DESIGN OF CASTING MOLD FOR NATURAL FIBER – METAL MATRIX COMPOSITE MATERIAL

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

by

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FACULTY OF MANUFACTURING ENGINEERING
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APPROVAL

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 (Design) (Hons.). The member of the supervisory is as follow:

………………………………

(Project Supervisor)
ABSTRACT

Casting is an important process to produce a product. Sand casting method is used to do research to combine metal matrix composite with natural fiber. This new material will be used as mold material to reduce the usage of raw metals and increase material properties for the mold. The objective of this research is to design the sand casting mold for the mixture of natural fiber and metal matrix composites (MMC). The pattern of sand casting product involved an Aluminum alloy (LM6) as metal matrix alloy, Titanium Carbide as reinforced material, and empty fruit bunch as natural fiber composites. Open mould sand casting was used to produce MMC and then introduce the natural fiber during the solidification stage. A problem occurred when the filling process in open mould must be laminar flow and there is no gating system to flow the molten metal. There are four design concepts which have pouring basin and runners are generated and simulated with ANSYS software. The result that has been analyzed to compare each design concepts were velocity, internal energy, pressure, turbulent kinetic energy, wall shear stress and cell Reynolds number. Furthermore, the evaluation of each concept were analyzed are the best design was chosen with the aid of ranking method. As the result, concept 3 was selected due to its features that provide a casting with low defects.
ABSTRAK

DEDICATION

Special dedicate to all persons that help me in completing my final year project especially to my project supervisor Dr Taufik.

To my beloved parents, my family, thank you for your comfort and supported me.

And not forgotten, Thanks to my lecturers and friend.

This report I’m fully dedicate to all of you.
ACKNOWLEDGEMENT

First and foremost, I want to thanks the god because without his grace I will not able to complete this Final Year Project (FYP) and report for the session 2012/2013 as well as possible. Here, I would like to thank my University Teknikal Malaysia Melaka (UTeM) coordinator/supervisor Dr Taufik, who advice and guide me to complete the Final Year Project and report in time. During to complete this Final Year Project (FYP) and report, I face lots of problems and difficulties. However, I manage to crossed it all with patience and complete it properly. The journey in completing Final Year Project (FYP) and report really teach me in terms of leadership, proper time management, communication skill, technical knowledge, soft skill and so many more. The advice and encouragement from supervisor is really motivating me to do the best. In addition, my family members and friends also became a part of in completing the Final Year Project (FYP) and report, which help me in giving some rational idea and supports. Finally, I would like to thank those involved directly and indirectly in completing the Final Year Project (FYP) and report successfully. Thank very much to you all.
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<td>Computer Aided Design</td>
</tr>
<tr>
<td>EFB</td>
<td>Empty Fruit Bunch</td>
</tr>
<tr>
<td>HTC</td>
<td>Heat Transfer Coefficient</td>
</tr>
<tr>
<td>FEA</td>
<td>Finite Element Analysis</td>
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<tr>
<td>FEM</td>
<td>Finite Element Method</td>
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<td>FMM</td>
<td>Federation of Malaysian Manufactures</td>
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<td>GHG</td>
<td>Greenhouse Gas Emissions</td>
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<td>MMC</td>
<td>Metal Matrix Composite</td>
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<td>OPEFB</td>
<td>Oil Palm Empty Fruit Bunch</td>
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<td>SDAS</td>
<td>Secondary Dendrite Arm Spacing</td>
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CHAPTER 1

INTRODUCTION

This research entitled “Design of Casting Mold for Natural Fiber-Metal Matrix Composite Material”. Generally this chapter provides information about background, problems statement, objective and scopes of the project. Besides that, outline of the study also included in this chapter.

1.1 Background of Project

Casting is a process where liquid material poured into a casting mold to produce desired parts. According to Federation of Malaysian Manufactures (FMM), there are about 16 companies who involve in casting process in Malaysia. Obviously, the casting industry are grown well in past few years and the opportunity to work in this industry are wide since this industry requiring more expertise to run this casting more efficiently. In Malaysia, this industry is growing rapidly specially in sector of manufacturing such as automotive, aerospace and shipping.
Generally, the quality of casting outcome must be archived in order to satisfied customer requirement by customization in customer desired shape. The quality of product is considering the dimensional accuracy and surface finish. These both considerations can be controlled with process choice and design parameters. The best quality product outcome can reduce production costs, processing time, and to assure reproducibility of the casting operation and increase of production.

