



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**CONCEPTUAL DESIGN AND PERFORMANCE ANALYSIS OF
THE AIR MOTOR FOR AIR POWERED MOTORCYCLE**

This report submitted in accordance with requirement of the Universiti Teknikal
Malaysia Melaka (UTeM) for the Bachelor Degree of Mechanical Engineering
Technology (Automotive Technology) (Hons.)

by

MUHAMMAD NORSYAFIQ BIN MD NASIB

B071110192

920211-14-6651

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I hereby, declared this report entitled “Conceptual Design and Performance Analysis of the Air Motor for Air Powered Motorcycle” is the results of my own research except as cited in references.

Signature :
Author’s Name : Muhammad NorSyafiq Bin Md Nasib
Date :

APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Engineering Technology (Automotive Technology) (Hons.). The member of the supervisory is as follow:

.....
(Project Supervisor)

ABSTRAK

Ideas generated in this project are the implementation of the problems that arise in terms of air pollution is more widespread now. The vehicle with an internal combustion engine is among one of the causes that lead to air getting polluted by the passage of time. Thus, in this study the students accountable for their results and analyze of air engines for air powered motorcycle. Students are required to refer the design or existing products for improvement of performance power generated by the air motor. In this project, students are also exposed some of the methods in this project as using Computer Aided Three-Dimensional Interactive Application, CATIA Software to produce a drawing for the conceptual design and do numerically to analyze the performance air motor. At the end of this project, the result is come out with a new conceptual design where the design is capable produce high performance of work and power output.

ABSTRACT

Idea dijana dalam projek ini adalah pelaksanaan bagi masalah yang timbul dari segi pencemaran udara yang meluas sekarang. Kenderaan dengan enjin pembakaran dalaman adalah antara salah satu sebab-sebab yang membawa kepada udara semakin tercemar oleh peredaran masa. Jesteru itu, dalam kajian ini pelajar dipertanggungjawab untuk menghasilkan rekaan dan menganalisis enjin udara untuk motosikal udara berkuasa. Pelajar dikehendaki merujuk reka bentuk atau produk sedia ada untuk meningkatkan prestasi kuasa yang dihasilkan oleh motor udara. Dalam projek ini, pelajar-pelajar juga didedahkan beberapa kaedah dalam projek ini menggunakan perisian CATIA untuk menghasilkan lukisan untuk reka bentuk konsep dan melakukan berangka untuk menganalisis prestasi motor udara. Pada akhir projek ini, hasilnya adalah keluar dengan reka bentuk baru di mana konsep reka bentuk adalah hasil mampu berprestasi tinggi kerja dan kuasa output

DEDICATION

To my beloved father, Md Nasib Bin Md Yasin
and my beloved mother, Noridah Binti Md Ali

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In the name of Allah, the Most Merciful and the Most Beneficent. It is with the deepest senses gratitude of the almighty that gives strength and ability to complete the project for this semester based on the project planning

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

APM	-	Air Powered Motorcycle
CAD	-	Computational Aided Design
CAV	-	Compressed Air Vehicle
RPM	-	Revolution per Minute
CATIA	-	Computer Aided Three-Dimensional Interactive Application
D	-	Diameter of Stator
R	-	Radius of Stator
L	-	Length of Rotor
r	-	Radius of rotor
d	-	Diameter of rotor
θ	-	Degree of Angle between Vanes
Θ	-	Degree of Angle between Nozzle Inlet and Rotor
γ	-	Density of Air (1.4)
$X_{1 \text{ min}}$	-	Length LM
$X_{2 \text{ min}}$	-	Length KS
$X_{1 \text{ max}}$	-	Length BG
$X_{2 \text{ max}}$	-	Length IH
$V_{1 \text{ min}}$	-	Volume ₁
$V_{2 \text{ max}}$	-	Volume ₂
P_2	-	Pressure Output
P_3	-	Atmospheric Pressure
w_n	-	Work output
W_{total}	-	Total power
pa	-	Pascal
W	-	Watt
N	-	Newton

CHAPTER 1

INTRODUCTION

1.1 Background

In recent years there has been increasing air pollution due to several factors, where the sources of air pollution come out in two types of source which are sourced from vehicle and source from the factory. This two type source can be categories as a major source for the air pollution. The vehicle sources include the forms of transportation such as on cars and trucks, as well as non road vehicle such as tractors, backhoes, trains, and airplanes. While, the factory sources are consist power plants, industrial facilities, gas stations, or construction site.

