Faculty of Mechanical and Manufacturing Engineering Technology

THE STUDY OF FLANK WEAR USING COATED ALNOVA (AlCrN) BORON STEEL (22MnB5) ON ALUMINIUM AA6061

Muhammad Nadzrin Zariq Bin Zakariah

Bachelor of Manufacturing Engineering Technology (Process and Technology) with Honours

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MUHAMMAD NADZRIN ZARIQ BIN ZAKARIAH

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ABSTRACT

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) 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 marten site 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

I would like to dedicate and confront this huge thankful and graceful feeling for this project especially to my beloved parents and my family which gives strength and spirit as well as also supporting for the whole time to completing this project. I would like to dedicate to my supervisor which always assist and provide guidance in implementing this project and always monitor my development of this project. To my entire lecturers I would like to say thank you to be always encouraging to complete this project idea. Besides, do not forget to say a big thank you to my entire friend will always calmly, supporting and reducing stress while preparing this prototype.

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CHAPTER 1

INTRODUCTION

1.0 Introduction

This chapter is about explanation of introduction and flow of the project. Introduction, project background, problem statement and objectives will be cover in this chapter.

1.1 Background

In this new era of modern manufacturing, manufacturing and process industries have to deal with great challenge in order to eliminate as much as possible defect in business term. Along with that, yet still remain in context of environmental friendly concept. Most of people realize importance of manufacturing industries after seeing the challenge faces in the modern manufacturing sector.

Development of the manufacturing industries in the present will generate national growth by either their product goods or service provided. This also will affect at their great of job opportunity provided to local citizen as workers by having large sector of local manufacturing industries.

In manufacturing, turning process can be classified as the oldest cutting tool device yet still in the top rank in commonly used machine for industries. Turning process commonly can be related with to remove unwanted part from cylindrical stock. It is broadly utilized as a part of a considerable measure of manufacturing industries including automotive and aerospace sectors.

Turning process can be either in wet condition or dry condition. In wet turning process, where can be defined as absence on cutting fluid as cooling medium and vice versa for dry turning condition. Good quality of turned surface focused within the performance of turning in order to obtain good result. In order to protect environment, limitation usage of wet turning was applied although by these method also can reduce the manufacturing cost of the industries. Main function of cutting fluid in this machining process is reduce temperature on both cutting tool and workpiece. The temperature was reduced by decreasing friction between tool and surface of workpiece. Therefore, by decreasing the friction will also minimize cutting force applied.

The main task or function for cutting fluid in machining processes is to minimize the tool and workpiece temperature. Material that used to undergo turning process with CNC turning machine is aluminium AA6061. The experiment will undergo with absence of cutting fluid during cutting process; wet turning. Machine parameter that being considered in this experiment are depth of cut, cutting speed and feed rate of the process.

The boron steel used in this test was taken from the frame used during the hot stamping process of the scrap vehicle. Boron has been commonly used in a number of industrial and automotive sectors today. To raise metal hardness, boron is applied to unalloyed and low alloy steel.

Hot Press Forming Boron Steel has very high strength compared to steel after heat treatment with a yield of approximately 1350-1400N / mm2. Hot Press Forming Boron Steel is one of the highly demanding steels in the automotive industry. The material undergoes a process of hot stamping, also known as the process of press hardening. One of the national brand cars from the survey was Proton Iriz, who took Hot Press Forming Boron Steel on the chassis in the automotive sector.

1.2 Problem Statement

As stated before, turning machine commonly used to produce cylindrical parts. The parameter optimized according to wear rate is minimum and maximum productivity. The optimal cutting condition usually held in wet turning process. Absence of cutting fluid are to prevent tool and workpiece from overheating. Based on that, cutting fluid was used during the machining process.

Effect from that process, to find the optimal parameter cutting condition will be a huge obstacle for researcher. Boron Steel will be used as the cutting tool insert then the cutting insert will be coated based Aluminium Chromium Nitride (AlCrN) based. To achieve the optimize parameter, to study a journal must be done 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

1.3 Objective

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

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

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
- Aluminium AA6061 will be used for workpiece
- The material for cutting tool insert will be using coated Hot Pressed Boron Steel

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This chapter will discuss 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

Nowadays, modern manufacturing industries is under large pressure of global competition, strict environmental legislation and demand chain for performance improvement. Although sheet metal forming industries seems to be the highest demand in the present, machining process operation still needed, mostly in automotive industries.

In general, machining is any process where a piece of raw material is shaped by removing unwanted material by cutting process into a desired final shape and size. Machining operation can be either milling, drilling, boring, tapping and shaping will produce a large amount of waste due to cutting process. In business term, their main objective is to minimize cost while maximize production is a must in order to achieve success. It has being confirmed in an article entitle *"Metal Machining Theory and Application"* that machining operation consume large amount of costing every year (Childs, Maekawa, Obikawa, & Yamane, 2000).

In lathe turning process, higher production efficiency can be achieve by obtaining best value of cutting parameter yet can be risk to other possible effect which is surface quality and tool insert life span. Form all machining process in industries, lathe turning still take place in role of important operation in manufacturing.

Lathe turning is a form of machining consist a material removing process that used to create rotational part by cutting away unwanted material. The process requires lathe turning machine, workpiece, fixture and cutting tool. This cutting process usually used to remove unwanted part from cylindrical shape workpiece. The workpiece is secured at the spindle jaw act as fixture itself attached to the machine and allowed to rotate at high speed. This process commonly used to remove outer diameter of the rotating workpiece yet also can remove inner diameter to specified dimension (Butola, Jitendrakumar, Vaibhavkhanna, Ali, & Khanna, 2017).