Using casting so many parts or products can be produced, in that case this project will take a look into casting a production tooling parts such as cutting tools. To fabricate this cutting tool, material that usually used is cast iron, high carbon steel, silicon nitride and many more. So in order to reduce raw material usage in this kind of applications and to get better mechanical properties, this project focuses on to introduce natural fiber - metal matrix composite as a material for casting mold.

It is very hard to combine metal matrix composite with natural fiber but there is a possibility to combine this both materials. Method that will use is sand casting process where the molten metal of the metal matrix composite is poured is the casting and adds the natural fiber at suitable temperature. This process done by using open mould sand casting with the metal used were Aluminum Alloy LM6, Titanium Carbide and the natural fiber is Oil Palm Empty Fruit Bunch (OPEFB).
1.2 Problem Statement

Problems that should highlight here is the metal matrix composite (MMC) melted up to 700° and then only will poured in sand casting and it is an open mould. A study on thermal flow should be conducted to get a laminar flow for molten MMC during filling the mold, so no defects occurred in it. This study will conduct by suggesting few designs to fill molten metal into the open mould sand casting. At this temperature also, natural fiber will vanish so there is challenges to get to know the suitable temperature for add the natural fiber into the solidifying molten metal.

1.3 Objective

a) To investigate the design parameters for casting mold and for material fiber – metal matrix composite.

b) To analyze the casting mold using engineering analysis tools.

c) To design the casting mold engineering application.

1.4 Scope of Project

The whole scope of this project is to study on thermal flow and design the runner system to flow the molten metal. For this project, open mould sand casting is used as casting technique. The project will focused on the design parameters such as velocity magnitude, internal energy, static pressure, turbulent kinetic energy, wall shear stress and cell Reynolds number. Aluminum Alloy LM6 and Titanium Carbide together with Oil Palm Empty Fruit Bunch (OPEFB) are used as the material for casting product. Silica sand used as the sand casting mold. The model of runner system for the sand
The casting designed using CAD tools, SolidWorks and the geometry of the runner system analyzed in engineering simulation software, ANSYS FLUENT. The thermal flow was determined during filling process in the sand casting. The outcome of the simulation has been discussed and later on will chose the best design of runner system based on the ranking of each concept. At the moment, there are no researchers have been studied in the field of study. Therefore, this project has potential to contribute to the manufacturing industries.

1.5 Synopsis of the Report

The project report should be arranged systematically in order to convey better understanding entire of the study. So that, an outline of the project has been constructed to briefly explain and summarize the content of every chapter. Overall of this study are divided into six chapters. They are:

a) Chapter One : Introduction

This chapter is about an introduction to the projects which include background, problem statements, objective, and scopes. At end of this chapter, the summarization of the project was shown.

b) Chapter Two : Literature Review

This chapter briefly explained about related information and research on the project. The previous findings and studies by other researchers and taken into consider for this project. There are many resource can used in order to find supporting details for this chapter such as books, journal, patents and etc.
c) Chapter Three: Methodology

This chapter will describe about the process flow of the project which indicates the whole project plan that to be followed in order to completing the project. There are 5 stages in this methodology, it is design planning, design generation, design simulation, design selection and design presentation.

d) Chapter Four: Result and Discussion

The result of the simulation towards the thermal flow showed here. The findings covered the pressure, velocity, internal energy, turbulent kinetic energy, cell Reynolds number and wall shear stress. The result has been discussed here in order to get the laminar flow during filling process. The best design was chosen using concept screening and concept scoring.

e) Chapter Five: Conclusion and Recommendation

At the end of this report, the findings base on result and the objectives of study was summarized. In this chapter, the suggestion and recommendation is given to improve the result on the future study.
CHAPTER 2

LITERATURE REVIEW

This chapter explains about the literature review that was used in this project to complete it. All the studies are summarized in this chapter.

2.1 Casting Technology

According to Kalpakjian & Schmid (2010, p258), casting is a manufacturing process where hollow cavity in a mold of the desired shape was poured liquid material into the mold and then allowed it to solidify. To complete the process, the solidified part is either ejected or broken out of the mold it is known as a casting. Metal casting was made during ancient times using metal moulds. By times goes by, too many casting process was improved where each of it has own characteristic which is use for various application to meet specific design requirements have. A large variety of parts and components are made by casting such as engine blocks, crack shafts, automotive components power strains, agriculture, railroad equipments and many more.