There are many systems have been developed by the federal government to counter and minimize the air pollution. Example controls the emission produce in factory by creating the filter to reduce the exposed chemical reaction on the air. While in the vehicle, use gasoline without lead to reduce emissions and develop an engine system that can minimize the emissions during it moving.

The emission comes from the vehicle often caused by incomplete combustion in internal combustion engine that will produce the nitrogen oxide, hydrocarbon and carbon dioxide. This condition occur cause of the failure of engine systems and until now this problem cannot be solved due to the lack of advanced tools and technologies in this country.

Today the air powered motor is a new advancement technology design in the automotive field that used the pure compressed air as the main source to operate the engine system. This new design was developed in order to reduce the emission level to save the world. Besides that, it can also eliminate the cost of gasoline and this current technology has been developed to be used especially for light compact vehicle.

Although the air powered motor has been left in this world since the 19th century ago, this technology is still not suitable in the automotive field because there it performance is still no match for existing technologies such as hybrid engines and electric vehicle.

1.2 Project Title

Conceptual design and performance analysis of the air motor for air powered motorcycle

1.3 Problem Statement

The air polluted that produce from vehicle are increasingly prevalent and can't be control by the federal government because of the lack of advance tool in this country. Besides that, the price of gasoline is increasing as follow the world market price and the costs to produce the internal combustion vehicle compartment are too expensive because due to complexity of the process such as ignition and coolant. The development has been made by produce the hybrid and electric vehicle, but based on the past research this development has still produced the polluted air.

1.4 Project Objective

- I. To study the concept of air motor system for air powered motorcycle.
- II. To analyze the power output of air motor based on numerical.
- III. To drawing conceptual design of air motor for an air powered motorcycle.

1.5 Project Scope

- I. Study the concept of air motor system based on previous research and references.
- II. To investigate the relation of the power output that the air motor provides based on numerical and experimental result.
- III. Focusing on the best conceptual design of air motor for the powered air motorcycle using CATIA software.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction of the Compressed Air Vehicle

This chapter is divided into several sections. The first two sections are described about a history and concept of compressed air vehicle. Type of air motor will be discussed later in the following section. There are three types of air motor have been focused which are vane motor, air rotary engine and radial air piston. Next is a previous research of the related study. The main components of air motor and the description will be explained after previous research section. The structure organization of the literature review is described as shown in Figure 2.1.

