UNIVERSITI TEKNIKAL MALAYSIA MELAKA

STUDY ON THE PREDICTION OF CUTTING TOOL LIFESPAN TOWARDS CASTING PROCESSED PRODUCT

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Mechanical Engineering Technology (Maintenance Technology) with Honours

by

AIZAD BIN ALIAS
B071110323
900618025511

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I hereby, declared this report entitled “Study on The Prediction of Cutting Tool Lifespan Towards Casting Processed Product” is the results of my own research except as cited in references.

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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 Engineering Technology (Maintenance Technology) (Hons.). The member of the supervisory is as follow:

………………………………

(Project Supervisor)

ABSTRAK

Tujuan kajian ini adalah untuk menyiasat ramalan terhadap jangka hayat mata alat pemotong daripada eksperimen kepada produk yang berasaskan hasil proses tuangan. Kajian ini telah dilakukan untuk menganalisis kecekapan pemotong High Speed Steel dengan memotong menggunakan berlainan jenis bahan.. Kedua untuk meramalkan jangka hayat matal pemotong dari berlaku nya rosak dan secara tidak langsung dapat melaksanakan program penyelenggaraan. Hasil kajian akan menganalisis melalui kecekapan pemotong High Speed Steel dengan menggunakan blok silinder dan aci engkol oleh pengiraan mass loss calculation. Jangka hayat mata pemotong seterusnya akan diramalkan. Pada akhir kajian ini, kecekapan alat pemotong High Speed Steel dianalisis menggunakan mengikut jenis jenis bahan berbeza.

ABSTRACT

The purpose of this research is to study on the prediction of cutting tool lifespan towards casting processed product. This study is been done to analyze High Speed Steel cutting tool efficiency using different type of material. Secondly to predict the lifespan of cutting tools and purposed maintenance program to prolong failure. The result will be analyzed by means of High Speed Cutting efficiency using cylinder block and crankshaft by mass loss calculation. Next lifespan of cutting tools will be predicted. At the end of this study, the High Speed Steel cutting tool efficiency is analyze using test will be conducted by different type of material.

DEDICATION

I decided my dissertation work to my family. A special feeling of gratitude to my loving parents, Alias bin Yusof and Noriza binti Zainol Abidin whose words of encouragement and push for tenacity ring in my ears plus their endless love and support. Finally yet importantly, I decided to the person whose permanence, perseverance and persistence in spite of all obstacles, discouragements, and impossibilities. It is this that in all things distinguishes the strong soul from the weak.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

m	-	The Slop
y	-	Salar Dependent Variable
c	-	Intercept of Line
x	-	Explanatory Variable Denoted
HSS	-	High Speed Steel
SS	-	Secondary Structure
PCD	-	Polycrystalline Diamond
GCI	-	Gray Cast Iron
TiC	-	Titanium Carbide
NCI	-	Nodular Cast Iron
RPM	-	Revolution Per Minute
PSM	-	Projek Sarjana Muda
RAM	-	Regression Analysis Method
R	-	Coefficient
HRC		Hardness Rockwell C
PDM	-	Predictive Maintenance
R&M		Reliability and Maintanability
FMEA	-	Failure Mode Effective Analysis
TPM	-	Total Productive Maintenance

CHAPTER 1
INTRODUCTION

This chapter contains the introduction and project background. Problem statements, objective and scopes of this project are also discussed in this chapter. Meanwhile, there are chapter organization that explain about overall chapter on this report

1.1 Background of Study

For centuries, casting is a process that was being widely used to produce components of excellent surface finishing, dimensional accuracy and complex shapes (Karanukara, 2012). Casting process has been proven useful for making complex and near-net shape geometry, where machining may not be possible or too wasteful. It is also considered to be the most ancient process of making an art casting. Technology advances have progress casting to be the most modern and versatile among all the metal casting process. Casting is a manufacturing process by which a liquid material is usually poured into a mold, which contains a hollow cavity of the desired shape and then allowed to solidify. The solidified part is also known as a casting, which is ejected or broken out of the mold to complete the process. In manufacturing industry, the correlation between casting process and machining process relate to one another.

In machining operations, the selection of cutting tool materials for a particular application is among the most important factors as is the selection of mold and die materials for forming and shaping processes (Kalpakjian et al. 2006). Only if the surface quality and the tolerances fall within the range of acceptance level, cutting tools can be used. Therefore, it must be replaced when a cutting tool reaches its life before the cutting edge of the tool cannot produce the required surface roughness and the accepted tolerance (Adesta, 2010). Wear is a gradual process, much like the wear of the tip of an ordinary pencil. The tool and workpiece materials, tool geometry, process parameters, cutting fluids, and the characteristics of the machine tool depending by the rate of tool wear. In all machining operations, these conditions induce tool wear, which is a major consideration, as are molded and die wearing in casting and metalworking. Tool life, the quality of the machined surface and its dimensional accuracy, and consequently, the economics of cutting operations adversely influences by tool wear (Kapaljian, 2006).

