



**DEVELOPMENT OF COMBUSTION CHAMBER  
FOR SOLID BIOMASS FUELS**

**KHAIRUL HELMI BIN HASHIM  
(2001194602)**

A thesis submitted in partial fulfilment of the requirements for the award of Bachelor  
of Engineering (Hons.) Mechanical

**FACULTY OF MECHANICAL ENGINEERING  
UNIVERSITI TEKNOLOGI MARA (UiTM)**

**APRIL 2005**

## **ACKNOWLEDGEMENT**

In the name of Allah S.W.T, The Almighty and The Most Gracious who has given me strength and ability to complete this project. All perfect praises belong to Allah S.W.T, Lord of Universe. May His blessing upon the Prophet Muhammad S.A.W and members of the family and companions.

Firstly, I would like to express my gratitude to the project advisor, Mr. Wan Ahmad Najmi bin Wan Mohamed for his guidance, supervision, encouragement and discussion throughout all the work in this project.

Secondly, I am indebted to my partner in this project, Mohd Azizul bin Mohd Noor, for all his commitment and efforts to ensure the success of this project. I hope all the experiences and knowledge accumulated from this project would be very beneficial to him as well as to myself.

To all the staffs of faculty workshops especially Mr. Ridhuan from Automotive Workshop, Mr. Khuzairi from Welding Workshop, Mr. Fadzly from Sheet Metal Workshop, and Mr. Adam from Machine Workshop, thank you for all the assistance and advises given for this project.

Lastly, I want to thank to my family for their support and to all individuals who directly or indirectly involve in the completion of this project.

## **ABSTRACT**

The project of ‘Development of Combustion Chamber for Solid Biomass Fuels’ has been carried out by the final year students of Bachelor of Engineering (Hons.) Mechanical, under the supervision of Mr. Wan Ahmad Najmi bin Wan Mohamed. The project aimed to develop a practical combustion chamber for solid biomass fuels for research and evaluation, and also acts as a platform for examining the combustion properties of biomass fuels. The development consist of three stages, namely design, fabrication, and testing. The combustion chamber is a manually fired type was made using common materials with firebrick as refractory wall. Results from the test firing using palm oil shell as a fuel showed that the design confirmed with the specification and left some rooms for further improvement.

## TABLE OF CONTENTS

CONTENTS	PAGE
AUTHOR DECLARATION	i
CERTIFICATION	
ADVISOR	ii
HEAD OF PROGRAMME	iii
PAGE TITLE	iv
ACKNOWLEDGEMENT	v
ABSTRACT	vi
TABLE OF CONTENTS	vii
LIST OF TABLES	xi
LIST OF FIGURES	xii
LIST OF ABBREVIATIONS	xiv

### CHAPTER I INTRODUCTION

1.0	Introduction	1
1.1	Project Objectives	2
1.2	Project Scope	2
1.3	Biomass as Energy Source	3
1.4	Advantages of Using Biomass Fuels	4
1.5	Methodology	5

## **CHAPTER II      LITERATURE REVIEW**

2.0	Introduction	6
2.1	Biomass Fuels	
2.2	Combustion Process	7
2.3	Theoretical and Actual Combustion Process	9
2.4	Methods of Generating Energy From Biomass Fuel	10
	2.4.1 Combustion of Solid Biomass	10
2.5	Examples of Combustion Technologies	12
	2.5.1 Manually Fired Combustion Chamber	12
	2.5.1.1 Burn-Through Combustion Chamber	13
	2.5.1.2 Underburn Combustion Chamber	13
	2.5.1.3 Reverse Combustion Chamber	14
2.6	Design Considerations	15

## **CHAPTER III      DESIGN AND FABRICATION STAGE**

3.0	Introduction	16
3.1	Problem Statement	16
3.2	Design Requirements	17
3.3	Introduction to Stoichiometric Air-Fuel Ratio Analysis	19
3.4	Air-Fuel Ratio for Biomass Fuels	21
3.5	Size of The Combustion Chamber	23
3.6	Fuel Feed Rate	23
3.7	Refractory Selection and Thickness	24
3.8	Air Supply Requirements	24
3.9	Preliminary Design	26
3.10	Final Design	27
	3.10.1 Specifying Chamber Dimensions	27
	3.10.2 Fuel Grate Inclination	29
	3.10.3 Openings and Hatches	32