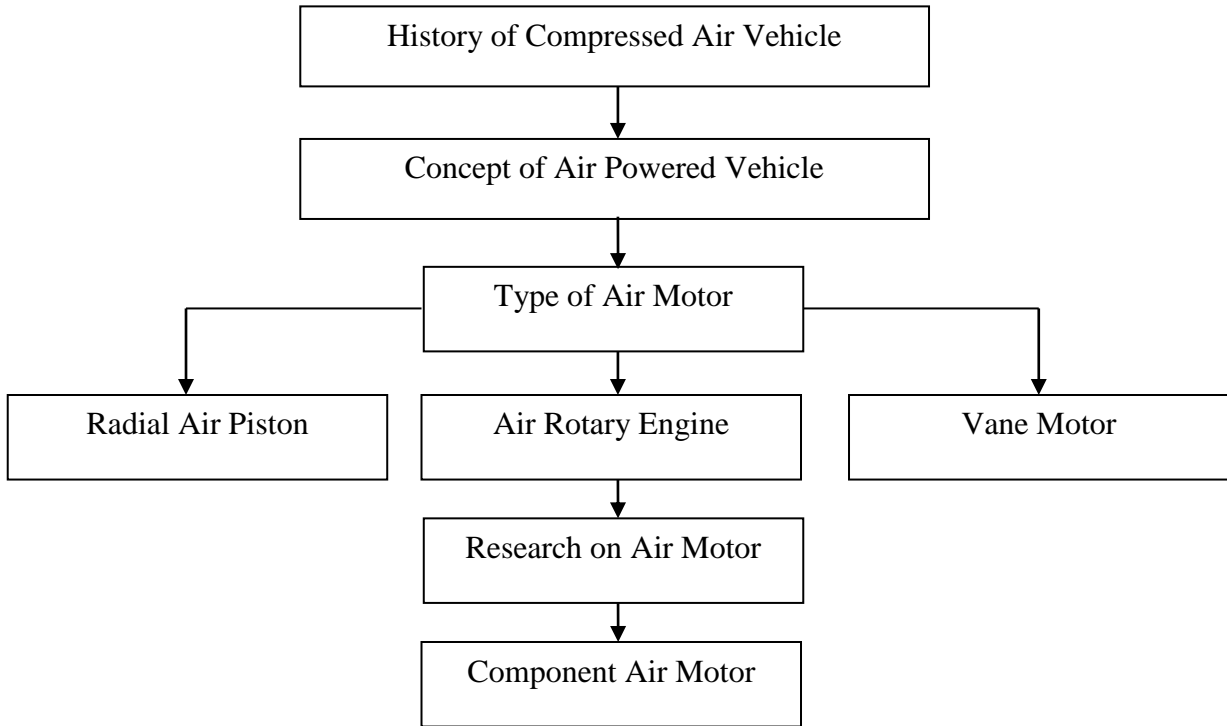


Figure 2.1: Flow chart for literature review

2.2 History of Compressed Air Vehicle

The compressed air vehicle is not a new vehicle in recent technology that exists in this world because it has been used since the 19th century. Denis Papen was among the earliest published ideas for the use of compressed air to locomotive pneumatics usage. In 1838, Andraud and Tessie from Motay, France have successfully to produce a compressed air vehicle and the result is the vehicle capable running and work out so well. Unfortunately an idea for improvements in the vehicle was not pursued at that time. (Manish, 2012)

In 1872, the emergence of the Meksarsari Air Engine Thermodynamic concept had been developed for the locomotive and its impact the use of this engine have been growing and used exclusively for road transit until 1879. Besides that, this vehicle was sold directly with large quantity to the coal mines in the United States. The design and energy produced by this vehicle can be categorized as a suitable and safe type of vehicle for the mining of coal and gaseous environments are the main factors. This vehicle has value. Furthermore, the vehicle was created without generating heat energy and sparks while running. (Manish, 2012)

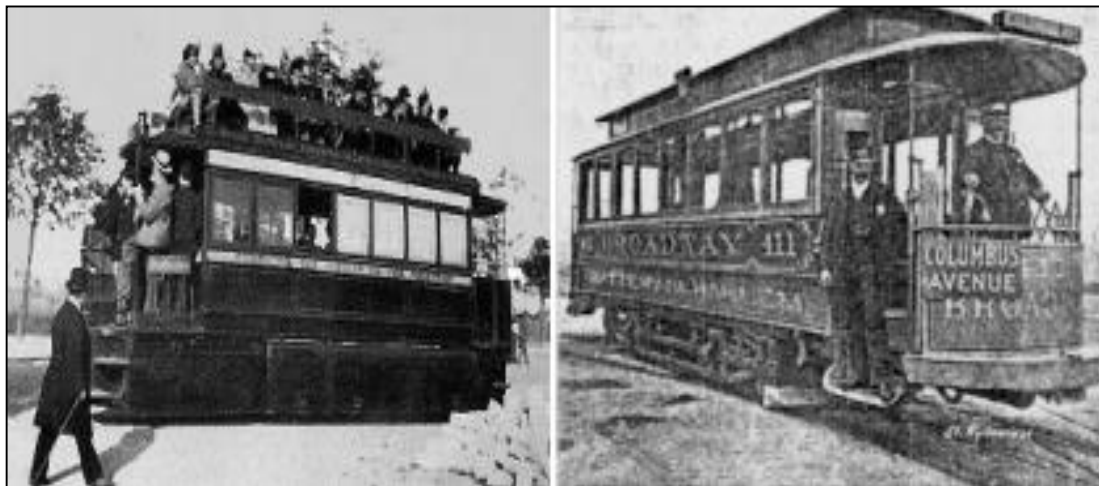


Figure 2.2: Compressed Air Vehicle usage at 18th century (Thipse, 2008)

Figure 2.2 shows that the compressed air vehicle was exclusively used in the 19th century for road transit and it had mass production where it was sold in large quantities, particularly in the United States.