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The motivation for this experiment is to identify the different substance during casting process which could reflect the machinability life span of cutting tools due to physical properties of material. The developments of this experiment will be carried out with a machining test to determine the lifespan of cutting tools. This experiment will take some sample casting process. This project is expected valuable because it can help to predict the life of cutting tools.

1.2 Problem Statement

Nowadays a manufacturing industry is to produce low cost, high quality products in short time. The selection of optimal cutting parameters is a very important issue for every machining process in order to enhance the quality of machining products and reduce the machining costs (Khorasani, 2011). Milling process is one of the common metals cutting operations and especially used for making complex shapes and finishing of machined parts such as casting process product. The quality of the surface plays a very important role in the performance of the milling as a good quality milled surface. The optimization of machining processes is necessary for the achievement of high responsiveness of production. However, it can cause wear on the tool. A result of physical interaction between the cutting tool and workpiece that removes small parts of material from the cutting tool is known as wear. Tool wear can cause catastrophic failure of the tool that causes considerable damage to the workpiece and even to the machine tool after a certain limit (Kapaljian, 2006).

To ensure a smooth production process, it is necessary to predict the time to change cutting tools. Thus, this project is to identify the variety of variable substance in casting process which can reflect the lifespan of cutting tools as well as to predict the life span of cutting tools.

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1.3 Objective of Research

The objectives of this project are as follows:

1. To analyze HSS cutting tools efficiency using different type of material.
2. To predict lifespan of cutting tools and purpose maintenance program to prolong failure.

1.4 Scopes of Research

In order to reach the objective, a few scopes have been drawn:

1. Analysis of HSS cutting tools efficiency using cylinder block and crankshaft by mass loss calculation.
2. Lifespan prediction of HSS cutting tools using linear regression methods.
3. Proposing maintenance program to prolong lifespan of HSS cutting tools with response to experimental data.

1.5 Organization of Final Project

The remainder of this thesis is compromised of five chapters as summarized below.

Chapter 1: The introduction of correlation between casting process and machining, its background and brief history and the significance of the project.

Chapter 2: A review of literature relevant to the present study of casting product and cutting tool.

Chapter 3: This chapter explains the working procedure to execute the whole project.

Chapter 4: This section analysis and discusses the results that have been complete.

Chapter 5: Conclusions are drawn from the overall findings of the research along with recommendations for future work.

CHAPTER 2
LITERATURE REVIEW

From the early stage of the project, various literature studies have been done. Research journal, reference books, printed or online conference article are the main sources of information for this literature review. The topics discussed in this chapter are type of manufacturing process, type of casting process product, type of cutting tools and linear regression.

2.1 Introduction of Cutting Tool

Any machining operation consists of three basic elements. There are the workpiece which is to be machined, the machine on which the operation will be carried out and the cutting tool which will be used to cut the workpiece (Edwards, 1993). Cutting tools where is any tool that is used to remove material from the workpiece by means of shear deformation Cutting may be accomplished by single-point or multipoint tools. Single-point tools are used in turning, shaping, and similar operations, and remove material by means of one cutting edge. Milling and drilling tools are often multipoint tools. Cutting tools must be made of a material harder than the material which is to be cut, and the tool must be able to withstand the heat generated in the metal-cutting process. Also, the tool must have a specific geometry, with clearance angles designed so that the cutting edge can contact the workpiece without the rest of the tool dragging on the workpiece surface. During the machining the cutting edge is stressed by high temperature and pressure in a small area, so it is important to use fluids with high pressure and a very accurate and high quality cutting edge (Zetek, 2014). The angle of the cutting face is important, as is the flute width, number of flutes or teeth, and margin size. In order to have a long working life, all of the above must be optimized, plus the speeds and feeds at which the tool is run. There are different type of cutting tools which is High Speed Cutting tool, carbide and diamond.