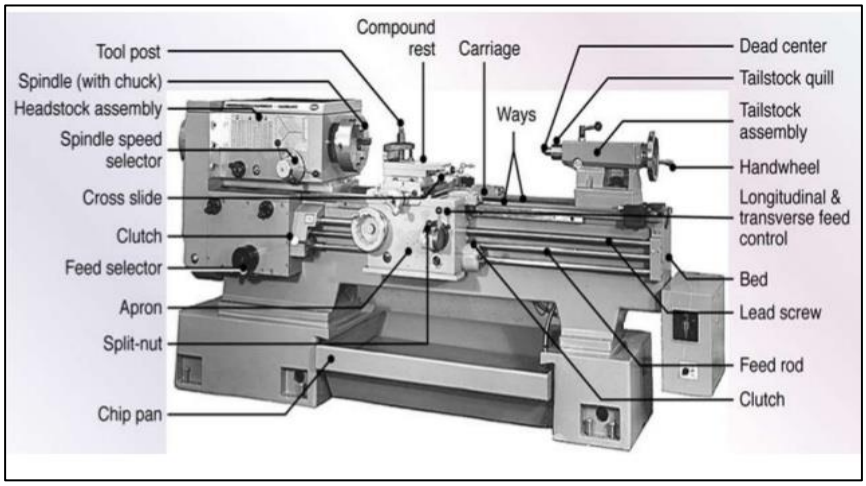

Figure 2.1: Conventional Lathe Machine

2.1.1. Dry turning

Basically, dry turning mean is no lubricant or cutting fluid use during the machining process. This method is becoming increasingly popular due to concern regarding safety of the environment. Nowadays, in manufacturing industry dry turning operation is the best way machining to

produce a good quality of product by using optimize parameter of machine (Sharma, Dogra, & Suri, 2009).

Dry machining is environmental friendly and it was considered necessity for manufacturing industries in present. Furthermore, dry turning also can provide better result and plenty of advantages such as:

- Non-pollution of the atmosphere (no water)
- Reduce disposal and cleaning cost
- No danger to health
- Non-injuries to skin (allergy free)

However, friction and adhesion between chip and tool tend to be higher in dry cutting operation. Friction will causes increase of tool temperature, higher wear rates and shorter tool life span. Optimize machining parameter is the main key to overcome all of the possible consequences happened in dry cutting method following by type of material that will be machine and suitable tool that will be use.

Figure 2.2: Example of dry turning process

Green machining, in other word for dry turning process due to absence of coolant that harmful to environment. Coolant that be used should be

dispose in a good way to avoid it pollute to environment because the use of cutting fluid can involve a serious environment and health hazard (Galanis, Manolakos, & Vaxevanidis, 2008a). This can be conclude as dry turning is environmental friendly that reduce pollution yet reduce machining cost in industries.

2.1.2. Wet turning

In wet turning, cutting fluid are required to perform this process. Cutting fluid in this term of machining function to reducing friction and eliminate any influence on the structure surface layer of workpiece(Galanis, Manolakos, & Vaxevanidis, 2008b). It also help to remove the heat generated during cutting operation in order to ensure better tool life span.

But in recent study, other opinion was observed where cutting fluid application fails to penetrate the chip-tool interface and thus cannot remove heat effectively due to which there is loss of surface finish and tool life (Borse, 2014).

Figure 2.3: Example of wet turning process

Thus, dry machining is now of great interest and actually, they meet with success in the field of environmentally friendly manufacturing.

2.2 Cutting Fluid

The main purpose of using cutting fluid in machining process is to reduce temperature of cutting tools instead of providing better surface finishing at workpiece that being machine. The other opinion was the fluid may also provide corrosion protection for machinery and the workpiece(Sharma et al., 2009).

In addition, over usage of the cutting fluid can cause costing issue since only 15% of the total cost of machining to produce a part need the cutting fluid or coolant (Butola et al., 2017). Thus, strict limitation must be set. It is because, these cutting fluid advantages can present potential environment harm. Dry turning with correct parameter can be a best solution to be replace with in this case.

These some limitation toward cutting fluid according to problem;

- Health problem to the machinist (respiratory and skin problem)
- Environmental pollution due to chemical reaction
- Infection of water and soil pollution
- Increase cost to dispose the used cutting fluid

2.2.1. Type of cutting fluid

In previous study, focusing on improvise tool life span and workpiece due to cutting fluids are important process aids in the manufacture of nearly all metal components and end products(Sharma et al., 2009). Thus, these are four type of cutting fluid:

i. Straight Oil

These oils are non-emulsifiable and very useful in machining operations where they function in undiluted form. Their composition is a base mineral or petroleum oil. Their

advantages are excellent surface finish and extended tool life, even in difficult operation. Also excellent corrosion protection take part when this method applied.

ii. Synthetic Oils

This fluid does not contain mineral oil base or petroleum. Instead, there have a great formulated from the alkaline organic and inorganic compound alongside additive to prevent corrosion. Synthetic fluids offer the best cooling performance. Mineral oil, chlorine, phenol and nitrate free as advantages in environmental friendly. They also provide excellent machine and component cleanliness.

iii. Soluble Oils

Soluble Oils usually form an emulsion after mixing them with water. The resulting concentrate contains emulsions and a base mineral oil to produce a stable emulsion. They function well in their diluted form and offer a great lubrication in addition to heat transfer performance. They are the least expensive and are the most widely used fluids in the industry.

iv. Semi-synthetic Fluids

These fluids are basically a combination of the soluble oils and synthetic fluids. Besides, the heat transfer performance and cost of the semi-synthetic fluids falls between those of the soluble and synthetic fluids. Their advantages more too suitable for wide range of material and machining operation.