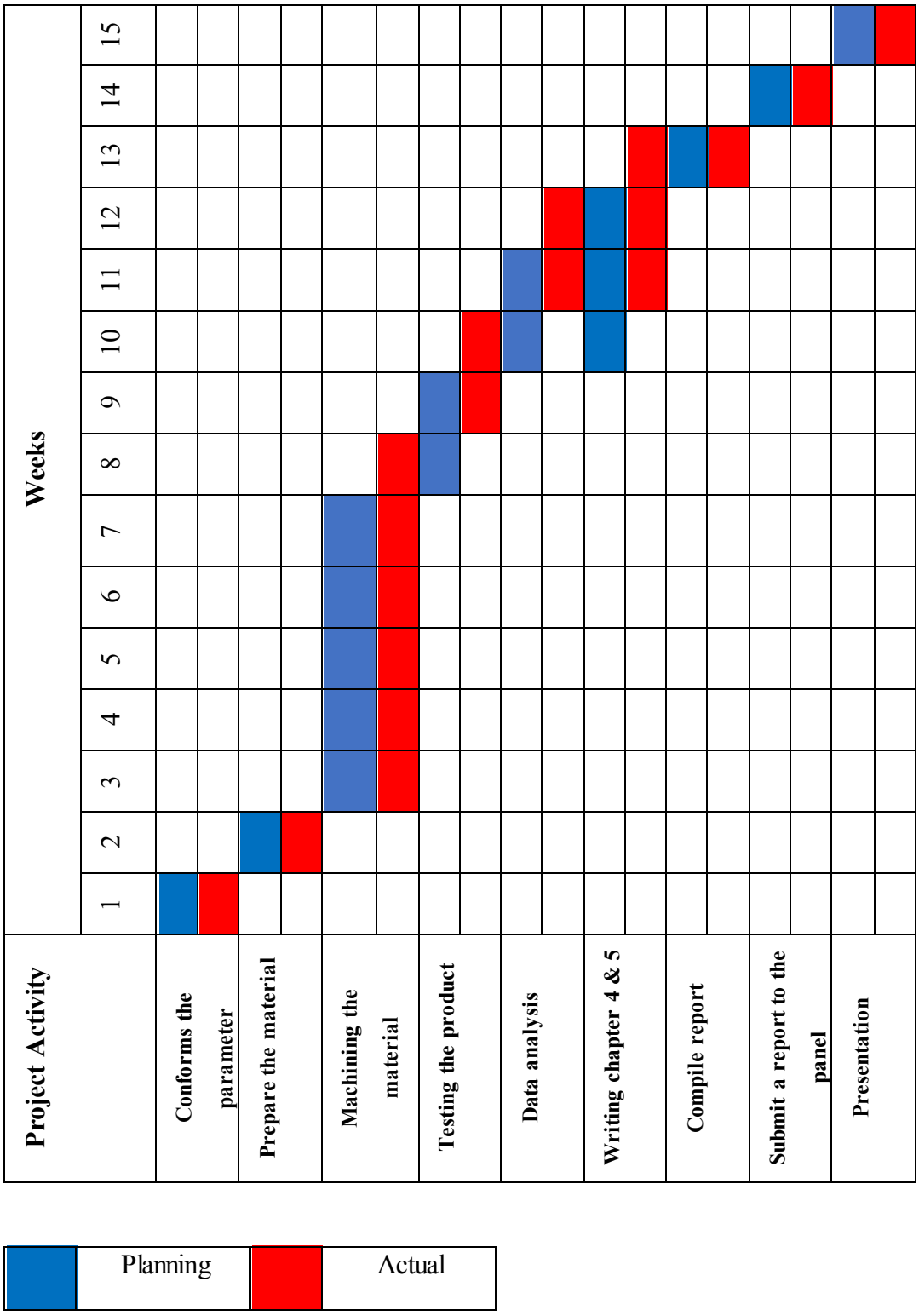

Table 1.2: Gantt chart PSM 2

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

From this chapter, it will have the background information I gathered from the journal, books also article about abrasive waterjet machining. Indirectly, it will help me to with the project I want to produce which is "Fabrication of Bottom Modular Nozzle for Abrasive Waterjet Machine By Using High Carbon Steel". This chapter will provide the facts about Abrasive Water Jet Machining (AWJM) include the part or component, the concept how the machine makes the cutting process, the parameter of the abrasive water jet and other important things about this machine.

2.1 Type Water Jet Cutting

In the water jet cutting manufacturing, there are available two types of water jet cutting machine;

Figure 2.1: Pure water pressure jet Figure 2.2: Abrasive water jet

Source: http://www.xinology.com/Glass-Processing-Equipments-Supplies-Consumables/glass-cutting/water-jet-cutting/overview/two-types-of-water-jet.html

Waterjet cutting equipment is one of the quickest growing machining processes in this world right now. Near the beginning 1970s for cutting soft materials like cardboard, plastics, rubber, pure waterjets are being used as a process to cut the material. Meanwhile to cut hard and solid materials like metal, ceramic, stone, glass, composite materials. The abrasive waterjet machining was introduced to develop the capabilities of the tool during the mid-1980s, (Mhamunkar, 2016)

Waterjet cutting systems are currently generally used in a number of industrial applications since of their illustrated capability to cut such materials like plastics, leather, asbestos, corrugated board, plus soft rock more efficiently and economically than conventional cutting systems. A system has been developed also tested tentatively to cut these harder materials by means of a water with the abrasive particles entrained in an extremely high-speed velocity. The operational principle of these abrasive water jets is the acceleration of abrasive particles by blending them with a stream of water driven by pressures of up to 45,000 psi. This blending and acceleration procedure takes place in a mixing chamber made of a durable material such as tungsten carbide or else boron carbide. The extremely focused and coherent slurry jet has the capability of cutting even the hardest materials. (Mohamed Hashish, 1984)