UNIVERSITI TEKNIKAL MALAYSIA MELAKA

THE STUDY OF FLANK WEAR USING COATED ALUMINIUM CHROMIUM NITRIDE (AlCrN) BORON STEEL 22MNB5 ON ALUMINIUM AA6061

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

by

NASRUL HAZIQ BIN MURAD

B071610729

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NASRUL HAZIQ BIN MURAD

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DECLARATION

I hereby, declared this report entitled “The Study of Flank Wear Using Coated Aluminium Chromium Nitride (AlCrN) Boron Steel 22MnB5 On Aluminium AA6061” is the results of my own research except as cited in references. This thesis has not been for any degree and is not concurrently submitted in candidate of any other degree.

Signature	:	…….
Author’s Name	:	NASRUL HAZIQ BIN MURAD
Date	:	……

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 Manufacturing Engineering Technology (Process & Technology) with Honours. The member of the supervisory is as follow:

Signature	:…….
Supervisor Name	: TS MOHD HAIRIZAL BIN OSMAN
Date	:……..

ABSTRAK

Keluli boron digunakan dalam proses stamping panas kerana sifat mekanik yang baik. Semasa proses stamping, orang mati terdedah kepada keadaan agresif termasuk memakai pelekat, tekanan haba, keletihan, dan lelasan. Dalam kerja ini, terdapat tiga sampel dengan HRC yang berbeza. Satu sampel akan menggunakan prosedur penyediaan yang berbeza yang menggunakan pelindapkejutan yang mengeraskan diri manakala dua lagi menggunakan stamping panas. Kemudian semua sampel disalut dengan Aluminium Chromium Nitride (AlCrN) menggunakan Pengurapan Wap Fizikal. Selepas itu, salutan sampel dicirikan dan diuji dengan menggunakan Mikroskopi Pengimbasan Elektron (SEM), memakai ujian dengan menggunakan pin pada cakera, ujian kekerasan dan mikroskop untuk memakai paku mengukur. Dengan menggunakan SEM, lebar strok menjadi lebih kecil apabila menggunakan proses stamping panas. Untuk ujian kekerasan, Aluminium Chromium Nitride (AlCrN) 82HRC lebih kuat daripada yang lain kerana menggunakan proses setem panas. Pakai rintangan salutan yang bertambah kerana penurunan pekali geseran yang diperolehi. Sedangkan yang lain menunjukkan bahawa transformasi lapisan menjadi fasa martensit menghasilkan dan lebih keras adalah yang paling bertanggung jawab untuk perubahan tersebut. Ketiga sampel ini akan membuat perbandingan dan mencari yang terbaik dengan menggunakan parameter yang berlainan bagi pemesinan. Yang terbaik akan pergi ke proses pemesinan. Hasil yang dijangkakan dari segi kekerasan dan pakai yang menggunakan stamping panas dengan sampel HRC yang lebih tinggi akan lebih baik daripada yang lain.

ABSTRAK

Boron steels are used in hot stamping process due to their good mechanical properties. During the stamping process, the dies are exposed to aggressive conditions including adhesive wear, thermal stresses, fatigue, and abrasion. In the present work, there are three samples with different HRC. One sample will use different procedure of preparation which is using quenching that self-hardening while other two used hot stamping. Then all samples are coated with Aluminium Chromium Nitride (AlCrN) using Physical Vapor Deposition. After that, the samples coating were characterized and tested using Scanning Electron Microscopy (SEM), wear test by using pin on disc, hardness test and microscope for measure flank wear. By using SEM, the width of the stroke becomes smaller when using hot stamping process. For the hardness test, the Aluminium Chromium Nitride (AlCrN) 82HRC stronger than others because using hot stamping process. Wear resistance of coatings increase due to the decreasing of coefficient of friction obtained. While others suggest that the transformation of the layer into produce martensite phase and more harder is the ultimate responsible for such changes. These three samples will make a comparison and find the best by using different parameter for machining. The best will go further to machining process. The expected results in term of hardness and wear which are using hot stamping with higher HRC of sample will be better than others.

