APPROVAL

This PSM submitted to the senate of UTeM and has been as partial fulfillment of the requirements for the degree of Bachelor of Mechanical Engineering (Automotive). The members of the supervisory committee are as follow:

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(En. Mohd Afzanizam Bin Mohd Rosli)

(15 May 2009)

DESIGN AN EXHAUST SYSTEM FOR FORMULA STUDENT RACING CAR

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This thesis is submitted to the Faculty of Mechanical Engineering, in partial fulfillment of the requirement for the Bachelor of Mechanical Engineering (Automotive)

Faculty of Mechanical Engineering
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(UTeM)

May 2009

DECLARATION

I hereby, declared this thesis entitled "Design an Exhaust System of Formula Student Racing Car" is the results of my own research except as cited in references.

Signature	:	
Author's Name	:	Mohd Samsudin Bin Mat
Date	:	15 May 2009

DEDICATION

To my beloved parents and friends.

ACKNOWLEDGEMENTS

In the Name of Allah almighty and the most Merciful and Blessing Be upon His Messenger prophet Muhammad s.a.w and his Companions

I would like to take this opportunity to express my utmost gratitude to everybody who had extended their valuable assistance in the process of completing my thesis work.

First and foremost, I would like to express my appreciation to my thesis supervisors, Mr. Mohd Afzanizam Bin Mohd Rosli, who has always been so kind and patient to guiding, advising and helping me in all the question and problems arose. He is always ready and willing to share all my problems and achievements in every stage of my thesis work. Thank you very much for all he has extended for the timely completion of my thesis work.

Secondly, my highest gratitude goes to Faculty of Mechanical Engineering of Universiti Teknikal Malaysia Melaka (UTeM). All the staff and lecturers that involved directly or in directly in processing to complete this study, thank you very much.

I would also want to thank my parents and friends for giving me the moral support throughout this busy but memorable period. Last but not least, I want to thank everyone who had granted their helps willingly and patiently.

ABSTRACT

Exhaust system is a very important system in automotive design. The efficiency of an exhaust system will affect the whole vehicles' performance. An exhaust pipe must be well designed to achieve the optimum power for this Formula Student racing car (F.S.R.C). In this project, the existing design of an exhaust system used by the Formula Student racing car will be investigated. The design was simulated using Computational Fluid Dynamics (CFD). A new design has been developed to compromise the better exhaust pipe for the F.S.R.C.

ABSTRAK

Sistem ekzos adalah satu system yang sangat penting dalam system automotif. Kecekapan system ekzos akan mempengaruhi seluruh persembahan kenderaan. Paip ekzos mesti direka dengan baik untuk mencapai kuasa optimum bagi “Formula Student Racing Car” (F.S.R.C) ini. Dalam projek ini, rekaan sistem ekzos sedia ada yang digunakan pada kereta lumba “Formula Student Racing Car” akan dikaji. Rekaan ini akan dianalisis menggunakan Dinamik Bendalir Berkomputer (CFD). Satu rekaan baru dibuat untuk menentukan paip ekzos yang baik untuk F.S.R.C.

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LIST OF ABBREVIATIONS, SYMBOLS, SPECIALIZED NOMENCLATURE

BDC	-	Bottom dead center
CAD	-	Computer Aided Design
CFD	-	Computational fluid dynamic
FEA	-	Finite element analysis
F.S.R.C	-	Formula Student Racing Car
CCC	-	Close couple converter
Cm	-	Centimeter
CO	-	Carbon oxide
COSMIC	-	Computer Software Management and Information Center
EPA	-	Environment Protect Agency
HP	-	Horsepower
In	-	Inch
Kw	-	Kilowatts
Min	-	minimum
Mm	-	Millimeter
Mph	-	Miles per hour
NO	-	Nitrogen oxide
NO2	-	Nitrogen dioxide
Pa	-	Pascal
PSM	-	Projek Sarjana Muda
RPM	-	Rotation Per Minute.
SAE	-	Society of Automotive Engineers
Utem	-	Universiti Teknikal Malaysia Melaka
3D	-	3 Dimensional
2D	-	2 Dimensional

