



**AN EXPERIMENTAL INVESTIGATION OF TiCN TOOL LIFE
AND TOOL WEAR IN TURNING OF TITANIUM**

MUHAMAD ANWAR BIN SALEHUDIN

A thesis in partial fulfilment of the requirement for the award of Bachelor Mechanical
Engineering (Manufacturing) (Hons)

Faculty of Mechanical Engineering
Universiti Teknologi MARA (UiTM)

JUNE 2016

ACKNOWLEDGEMENT



‘In the name of Allah, the Most Gracious, the Most Merciful’

First and foremost, I would like to thank Allah SWT for making all good things possible, giving a good health condition, which consents and enables to accomplish this study successfully. Besides that, the strengths and efforts that were put in, to ensure this Final Year Project finished. The first appreciation goes to Dr. Aznifa Mahyam binti Zaharudin and Pn. Nor Liawati binti Abu Othman, on their capacity in being and advisors for this project. She had given a lot of guidance and advices for me in order to accomplish this project. I would like to thank to parents and friends for being supportive, and, encouraged me to finish up this project. Other than that, their willingness to sacrifice their time and assistance whenever their involvements and suggestions especially when I face difficulties to accomplish the task. Appreciation also goes to all the lab technicians involved for their kindness and cooperation in giving and sharing with me their experience and advices. The authors also would like to thank to Advanced Materials Research Center, SIRIM Berhad, Malaysia for using their equipment. Last but not least, this work was supported by SCIENCEFUND, Ministry of Science, Technology and Innovation (Malaysia). Thank you so much.

ABSTRACT

Coated cutting tools have been successfully used in the turning of Titanium alloys. Since the demand of titanium is extremely high, many studies in machining, especially turning had been conducted. In this work, the tool life and tool wear of the coated cutting tool inserts using titanium carbon nitride (TiCN) is investigated in turning of titanium alloy under dry cutting condition. The study is focused on the machining parameters which are feed rate (f), cutting speed (N) and the depth of cut (d). Turning experiments were conducted at rotational cutting speeds of 125, 140 and 185 rev/min on the workpiece of Ti-6Al-4V using TiCN cutting tool inserts. The depth of cut and feed rate were remained constant at 0.2 mm and 0.15 mm/rev, respectively. The cutting tools undergo 30 times turning process in a length of 200 mm per cycle at three different cutting speeds. The tool life was calculated using Taylor's equation and surface roughness of the workpiece was measured using portable Surface Roughness. The wear mechanism was examined using Scanning Electron Microscope (SEM). The tool life is decreased dramatically while the tool wear and surface roughness of the workpiece increased as the rotational cutting speeds increased. The increasing of the average roughness illustrates the low quality of the surface finish. The wear mechanism acting on the tools were found to be flank wear and crater wear. It was found that diffusion of carbon between the cutting tool and workpiece material occurred during the machining.

TABLE OF CONTENTS

PAGE TITLE.....	i
ACKNOWLEDGEMENT	ii
ABSTRACT	iii
TABLE OF CONTENTS.....	iv
LIST OF FIGURES	vii
LIST OF TABLES	ix
LIST OF ABBREVIATIONS.....	xi
CHAPTER 1	1
INTRODUCTION	1
1.1 Project Background	1
1.2 Problem Statement	3
1.3 Objective	4
1.4 Scope of Works	4
1.5 Thesis Organization.....	5
CHAPTER 2	6
LITERATURE REVIEW	6
2.1 Introduction	6

2.2	Machining.....	6
2.3	Work Material	8
2.3.1	Titanium Alloy, Ti-6Al-4V.....	8
2.3.2	Surface Roughness.....	11
2.4	Cutting Tool Inserts.....	15
2.4.1	Titanium Carbonitride (TiCN).....	15
2.4.2	Tool Wear.....	18
2.4.3	Tool Life.....	20
2.5	Summary	24
CHAPTER 3		25
METHODOLOGY.....		25
3.1	Introduction	25
3.2	Material	25
3.2.1	Workpiece Material.....	25
3.2.2	Cutting Tool Inserts	28
3.3	Equipment and Testing.....	28
3.3.1	Turning.....	28
3.3.2	Workpiece Surface Roughness Measurement.....	30
3.3.4	Microscopic Observation	31
3.3.4.1	Tool Wear.....	32
3.3.4.2	Tool Life.....	33
3.4	Summary	33
CHAPTER 4		34
RESULTS AND DISCUSSION		34