DEDICATION

A special appreciation, I dedicate this thesis to my beloved parents, Murad bin Adam and Rozeyati Binti Kamsir. Not forgetting to my beloved wife Ainal Mardia Binti Ahmad Mustaffa Goh. Finally, for my supervisor TS Mohd Hairizal Bin Osman, a lot of thanks to him for him guidance and advices in completing this thesis.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

22MnB5	-	Boron Nitrade
AlCrN	-	Aluminium Chromium Nitride
CNC	-	Computer Numerical Control
HSS	-	High-Speed Steel
LST	-	Laser Surface Technology
EDM	-	Electron Discharge Machining
FIB	-	Focused Ion Beam
mm	-	Millimetre
RPM	-	Revolution Per Minute
kg	-	Kilogram
Mpa	-	Mega Pascal
Gpa	-	Giga Pascal
SEM	-	Scanning Electron Microscopy
XRD	-	X-Ray Diffraction
UTS	-	Ultimate Tensile Strength

CHAPTER 1

INTRODUCTION

1.0 Introduction

This chapter explains the project and the introduction of the project in full detail. Firstly, introduction will be discussed project background as well as problem statement, objective and scope of project will then be covered by this first chapter.

1.1 Project Background

Today, in modern manufacturing, the manufacturing and process industry now get to faces a great deal of challenge. Then, the quality of the final product and the increase in productivity are the example of the challenge of this modern manufacturing sector. This is why many people understand that the manufacturing industry is so valuable for the global. Manufacturing will produce goods service and product in this sector, which will improve and generate domestic growth. Next, this is important to ensure that a country has one of the main factors in the manufacturing industry. It can also help to increase the employment opportunities for employees by having a large industry.

During the turning process, the tool is the oldest tool in the manufacturing sector still used for the production of cylindrical part. It is widely used in the manufacturing sector, including automotive and aerospace, as a significant measure. In dry and wet conditions, this turning process can be done either, because the fluid is not cut and the wet state is dry. Then, surface quality is an important part of the rotational surfaces are critical importance while increasing the strength of fatigue, corrosion and creep life. `

In order to reduce manufacturing and protect the environment, there are several methods that was available for this type of machining. Due to different parameters such as life of a tool, cutting temperature, surface finish, chip formation and material removal and the application of lubricant and coolant could be important to the manufacturing process. The use of cutting fluid at production costs is approximately 7 to 17 %. For this type of machining, there are several methods that can be used to reduce the manufacturing cost and to protect the environment.

In the manufacturing process, the application of lubricant and coolant could be an important factor in different parameter such as tool life, cutting temperature, surface finish, chip formation and material removal rate. About the range of 7 to 17% the use of cutting fluid in the manufacturing cost. In this support, the dry machining process can be applied in order to reduce costs and at the same time it will be help to protect the environment. The aerosol group in the machining process is the main problem with the use of the cutting fluid instead of reducing the cutting zone temperature.

Reduced tool and workpiece temperature is the main task or function for cutting fluid in machining processes. The fluid also will help to reduces the tool chip heat coefficient by reduce the friction, which minimizes both cutting forces and heating of the cutting tool and workpiece. Aluminium Bar is being turned into a with a CNC machine. This experiment is made in a held dry state, that mean the workpiece has a present of lubricant or cutting fluid. During this experiment, machine parameter are considered which is depth of cut, cutting speed and feed rate on the surface of the cutting tool.

The boron steel used in this experiment is taken from the chassis of the scrap car that has been used through the hot stamping process. Using Computer Numerical Control (CNC) Laser Machine, this Boron Steel is used to coated at the surface cutting tool in this experiment. Boron Steel used in this test is also from automotive shell waste. During processing, any or a few items will be inferior to the consumer, not all goods during one row. During the consumer development process, errors arise when output miss happens and the material diverges from its expected nature. Car life cycle is begin and ends in a factory. In life cycle, more material can recycle better the product design. In this case, Boron steel that has end of life cycle can be reused to produce the cutting tool insert. Hence, the cycle life of car chassis is improved.