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CHAPTER I

INTRODUCTION

1.1 Background

Generally, the exhaust system begins with manifolds on the engine and ends with the tail pipe. Basically, it includes an exhaust manifold, heat riser, exhaust pipe, catalytic converter, muffler, resonator (optional), and tail pipe. Exhausts maybe made from steel, aluminium, titanium, carbon fibre or kevlar. Exhaust system comes in many different varieties depending on the type of engine and its intended use. An exhaust system is usually tubing used to guide waste exhaust gases away from a controlled combustion inside an engine. The entire system conveys burnt gases from the engine and includes one or more exhaust pipes. Depending on the overall system design, the exhaust gas may flow through one or more of:

1) Cylinder head and exhaust manifold
2) A turbocharger to increase engine power.
3) A catalytic converter to reduce air pollution.
4) A muffler / silencer, to reduce noise.

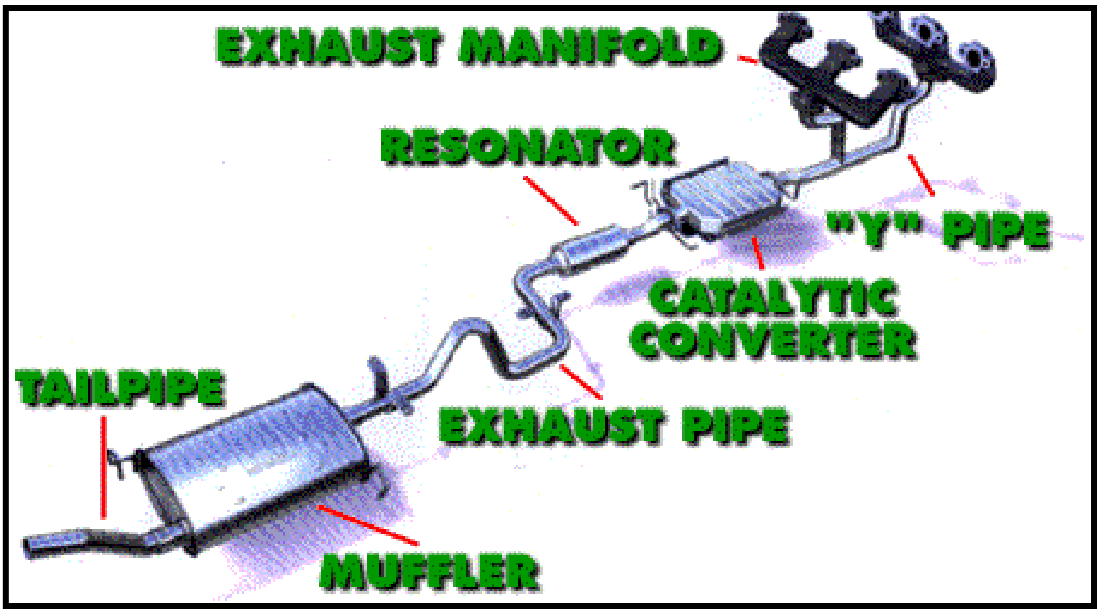

Figure 1.1 Basic components of an exhaust system

Over the years, the exhaust system has been given more responsibility and its job has grown. Originally, it was a relatively simple duct system designed to prevent toxic exhaust gases from entering the driver's cab. Today, the modern diesel exhaust system reduces noise and even lends a hand with increasing a vehicle's fuel economy, power and overall drivability.

Legislation to control the levels of these emissions occurred in 1988, 1990, 1991, 1994, 2004, and 2007. Each regulatory change reduced the acceptable levels of combustion-related gases which could be allowed to exit the exhaust system. To meet these emission laws, Cummins Filtration works closely with all engine manufacturers to provide exhaust system components. As the global leader in exhaust design, Cummins Filtration develops and provides highly specialized. Fleetguard exhaust systems that reduce noise and minimize harmful gases. (www.quickhonda.net/exhaust).

But, this project just briefly study and discuss the exhaust pipes of the formula student racing car of University Technical Malaysia Melaka (Utem).This paper presents some results of past researches and simulation results of the existing exhaust model (Formula Student Racing Car's exhaust) and the modification exhaust model. From these results, the better exhaust designs can be defined.

