ANALYSIS OF PERFORMANCE AND EMISSION ON 4-STROKE 4-CYLINDER SPARK INGNITION GASOLINE ENGINE AT DIFFERENT AIR INTAKE TEMPERATURE

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BACHELOR OF MECHANICAL ENGINEERING TECHNOLOGY
(Automotive Technology) WITH HONOURS

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NAVEEN A/L CHANDRAN

**A thesis submitted
in fulfillment of the requirements for the degree of
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DECLARATION

I hereby declare that the work in the thesis is my own except for quotations and summaries which have been duly knowledge.

Signature	:	
Name	:	NAVEEN A/L CHANDRAN
Date	:	27/01/2022

APPROVAL

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor of Mechanical Engineering Technology (Automotive) with Honours.

Signature	:	
Supervisor Name	:	MR. ADNAN BIN KATIJAN
Date	:	27/01/2022

DEDICATION

This project report is dedicated to my beloved mother, Muththamil Selvi d/o Suppiah, my beloved father, Chandran s/o Perumal Marimuthu and my beloved family. Thank you for your love which support and prayer throughout the year my supervisor, Mr. Adnan Bin Katijan. Thank you for your monitory, advice and suggestions that drive me forward all my beloved seniors and friends. Thank you for all your helps and endless supports throughout the years.

ABSTRACT

The impact of changing in air intake temperature assumes a significant part to the spark ignition engine. Consequently, expanding or diminishing of surrounding temperature on the earth these days will impact the performance and the quality of air especially related to spark ignition engine. Thus, this study will be led to decide the warmed worth of air intake temperature that impact for better engine performance and emission. Spark ignition engine also called heat engine depends on such a great amount to the progressions in temperature. This proposal will present the trial result on the performance of spark ignition engine at various heated air intake temperatures on four-stroke four-cylinder spark ignition engine. It also researched the level of emission delivered to the climate because of expansion in air intake temperature. In this study, to measure the Torque value and calculate the Brake Power value the four-stroke four-cylinder spark ignition engine (Satria neo-1.6L G Manual) were tested using Chassis Dynamometer (DYNOMITE). While the exhaust emissions percentage values of CO_2 and HC was recorded by using EMS gas anayzer. The data was taken under three different gears (gear 2,3 and 4) at varying speed (1500,2000,2500,3000 and 3500 rpm) and intake temperature range (55℃~60℃). Based on the data and result recorded increase in temperature do increase the engine performance in terms of brake power and torque but also increase the emission percentage as well.

ABSTRAK

Kesan perubahan suhu pengambilan udara memainkan peranan penting kepada prestasi enjin penyalaan percikan. Oleh itu peningkatan atau penurunan suhu sekeliling di dunia pada masa kini akan memberi kesan kepada prestasi dan kualiti udara terutamanya yang berkaitan dengan pencucuhan enjin. Oleh itu, kajian ini akan dijalankan untuk menentukan nilai panas suhu pengambilan udara yang mempengaruhi prestasi enjin yang lebih baik dan pelepasan. Enjin pencucuh api juga dikenali sebagai enjin haba sangat bergantung kepada perubahan suhu. Tesis ini akan membentangkan hasil eksperimen tentang prestasi enjin pencucuh api pada pelbagai suhu pengambilan udara yang dipanaskan pada enjin pencucuh empat silinder empat lejang. Ia juga menyiasat tahap pelepasan yang dikeluarkan ke alam sekitar akibat peningkatan suhu pengambilan udara. Dalam kajian ini, untuk mengukur nilai Tork dan mengira nilai Kuasa Brek, enjin pencucuh api empat lejang empat silinder (Satria neo-1.6LG Manual) telah diuji menggunakan Dinamometer Casis (DYNOMITE). Manakala nilai peratusan pelepasan ekzos CO2 dan HC direkodkan dengan menggunakan analyzer gas EMS. Data diambil di bawah tiga gear yang berbeza (gear 2,3 dan 4) pada kelajuan yang berbeza-beza (1500,2000,2500,3000 dan 3500 rpm) dan julat suhu pengambilan (55°C ~ 60°C). Berdasarkan data dan hasil yang direkodkan peningkatan suhu meningkatkan prestasi enjin dari segi kuasa brek dan tork tetapi juga meningkatkan peratusan pelepasan juga.

