INVESTIGATION OF HOT PRESS QUENCHING ON HARDNESS AND MICROSTRUCTURE FOR HIGH STRENGTH BORON STEEL

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This report is submitted in accordance with requirement of the University Teknikal Malaysia Melaka (UTeM) for Bachelor Degree of Manufacturing Engineering (Hons.)

by

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Sesi Pengajian: **2019/2020 Semester 1**

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DECLARATION

I hereby, declared this report entitled “Investigation of Hot Press Quenching on Hardness and Microstructure for High Strength Boron Steel” is the result of my own research except as cited in references.

Signature : ……

Author’s Name : AMIRUDIN BIN YAHYA

Date : 23 DECEMBER 2019

APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of Universiti Teknikal Malaysia Melaka as a partial fulfilment of the requirement for Degree of Manufacturing Engineering (Hons). The member of the supervisory committee is as follow:

…….....

DR. MUHAMMAD SYAFIQ BIN SYED MOHAMED

ABSTRAK

Kajian di dalam projek ini mengfokuskan kepada kekerasan and mikrostruktur besi Boron. Spesimen utama yang telah digunakan ialah besi Boron dengan kod 22MnB5 iaitu sejenis bahan besi aloi. Sebelum besi tersebut dikaji, beberapa prosedur harus dijalankan terlebih dahulu. Proses utama di dalam kajian ini yang telah dijalankan kepada besi Boron ialah proses rawatan panas dan tekanan dan proses pelindapkejutan. Kedua-dua proses telah dijalankan menggunakan cara dan mesin yang telah diterangkan pada bab seterusnya. Untuk melihat dan menganalisis variasi terhadap hasil proses, beberapa parameter telah dijalankan pada bahan tersebut. Hasil dari data eksperimen, pembezaan telah dilakukan dan pemilihan parameter terbaik telah dilakukan untuk melihat parameter yang memberi kesan terbesar kepada bahan. Hasil dari eksperimen ini, bahan tersebut telah dijadikan sebuah alat memotong untuk mesin pada projek yang seterusnya.

ABSTRACT

This research of this project mainly focused on the hardness and microstructure of a Boron Steel. The main specimen of Boron Steel that has been used is the 22MnB5 a material considered as an alloy material. Before the analysis of the Boron Steel is done, a few procedure have been done first. The main process that was experimented on the specimen is the Hot Press heat treatment and Quenching. Both of the process has been done using a significant method and machine that will be discussed in detail at the following chapter. In order to see and analyse the variation of the process effect, some parameters was set to test the material. By obtaining a bunch of raw data from the experiment, we have differentiate and determine which parameters that suits the most with the specimen material. The output or final product of this project is to produce a cutting tools from the treated specimen in the coming project.

DEDICATION

To my supervisor Dr Muhammad Syafiq bin Syed Mohamed

To my supportive parents and siblings

To my fellow friends

ACKNOWLEDGEMENT

In the name of Allah, the Most Gracious and the Most Merciful

Alhamdulillah, I am thankful and grateful to Allah S.W.T on His blessing that He has shed upon me and given me strength to complete and finish my Project Report for this semester. Without His permission I will not be able to achieve this success and complete my studies. Next, I would like to thank my supervisor in this project which is Dr. Muhammad Syafiq bin Syed Mohamed for his guidance, support and assistance throughout the project. Your service will remain in my heart forever and I hope that our relationship does not end here as I am grateful to continue in becoming your student. To my father, mother and family members I would like to say thank you for the endless support and motivation. To my friends and all that is related both directly and indirectly to this project I would like to thank all of you. I would also like to apologise if I have done any mistakes to all of you during the completion of this project. I hope that we all will meet again one day and I pray that all of us will granted Jannah by Allah S.W.T, Aamiin.

Thank you.

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HSS	-	High Speed Steel
PCD	-	Polycrystalline Diamond
PVD	-	Physical Vapour Deposition
CVD	-	Chemical Vapour Deposition
EBID	-	Electron-Beam-Induced Deposition
SEM	-	Scanning Electron Microscope
AFM	-	Atomic Force Microscope
UHSS	-	Ultra-High Strength Steels
UTS	-	Ultimate Tensile Strength
HFDQ	-	Hot Forming Die Quenching

CHAPTER 1

INTRODUCTION

1.1 Background of the Study

In current era of automation industry, the usage of Boron steel is highly recommended. It is because the characteristics of the Boron steel itself. According to Güler, Ertan, & Özcan (2013), designing vehicles with reduced weight but maintaining the high safety characteristics is the major requirement for variety type of product. By reducing the weight of the vehicles, less fuel consumption can be achieve as the weight carried by the engine is less compare to car with mild steel chassis.