In the 19th century, Louis C. has managed to convert an internal combustion engine to an engine system using compressed air. In his research, he has changed several important components in the internal combustion engine system such as the water cooling system, self-starter, and cylinder head, gasoline tank, and others. He also made some modifications to the internal combustion engine by adding a special cylinder head to the engine, replacing the gasoline tank with an air storage tank, and changing the inlet and exhaust system. (Miguel, 2006)

Unfortunately, the compressed air vehicle used the same concept and the development on it does not continue until the 20th century. In the early 20th century, the compressed air vehicle has come with new technology where this advancement was formed by Formula One engineer, Guy Negre. He was developed Motor Development International (MDI) and also cooperated with the other companies to develop the design of an air powered vehicle shown as Figure 2.3. The MDI and Indian car manufacturing, Tata Motor have signed deals to produce and marketing for the MDI air powered vehicle, while the MDI only focuses on the advancement of the air powered vehicle. (Andrew et.al, 2010)



Figure 2.3: Model of Air Compressed Vehicle by Tata Motor (Verma, 2013)

2.3 Understanding the Concept of Compressed Air Vehicle

The air compressed vehicle work by using high pressurized air to convert the energy compressed air into mechanical energy o powered the vehicle. The principles operational of air compressed vehicle produce zero emission level compared to the other engine. (Yu-Ta Shen and Yean-Ren Hwang, 2009)

The operation system of the compressed air vehicle is start with receives high pressurized air from the storage tank located inside a vehicle. The high pressurized air will slowly powered the mechanical part inside air motor. The function of the air motor is to convert the adiabatic and isobaric expansion of pressure into the mechanical energy. These powers were transmit to the wheels. (Baggott and Mullen, 2012)

There are two methods that can be used to collect compressed air in its storage tank. The first method is the vehicle used advanced components such as electrically injected directly supply compressed air into the tank and the second method is by plugging the car into a wall outlet of vehicle. (Strumpf et.al, 2009). The energy storage of compressed air vehicle is mostly similar with an electric storage. (Papson et.al, 2010)

The storage tank is function to maintain the pressurize air and supply it to the air motor by using hose as a connection between these two component. The pressurize air inside the air motor move the rotor or mechanical part inside air motor and it directly transmit the power to the wheel. The 90 percent claim that design of the air compressed system can affect the performance of the air motor. (Bonser, 2008)

The air compressed vehicle does not need several important components or systems seem like internal combustion engine such as cooling system, spark plug or fuel tank. Thus, this new technology was reducing the cost of vehicle production compare to the other type engine. Unfortunately, the air motor does not available compare to the other engine such as hybrid and internal combustion engine due to the lack of technology. Thus, the main factor is needed to develop the design of air motor to improve the performance to match with another engine. (S. S. Verma, 2013).

The exhaust temperature that comes out from air compressed vehicle was less than atmospheric temperature and this situation is mostly helping in controlling global warming and reducing temperature rise. The design for this air motor also helps in reducing wear and tear at its component because there are no combustion inside the cylinder and, material that used in air motor are mostly self-lubricating and the working temperature of air motor are less than normal temperature atmosphere. Thus, this air motor does not require installing the cooling and lubricating system. (Patel et.al. 2001). The energy produces from compressed air vehicle is less compared to the other energy such as energy produce hybrid engine, electrical motor and combustion internal engine. (Schipper, 2010)

2.4 Type of Air Motor

The advantages of air motor had been recognized for automotive because it does not require electrical power, gasoline and zero emission. It also has various designs and concept to power the compressed air vehicle. The design of air motor was producing energy with different ways and affect the performance during it work. In other word, the design and part of air motor are depending on the type and performance of vehicle