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LIST OF SYMBOLS AND ABBREVIATIONS

BP	-	Brake Power
cc	-	Cubic centimeter
cm	-	Centimeter
CO	-	Carbon monoxide
CO_2	-	Carbon dioxide
h	-	hour
HC	-	Hydrocarbon
kg	-	kilogram
kW	-	kilowatt
MPa	-	Megapascal
Nm	-	Newton meter
NO_x	-	Nitrogen oxides
HC	-	Hydrocarbon
^{o}C	-	Degree Celsius
rpm	-	Revolution per minute
s	-	Second
SI	-	Spark ignition

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CHAPTER 1

INTRODUCTION

1.0 Background of Study

The air intake system is important to the engine's functioning, air collection and cycle transmission. As the air intake system is a motor gear, the engine must be understood first to determine how the air intake system works. Most of the motor converts thermal energy into mechanical energy and it is known as a heat motor. Heat motor classified in two types: one is an automotive and the other an external fusion reactor such as a steam motor. In the drying circuit with fuel and air mixed with concern for isothermal conditions, the electric motor relates to the ignition [1]. The air to be combined with the fuel is supplied via the air intake system. Air oxygen is one of the key components in the combustion process. A proper air intake system ensures the clean and continuous air flow to the engine, which delivers more power and improves vehicle efficiency.

The air intake system includes the air filter, the level raise and the mass transmission sensor. Engine performance is one of the most important problems nowadays for customers, designers and manufacturers of internal combustion engines. The designers are always interested in technology to improve vehicle performance without increasing the cost by altering cargo capacity or the mix of air- fuel [2]. The cheapest way is to change temperatures or heat. One big plans alteration is to change the humidity intake. The aim of this research is to study the effect on engine power (brake power and torque) and pollution of different heat air intake temperatures. This research is conducted using a 4- stroke ignition engine to collect scientific results from the test rig.

1.1 Problem Statement

The spark-ignition engine is the most prevalent motor type used in Malaysia and globally because petroleum fuel is utilized more than diesel fuel in most nations. The SI engine's intake temperature depends on the ambient temperature. Various temperatures result in varying engine performance and emissions. This research thus determines the optimal average temperature intake value, which affects fuel efficiency and pollution.

1.2 Objective Study

The objective of the study is to analyze the performance and emission of 4-stroke engine at various air intake temperature (55℃ ~ 60℃) under different speed (1500,2000,2500,3000 and 3500 rpm) and different gears (Gear 2,3 and 4) by installing air heater. Below are the objectives that need to be achieved at the end of the study:

i) To investigate the engine performance and emission characteristics of a 4-stroke spark ignition gasoline engine based on various air intake temperature.

ii) Compare the emission level from vehicle by using heated air intake temperature (55℃ ~ 60℃)

1.3 Scopes of Study

The research focuses on 4-cylinder spark ignition engine or petrol engine car, which are commonly used in Malaysia. The research has placed some restrictions to guarantee the results of the study are useful and practical. Here are the scopes of the research:

i) The study conducted on 4 – stroke 4 – cylinder spark ignition engine with engine capacity of 1.6L

ii) The experiment was conducted under three different gears (gear 2, 3 and 4) varying speed (1500, 2000, 2500, 3000 and 3500 rpm) and temperature range (55°C ~ 60°C)

iii) The performance (brake power and torque) and emission level (Carbon dioxide and Hydrocarbon) of 4 – stroke spark ignition gasoline engine on different heated air intake temperature (55°C~60°C) were measured.

1.4 Significant of Study

The finding of the study will contribute to:

i) Increase further understanding of engine performance and emission characteristics under different heated air intake temperatures.

ii) To suggest the most appropriate air intake temperature condition to obtain the best result of performance and emission of the engine.

1.5 Summary

In this study, an attempt has been made to experimentally investigate the suitable air intake temperature for the engine performance and emission. The engine performance parameters are brake power and torque of the tested vehicle which is the SATRIA NEO 1.6L G manual with 3 different gears with varying speed (1500,2000,2500,3000 and 3500 rpm) and temperatures. Moreover, the experiment also conducted to study whether the varying air intake temperature does it effects the emission level which are the Hydrocarbon and Carbon dioxide. The result will contribute to the future car designers to set the default temperature without depending on the ambient temperature.

