DESIGN AND ANALYSIS OF CASTING MOLD USING CAD TOOL

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Manufacturing Design) with Honours.

by

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I hereby declared this entitled “Design and Analysis of Casting Mold Using Cad Tool” is the results or my own research except as cited in references.

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Date : 11th May, 2010
This report is submitted to the faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the degree of bachelor of Manufacturing Engineering (Manufacturing Design) with Honours. The member of the supervisory committee is as follow:

Supervisor: MR. TAUFIK
Date: ................................................
Stamp: .............................................
This project presents the design and analysis of casting mold using CAD Tool. The project basically investigated the design parameters for the casting mold and simulated the temperature and pressure on the mold. Turbocharger impeller was selected as the product of the study. Among the various types of casting techniques, investment casting process is the most suitable process to produce the turbocharger impeller. The alternative design of casting mold by investment casting was generated using CAD software. Concept scoring was prepared in order to select the suitable design for the investment casting process. Material selection of turbocharger is Aluminum Silicon Carbide. Stainless steel AISI H13 is selected as the material for the mold. The parameter for the mold design is included branch, gating, sprue and runner. Analysis was presented to the mold by using ANSYS simulation tool, in order to determine the temperature and pressure of the mold. In addition, three case studies were presented in order to compare the static pressure in different velocity and temperature of the mold design. The result showed the runner and the branch size were important to produce the molten metal flow into the mold pattern. As a result, the design of investment casting mold was proposed.
ABSTRAK

DEDICATION

This report is dedicated to my father and mother who have taught me that even the largest task can be accomplished if it is done step by step.
ACKNOWLEDGEMENT

I would like to take this opportunity to express my highest gratitude and appreciation to my supervisor Mr. Taufik for continuing supports, supervises, encouragement, patience and constructive opinions throughout this project.

I am grateful for the cooperation and guidance which are given by my friends. First of all, I really appreciate the kindness of my friends who gave me so much important information about the project and willing to help me answering my entire question without hesitation.

I am as ever, especially indebted to my parents for their love and support throughout my life. I also wish to thanks my sisters and brother for their encouragement and understanding on this project.
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LIST OF ABBREVIATIONS

AISI H13 - Chromium-Molybdenum-Vanadium Allooyed Steel

CAD - Computer Aid Design

CFD - Computational Fluid Dynamics

CFX - Advanced Computational Fluid Dynamics

STL - Stereolithography

Utem - Universiti Teknikal Malaysia Melaka
CHAPTER 1
INTRODUCTION

1.1 Background

There is various manufacturing process to produce parts which is including machining, casting, joining, forming and shaping. Among these manufacturing processes, metal casting is the most effective to produce metal parts. Metal casting processes include sand casting, plaster casting, investment casting and etc. Each of the process has its own characteristics and application to meet specific engineering and services requirement.

According to Kasim, et al. (2008), manufacturing process selection is the task of choosing a method for transforming a set of material into a given shape using one or more processes. The material and manufacturing process selection problem is a multi-attribute decision-making problem. These decisions are made during the preliminary design stages in an environment characterized by and uncertain requirements, parameters, and relationships. Material and process selection decisions occur before design for manufacturing can begin.

According to Ravi and Datta (2004), metal casting has been mentioned in ancient Sanskrit texts such as Shilpashastra and Yantra Sarvasva and detailed in mediaeval texts such as Shilparatna and Manasara. The major application was in creating the idols used for worship; and very strict rules were laid down to achieve perfection in terms of talmana (proportions), mudra (stance) and bhava (expression). Other products included lamps, doors, frames, bells, cooking utensils, agricultural implements and weapons.
According to Kalpakjian and Schmid (2006), metal casting technology was started before 4000 B.C. by using materials such as gold, copper and meteoric iron. Lost wax process which is known as investment casting was started around 4000 B.C to 3000 B.C. The technique of metal casting is keeping improved until nowadays to produce the best quality of metal product and to achieve public need and requirement.

For metal casting process, mold filling is the most important step in determining the quality of a casting. Surface quality, porosity caused by gas entrapment, misruns, micro segregation and mold erosion caused by strong metal streams. All these phenomena can be closely related to the mold filling condition. Therefore, mold life is also affected by mold filling. Although the solidification process appears to be of primary interest to the foundry engineer, solidification alone does not suffice for accurate prediction of casting quality refer to Attar et al. (2005).

A good design of mold will allow a smooth flow when filling. Therefore, mold design process is important to produce a better metal casting product. This study will carry out a casting mold design by using a CAD tool SolidWorks. The designation and the type of casting mold will be validated. The finite element analysis will be done on the mold. The analysis of heat transfer, temperature & pressure will be presented by using ANSYS. An automotive part, turbocharger impeller will be used as the product for the casting mold.

1.2 Problem Statement

As an automation part the turbocharger impeller is a very unique product. It needs sharp edge and strength to sustain it life. The angle of curvature at the inlet of curve inducer blades is hard to produce using machining technique. It is a time wasting if producing turbocharger impeller by using machining technique. Therefore, a sufficient technique is needed to produce this product with perfect quality and quantity. Metal casting is suitable for producing a metal product. To produce complex shape product with curve inducer blades, the type of metal casting process for the mold need to be determined.
1.3 Objectives

The objectives of this project are:

a) To investigate the design parameters in designing casting mold.
b) To analyze the temperature and pressure in casting mold.
c) To propose a design of investment casting mold.

1.4 Scope and Key Assumption

This project presents the design of casting mold using CAD tools. SolidWorks is used to perform the details drawing of the mold. The analysis of temperature and pressure is presented by using simulation ANSYS. As a result, the design of investment casting mold is proposed. Stainless steel H13 is selected as the material of the mold.

1.5 Organization of the Report

The whole report is divided into six major parts, which is known as Introduction, Literature Review, Methodology, Results, Discussion, and Conclusion. Each chapter is briefly such as below:

a) Chapter 1: Introduction

This chapter briefly describes about the background of the study, problem statement, the objectives and scopes of the project. In the end of this chapter, it summarized the whole project and Gantt chart of the project will be shown at the end of this chapter.

b) Chapter 2: Literature Review

In this chapter, related information of the project is summarized. The literature reviews includes the introduction to technology of casting, selection of the casting mold type, material selection for the mold and tool selection for design the mold and
to analysis it. The sources which are from journals, books, internet, articles and others are the guide to completing this project.

c) Chapter 3: Methodology
Methodology shows the flow of designing of the project. It starts from the problem analysis to the concept generation and concept selection and make the design decision. It is then following with the process of investment casting mold to produce the turbocharger.

d) Chapter 4: Results
In this chapter, the analysis of the mold is presented which is including temperature and pressure of the selected mold. At the end of the process, the design parameter is defined and an investment casting mold is proposed.

e) Chapter 5: Discussion
This chapter generally discusses on the result of the finding and implicate of the project. The finding is comparing to the objectives of the project whether it cover the scope of the study.

f) Chapter 6: Conclusion
At the end of the report, summarize of the project is make. Alternative suggestion or recommendation is given to improve in future study.
Gantt chart is built to show the sequence of the project flow and activities. Figure 1.1 such as below shows the Gantt chart for PSM 1 which is briefly shows the time taken to finish the task in completing the project.

**Figure 1.1:** Gantt Chart of PSM 1.