Nowadays, Boron has widely used in variety of sector of manufacturing and automotive industry. In manufacturing industry, Boron is added to unalloyed and low alloyed steel to increase the hardness of steel. The small amount of Boron to steel, the hardenability should be increase. The advantages of Boron excellent heat resistant and very hard of surface.

Hot Press Forming Boron Steel has very high strength compare to steel after heat treatment process whereby the yield point is about 1350-1400N/mm^2. The strength of this steel is come from boron and manganese content. Hot Press Forming Boron Steel are tempered boron-alloy steel is one of the steel that have highly demand among automotive industry. From the survey, one of the national brand car was Proton Iriz that adopted Hot Press Forming Boron Steel in automotive part at the chassis. The material undergoes hot stamping process also known as press hardening process.

The hot stamping process is one of the innovative sheet metals used to produce parts that are lightweight and strength. In 1997, the Swedish company introduced hot stamping processes. Saab Automobile Ab was the first company in the automotive industry to produce a part using a hardening Hot Press Forming Boron Steel component. The steel can be increased from 500 Mpa to 1500 Mpa by heating stamping process. In the hot stamping process, Hot Press Forming Boron Steel is heated when the material is heated to 900° C and the hot stamp before it is being quenched at 4° C. the austenitic phase occurs during heating and in the cooling process changes to martensitic phase. The strength of steel is increased by this phase of transformation from austenitic to martensitic.

Hot Press Forming Boron Steel is one of the most commonly used high resistance materials in hot stamping. For example chassis, bumper, tunnel, door beam, and many more of component of a car produced by hot stamping. In the automotive industry, demand for safety and weight reduction of automotive body continually increase by reducing car body weight the mass of the material used is one effort to comply with Carbon Dioxide (CO2) regulation is also achieved by reducing the consumption of fuel in the car due to the production of lightweight car body part.

The B-pillar may increase the tensile strength by 500 Mpa by adding heat to the stamping process. The B-section steel standard is within the range 500-700Mpa, but this process is a part of the range 1500-1650Mpa. So, this project is to fabricate the cutting tool by using Hot Press Forming Boron Steel.

By using Computer Numerical Control (CNC) Laser Machine, the machining process on the Boron Steel will be operated in this project. Surface on the cutting tool will be coated by Aluminium Chromium. This process can get a result for flank wear on material from Boron Steel. The surface on the product can improve the performance of slicing, frictional action and more. The cutting parameter used in laser processing may affect the texture performance of the cutting tool.

Sustainable development has in turn been described in many ways, such as in production, which includes conservation in all areas, including climate, social and living, which is the aim of development, while at the same time including the process of natural resources. Not only that, with technological development such as in machining, sustainable development also happens.

1.2 Problem Statement

Turning machining include the use of the turning machine and is mainly used for cylindrical components. There are many manufacturing companies, tool life is a concern. The cutting tool insert will naturally wear because it is used for cutting the workpiece to remove the outer surface of specimen. The machinist usually change the cutting tool on a regular basis so that defective part are not produces. The type of part that will be cut, type of cutting tool insert and the quantity of

material removed all the determine how quickly the insert will wear. It is necessary that operator must check cutting tool insert frequently by measuring a specimen produce by the tool in order to determine if the insert needs to be changed.

By this type of process, research is challenged to find the best and the optimum parameter cutting condition. This project will be use Hot Press Forming Boron Steel as the cutting tool insert then the cutting tool insert will be coated based Aluminium Chromium Nitride. To achieve the optimize and study the parameter, it is necessary to study a journal is needed to get a parameter to perform a turning process. For that reason, the best parameter and quality of the tool and piece of the insert cutting tool is very important to determine. Thus, it must have high hardness properties for the tool material. In additions, during the cutting process, the structured of cutting tool may also decrease a tool wear.