CHAPTER 2

LITERATURE REVIEW

2.1 Internal Combustion Engine

At the end of the sixteenth century the first theory of internal combustion engine was developed; nevertheless, it was abandoned because the steam control engine began to show significant promise in the development of steam-powered engine. The actual main four-stroke cycle was presented to Nicklaus August Otto in 1876 and it ended up known as Otto Cycle [4]. Otto-cycle petrol engines were still the main movers for rider vehicles as for the first aircraft, while diesel engines were originally limited to high-speed sea and rail applications [5]. Internal combustion (ICE) engines produce mechanical energy from the fuel as the consequence of the combustion process happened inside the ICE. The gases expand and push the piston to a mechanical mechanism to spin its revolving shaft. The spinning shaft responded as an engine output, linked to the gear or transmission train to transfer the driving power of the vehicle. There are three kinds of internal combustion engine.

Rotating engine unit, internal combustion engine and gas turbine engine are provided. In rotating motors, a rotor spins in the motor to provide power. In the case of mutual motors, a piston interfaces with a cylinder. The reciprocal piston action is reborn into the movement of the wheels of the vehicle. Mutual motor area unit used in automobiles. They're the most often utilized engine kind. Figure 2.1 shows the categorization of the combustion engine. The ICE mechanism comprises of a piston movingin a very cylinder, forming a moving gas screen tight from the crankshaft and rod for motion. [1] Pistons are usually dome-shaped on the top and hollow on the rock bottom on a very ICE, and complete a cycle of reciprocation with four intakes, compression, power, and exhaustion. There are 2 kinds of 4-stroke engine; the spark-infection (SI) area unit engine is a combustion engine and a combustion-infection (CI) engine or is usually called the diesel engine. Since 4-stroke engines are the most wide-spread engines, the so-called IC engines are known.