2.1.1 Tool Wear

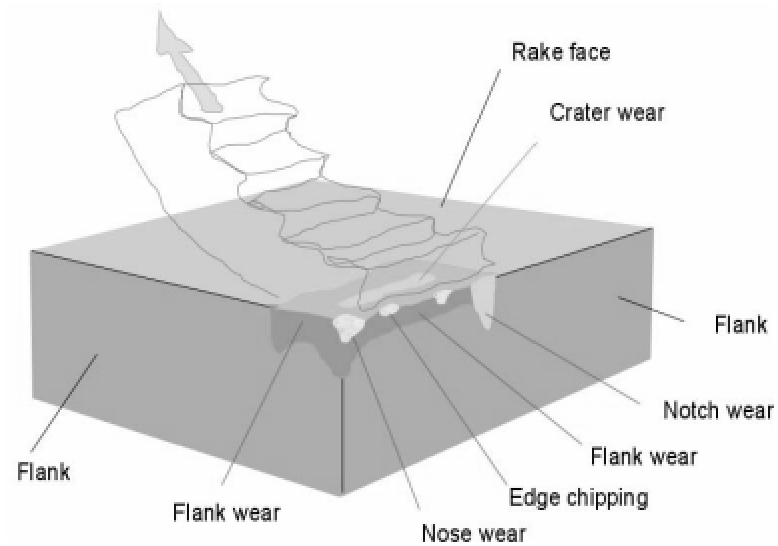

Figure 2.1: Different modes of wear (Hogmark, 2011).

Figure 2.1 above shows the different modes of wear. (Hogmark, 2011)states the cutting tools are exposed to an extremely harsh rubbing process. They are in metal to metal contact, between the chip and work piece, under circumstances of every high stress at a high temperature. The condition is further worsened due to the existence of extreme stress and temperature gradients near the surface of the tools. Cutting tools remove the material from the component to achieve the required shape, dimension and surface roughness during cutting. However, during the cutting action, wears occur, and it can result in the failure of the cutting tool. The worn out tool or edge has to be replaced to guarantee the ordinary cutting action when the tool wear reached a certain extent. Tool wear is the changing of shape of the tool from its original shape, during cutting, resulting from the gradual loss of tool material.

2.2 Type of Cutting Tool

In the industry, machining process uses the tool to cut the material. There are different types of cutting tools which is High Speed Steel (HSS), carbide and diamond. The main properties which any cutting material must possess in order to carry out its function are, it must have a hardness to combat the wearing action, hot strength to overcome the heat involved and sufficient toughness to withstand any interruptions or vibration occurring during the machining process. (Edwards, 1993)

2.2.1 High Speed Steel (HSS) Cutting Tool

Table 2.1: Properties of HSS Cutting Tool (Edwards, 1993)

Tool Material	Properties	Remarks	
High Speed Steel (HSS)	• Unstable. • Inexpensive. • The most common cutting tool material used today. • Hardness up to about HRC 67. Sharp cutting edges possible	Roughing and Finishing	

Table 2.1 above show the properties of High speed steel (HSS) which is the material used in cutting tools. High speed steel has the lowest hardness and the highest toughness of the coating materials in general use (Edwards, 1993). Their major disadvantage is that their hardness is brought about by a heat treatment process so they are not naturally hard. Cutting tools made of high speed steel based deformed composite powder materials are known to develop oxygen containing film, it's called secondary structure (SS). HSS tools are so named because they were developed to cut at higher speeds. Developed around 1900 HSS are the most highly alloyed tool steels. The tungsten was developed first and typically contain 12 - 18% tungsten, plus about 4% chromium and 1 - 5% vanadium. Most grades contain about 0.5% molybdenum and most grades contain 4 - 12% cobalt. In materials under consideration, these layers protect the tool surface from wear. Such material includes, among others, coronets, HSS-based and other similar materials (Kovalev, 2000).

2.2.2 Carbide Cutting Tool

Table 2.2: Properties of Carbide Cutting Tool (Ghani, 2013)

Tool Material	Properties	Remarks	
Carbide	• Stable. • Moderately expensive . • High resistance to abrasion. • Hardness up to about HRC 90. Sharp edges generally not recommended.	Roughing and Finishing	

Carbide tools in machining titanium alloy are being conducted worldwide. Titanium alloy has special characteristics such as high strength at elevated temperature and high mechanical resistance that makes carbide tools suitable to cut this material. This is because carbide tools are classified as hard and highly resistant to wear even at high temperature (Ghani, 2013). Also known as cemented carbides or sintered carbides were introduced in the 1930s and have high hardness over a wide range of temperatures, high thermal conductivity, high Young's modulus making them effective tool and die materials for a range of applications. The two groups used for machining are tungsten carbide and titanium carbide, both types may be coated or uncoated. Tungsten carbide particles are being bonded together in a cobalt matrix using powder metallurgy. The powder is pressed and sintered to the required insert shape. Titanium and niobium carbides may also be included to impart special properties. A wide range of grades is available for different applications. Sintered carbide tips are the dominant type of material used in metal cutting. The proportion of cobalt (the usual matrix material) present has a significant effect on the properties of carbide tools. 3 - 6% matrix of cobalt gives greater hardness while 6 - 15% matrix of cobalt gives a greater toughness while decreasing the hardness, wear resistance and strength. Tungsten carbide tools are commonly used for machining steels, cast