Figure 1.2: Formula Student Racing Car (Faculty of Mechanical Engineering, UTeM)

1.2 Objective

The objective of this project is:

- to design the optimum exhaust pipe for ‘Formula Student Racing Car’.
- to investigate the flow distribution along the exhaust pipe..
- to fabricate a new design of exhaust for Formula ‘Student Racing Car’.

1.3 Scope of The Project

- Studying an existing design of exhaust system
- Fabricating the exhaust (model)
- Analyzing exhaust system using Computational Fluid Dynamics (CFD)

This project involves theoretical and analytical investigation of an exhaust system. Literature study on the exhaust will be discussed to analyze the details due to existing exhaust system. Then, an example of an exhaust pipe, the existing exhaust of Student Racing Car's exhaust is designed and modelled using AutoCAD. Using Gambit software, the model is redesigned. After that, Computational Fluid Dynamic (CFD) will be used to simulate and analyze the designed exhaust pipe and the result gathered. A new model, modification exhaust model of the existing exhaust is designed whereas it also being simulated and analyzed.

From the result, improvement will be make to justified the exhaust system condition and structure for the purpose of identification of failure behaviours by referring to the analyzed data and the different factor of failure.

1.4 Problem statement

Currently, existing formula of student exhaust was designed without being analyzed. Therefore, there is lack of information of the existing Formula Student Racing Car (F.S.R.C). The performance of the exhaust can't be study or investigate for improvement work to increase the performance.

1.5 Importance of the study.

This study will help to understand more details about the exhaust pipes of formula student racing cars. Then, it can be used to increase performance level of the exhaust pipes for future design.

1.6 Thesis organization

This thesis consists of six chapters. Chapter 1 introduce generally about the exhaust system including basic components, function and operational of the exhaust system. Chapter 2 is literature section where some past journal and researches about exhaust system is studied. Chapter3 explain about the methods involved in this project while chapter 4 is results section that gained from the simulation. Chapter 5 is discussion section and lastly chapter 6 contains the conclusion of this project.

Chapter I

Introduction

I. This chapter contain introduces of exhaust system.The design and operational variables of intake and exhaust systems are decisive to determine overall engine performance. The best engine overall performance can be obtained by proper design of the engine intake and exhaust systems. Therefore, this paper pays attention to the exhaust system parameters. The effects of exhaust pipe length and exhaust valve timing on the performances of engine are investigated. The results demonstrate that the exhaust pipe length and exhaust valve timing exert great influences on the engine efficiency, volumetric efficiency, mean pressure loss for gas exchange, etc.

Chapter II

Literature Review

II. Reviews on the literature from journal, books and internet. This section covered including system exhaust description, components, flow in an exhaust system and etc. Past researches was studied and being included in this chapter. Some theoretical and experimental results and data is observed and being used as a guideline to complete this project.

Chapter III

Methodology

III. Describes methodology involved, flow chart, material and software being used in this project. This project involves CFD software, so the application of the software should be studied first. Then throughout literatures review, basic theory and exhaust flow characteristics consideration is investigated. Model of the existing and modified exhaust are firstly drew using AutoCAD and the being designed using Gambit software. The models' designs then simulated using CFD (Fluent)

Chapter IV

IV. Consist the simulation results of both existing modification exhaust models. More attention is given to the pressure issue in this chapter where some calculations of power loss coefficient is made. Figures, graphs and calculation results are included to represent the simulation results for both of the exhaust models.

Chapter V

V. Chapter 5 will discuss in detail the results that achieved in previous chapters and comparison of both exhaust simulation results is made.

Chapter VI

VI. Consist the conclusion of this project and whole theory and results is being considered.

Table 1.1: Gantt chart for semester 1

Project Planning																	
Major Activities Involved in Project Sarjana Muda 1 (2008)																	
Project Activities	Weeks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Choose and understand the project that have been suggested	Planning																
	Actual																
Literature reviews	Planning																
	Actual																
Draft proposal of project	Planning																
	Actual																
Study AutoCAD, Gambit and CFD.	Planning																
	Actual																
Finish chapter 1	Planning																
	Actual																
Finish chapter 2	Planning																
	Actual																
Finish chapter 3	Planning																
	Actual																
Prepare final report	Planning																
	Actual																
Slide Preparation and PSM 1 Presentation	Planning																
	Actual																