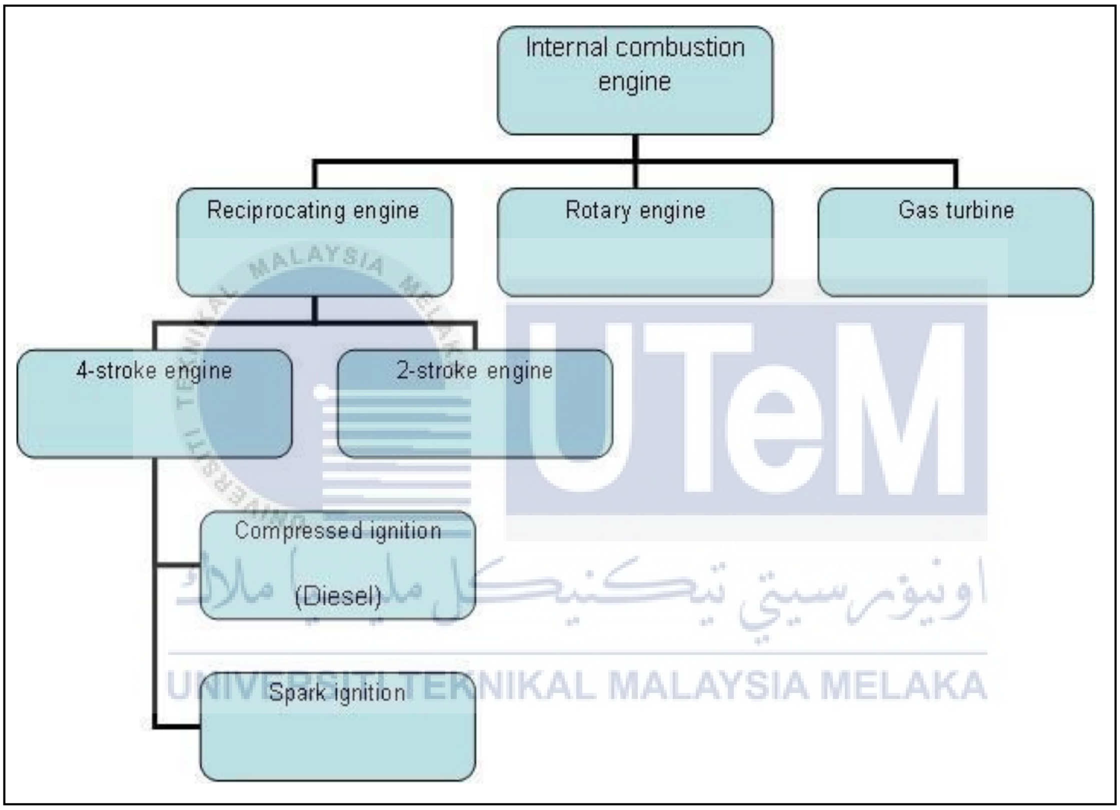

Figure 2.1: Types of Internal Combustion Engine [2]

2.2 Engine Emission

Engine emissions are mainly pollutants in exhaust fuel gases that are damaging to air quality, the engine exhaust, the carcass, and the fuel and carburetor are three major sources. Burned and unburned hydrocarbons, carbon monoxide and nitrogen oxides are discharged from the emissions. The crankcase is a supplementary source of hydrocarbons unbranded and, to a less degree, carbon monoxide. Hydrocarbons that constantly evaporate from gasoline are a small but not an inconsequential contributing element in pollution in the fuel tank and older cars.

2.2.1 Complete Combustion

Complete or simply renowned combustion is necessary to use all petrol correctly, without leftovers. Fuels or chemicals completely burned and only produce greenhouse emissions and water in full combustion. For each atom inside the molecule, there must be sufficient chemical element to search for a match or a combination within the surroundings. The organic molecule combines the chemical element O2 of the atmosphere with the water and greenhouse emission, CO2.

$$\mathbf{CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O + energy} \quad (2.1)$$

2.2.2 Incomplete Combustion

If another fuel is not fully burnt with oxygen to carbon dioxide and water, the whole combustion is termed. Unfinished combustion may cause fuel inefficiency and pollutants. Normally, in full combustion, less heat is produced than full combustion. Incomplete combustion is caused to incorrect mixing and flame shock, according to [1]. Inappropriate air and fuel mixing is incomplete if some fuel particles do not locate an oxygen molecule to ignite. This may lead to a release of exhaust. Flames quench when flames near to the wall and a tiny quantity of fuel mixture is unreacted, are additional causes of incomplete combustion.

$$\mathbf{4\,CH_4 + 7O_2 \longrightarrow 2CO + 2\,CO_2 + 8H_2O} \quad (2.2)$$

2.2.3 Emission in Internal Combustion Engine

Internal combustion engine emissions are becoming one of the world's main concerns because of its detrimental effect on air quality, human health and global warming. Therefore, most governments make an integrated effort to regulate them. Unburned hydrocarbons (HC) and carbon dioxide (CO2) are emissions from combustion [6]. These are the gases emitted from the combustion of natural gas, petrol, biodiesel blends, diesel fuel, fuel oil or coal. It is released into the river via a tailpipe, flue gas stack, or propelling nozzle, according to the motor type. In a pattern termed an exhaust feather, it frequently spreads downwind.

Over the years, the engineering behind a vehicle emission system has evolved significantly, yet pollutants are still being emitted into the air which should be of concern to the public. By comprehending the hazardous emissions of car exhaust, individuals may take a more active part in decreasing car traffic pollution. There are three kinds of car emissions known as evaporative emissions

Emissions, refueling losses and emissions from exhaust. This research focuses primarily on exhaust emissions, but it is still essential to know other kinds of emissions to understand the functions, effects and consequences of this emission. [7], indicated that the emissions from the spark-ignition engines are three methods can be reduced modifications in engine design, circumstances of combustion, and catalytic treatment afterwards.

Each of the pollutants resulting from normal combustion has its own degree of toxicity and may produce hazardous contaminant situations in combination with other components, such as water droplets in the atmosphere. Each element has its unique characteristics, which may cause major issues if big groups of cars are travelling continuously on the same routes every day [6]. Nitrogen oxide (NOX), total organic compounds (TOC), carbon monoxide (CO) and particulates are the primary pollutants of internal combustion engine which include both