Most of the study that are related to Boron steel is connecting to the automotive industry. This is due to the investigation on how to produce a higher strength Boron chassis still continue until today. The microstructure and hardness of the Boron steel limit are yet to be investigated. So, this study will focus on the effect of hot press quenching on hardness and microstructure of the Boron steel.

Other than automotive industry, Boron steel also applicable to the machining and other manufacturing process. The main part which Boron steel used in manufacturing part is the cutting tool usage in the industry. This is because its basic characteristics which make is suitable for cutting tools application. This will be discussed deeper in the next chapter.

The target or desired product of this study is a high strength boron steel material with good microstructure surface for multi-propose application whether in automotive industry or any other related fields such as cutting tools for machining application.

1.2 Statement of Problem

According to current situation in automotive industry the problem faced are:-

- Current heat treatment for Boron steel waste a lot of energy as large furnace is used even for a small specimen need to be treated.
- When heat treatment is done, the operator can be harm due to hot condition in furnace is released to the environment when the operator open the furnace door.
- Current furnace is suitable only for large component as the energy exerted to perform heat treatment is same either small or large components.
- Hardness and microstructure of Boron steel after the heat treatment is not analyse yet for small specimen.

1.3 Research Objectives

The objectives of this study are:-

- To perform Hot Press Quenching on Boron steel without using large furnace in order to save more energy.
- Analyse the hardness and microstructure of Boron steel after using the heat treatment process is done.
- To investigate suitable cooling medium after Boron steel heating is done.
- To produce a cutting tool from the harden Boron steel specimen.

1.4 Scope and Limitation of the Study

The scopes of this study are:-

- The material that will be used to carry out the experiment is Boron steel 22MnB5 only.
- Hot Press Quenching process will be done using resistive sintering machine.
- Cooling medium that will be used are water, ice and oil.
- Microstructure and hardness analysis will be done using experimentation process.

CHAPTER 2

LITERATURE REVIEW

Introduction

This chapter will discuss about materials, components, machines and processes that will be used in the experiment and project. All of the information are collected from previous studies, research and engineering handbooks.

2.1 Materials for Cutting Tools

2.1.1 High Speed Steel (HSS)

According to Materials (2019), in the Materials and Manufacturing book stated that High Speed Steel (HSS) is a suitable material for cutting tool because of its characteristics which is high hardness and wear resistance. This is because the basic requirement of a cutting tool that the material for the tool need to be harder than the material that need to be cut.

Although HSS is considered an old material compared too much advanced material, it is still a tougher material and can withstand relatively high impact which make it is a favourite material for cutting tool. HSS also have the abilities to be sharpen multiple times by using only basic abrasive process. This not only elongate the cutting tool life span but will also save the cost for the manufacturer.

Figure 2. 1: HSS cutting tool insert. (Source: Google)

The disadvantage of HSS cutting tools are it is not as hard as ceramic cutting tools which means that material with high hardness characteristics may damage the cutting tool or the cutting tool will not be able to cut through the material. It also allow only low cutting temperature thus limiting the type of material that it can cut. After sharpen the geometry of the HSS cutting tools is also permanently changed. This will lead to unfit cutting tool with the carbide inserts making it need to be changed into a new one.

2.1.2 Ceramics and Cermet Cutting Tools

In 1930, the Cemented Titanium Carbide is the first type of material that is used as a high-speed cutting for steel. It is also known as Cermet a cutting material with desired properties which are high temperature strength and toughness. (Moskowitz & Humenik, 2012)

The material is a combination of titanium and ceramics. Ceramics are commonly known as a hard material, wear resistance and high melting point. For a ceramic cutting tools there are no presence of metal or easier to call non-metallic (metallic binder absence) and basically made of oxides such as alumina (Al_2O_3). But, for Cermet is different because it has the element of ceramics cutting tools which is it has the non-metallic elements but the particles are held together by metallic binder such as titanium carbide and titanium nitride.

Cermet is also reserved for carbides other than tungsten carbide and sometimes recognised as hard metal especially those based on titanium carbide.

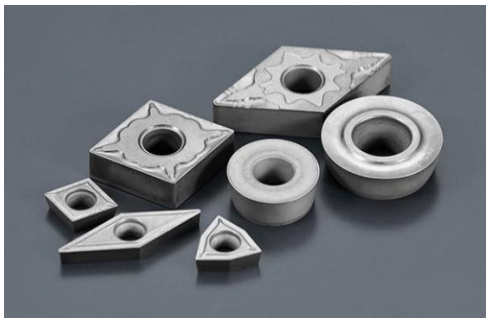

Figure 2. 2: Cermet cutting tools. (Source: Google)