Like all know machining is one of the several process in which a piece of raw material is going thru a cutting that controlled the material removal process into a desired shape and size that usually implies in the same theme with controlled the machining removal and the exactly what the controlled part definition implies is use the machine tools that always use. Machining and parameter is two things that can be apart. A naval approach to increasing cutting tool in term of machining that can be used in present with resource reduction and energy in order to increase overall life of the machining.

1.3 Objective

This project is a study with a CNC turning machine on the parameter in wet turning conditions. The aim of the project is therefore:

- To produce the cutting tool from Hot Press Forming Boron Steel
- To identify the suitable parameter for wet turning process of Aluminium AA6061 Shaft
- To study the tribology and flank wear of insert cutting tool from Hot Press Forming Boron Steel coated by Aluminium Chromium Nitride (AlCrN)

1.4 Work Scope

- Cutting speed, feed rate and depth of cut were the measured machining parameter
- During the process will use lubricant and coolant for wet turning
- 50 mm diameter and 300 mm of length of Aluminium AA6061 Bar will be used for workpiece
- The material for cutting tool insert will be using Hot Press Forming Hot Press Forming Boron Steel
- Turning operation will be perfomed by using Computer Numerical Control (CNC)
- The coating based will using Aluminiun Chromium Nitride
- The experiment layout will use recommended parameter from journal
- Observed the flank wear by using Microscope Nikon Eclipse Lv100

CHAPTER 2

LITERATURE REVIEW

2.0 Literature Review

This chapter will describe about the content of the literature review that related with previous studies about the cutting tool insert in turning process. This chapter will a better research about this project. Literature review will consist of cutting tool for turning process, the material used for the cut and turning process.

2.1 Turning Process

Commonly machining is the most widespread in manufacturing industry for metal shaping process. Usually in manufacturing industry, machining operations such as turning, milling, drilling, boring, tapping and shaping consume large amount of costing every year (Childs, Maekawa, Obikawa, & Yamane, 2000). The aim has always been to successfully achieve increased productivity and to reduce manufacturing costs. Higher value of the cutting parameter provides an opportunity to increase production in the turning process, but there can also be an increased risk that material surface quality and material tool life. The turning process remains the most important function in these machining processes for forming metal by removing the external and internal diameter. The rotating cylindrical external diameter of the workpiece is usually removed by turning process. This operation also can reduce the inner diameter until to specified dimension (Butola,

Jitendrakumar, Vaibhavkhanna, Ali, & Khanna, 2017a). This process is conducted in a chuck on the head provided at the tailstock. This case is rotated by the head stock at the default speed. With help of carriage, cross slide or compound rest, the tool is moved relative to the workpiece. In chip form from the workpiece, the desired metal quantity is removed.

The turning process can be defined as the process is using a single point cutting tool by rotating a workpiece where there is form of the chip will produce by rotating of workipece and will cut by cutting tool. In this case, the chip will produce due to the cutting tool and originated surface were slides each other and will cause a damage to the tool as well as the surface integrity of machined part by the friction induces high temperature (Mia & Dhar, 2017). The importance factor in turning process to improve the surface roughness, increase the tool life, reduce the cutting force and material remove rate through an optimization study. The surface roughness and material removal rate are the most important thing of the performance of this case. Next, there are factor and parameter will affect the performance methods in turning process is feed rate, cutting speed, depth of cut and cutting fluid (Sharma, Dogra, & Suri, 2009).

In this case, the main movement is the feed motion of cutting tool and the rotation of workpiece. The feed movement is the movement of the cutting tool parallel to the rotation of the workpiece, also called a length turn or a perpendicular. In several studies for turning the tool wear made from laminated tools, the wear reate of latter was be found to be considerably higher than the uncoated. Some experimental studies have investigated the effect of the hard layer thickness