STUDY OF COMPRESSED NATURAL GAS (CNG) ENGINE USING INTAKE VALVE SWIRL

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ABSTRACT

The compressed natural gas (CNG) is the alternative fuel was used in this project for the modified diesel engine convert to CNG engine. The improvement was giving more advantage in emission but it was lowering the performance of the engine. This project is concentrates to improve the air-fuel mixing in the combustion chamber. The modification is focused on the intake valve part to the new design with added fin. This is to produce the swirl to the flow of the fuel mixture which entering into the combustion chamber and produce the turbulent that will increase the combustion ability.

The mix between the fuel and clean air completely could increase efficiency from the burning for the reduce of emissions. The perfect mix was influenced by the swirl air flow into intake flow. The addition of fins on intake valve is expected to be able to increase velocity and the value of the massflow, hence produced more swirl air flow enter into combution chamber. The configuration of the dimension from fins also could become the stage factor from swirl.Because of that the analysis of the form is expected to be able to become a solution to get the form of fins that could give more swirl air flow.This Final Project is discussed concerning the analysis of the problem above through pemodelan use the simulation of the computer by software SolidWork. The use of this SolidWork simulation is very exact because of planning still in the stage conceptual design, so as if being carried out modelling physical, will need the big cost and relative time for quite a long time.

Key Words : Intake valve, swirl, fin, SolidWork

ABSTRAK

Gas Natural Termampat (GNT) adalah salah satu bahan bakar alternative yang digunakan di dalam projek ini untuk enjin diesel yang di ubah suai untuk mengubah kepada enjin GNT. Penambahbaikan memberikan kelebihan dalam pencemaran tetapi ianya mengurangkan keupayaan enjin. Projek ini menumpukan untuk menambahbaik percampuran udara dan bahan bakar di dalam kebuk pembakaran. Penambaikan ditumpukan pada bahagian injap masukan kepada rekabentuk yang baru dengan penambahan sirip. Ini adalah untuk pembentukkan aliran pusaran campuran bahan bakar yang masuk ke dalam kebuk pembakaran dan menghasilkan pergolakan yang mana menambah keupayaan pembakaran.

Percampuran di antara bahan bakar dan udara bersih yang lengkap akan menambah keupayaan dari pembakaran untuk mengurangkan pencemaran. Percampuran lengkap telah diberikan oleh aliran udara pusaran ke dalam aliran masuk. Sirip-sirip tambahan pada injap masukan di jangkakan untuk boleh menambah halaju dan nilai aliran jisim, dan sekarang lebih aliran udara dihasilkan masuk ke dalam kebuk pembakaran. Rupa bentuk dimensi dari sirip juga akan menjadi faktor peringkat daripada pusaran. Oleh kerana itu analisis pembentukan adalah dijangkakan boleh untuk menjadi penyelesaian untuk mendapatkan pembentukan sirip-sirip yang akan memberikan lebih aliran udara pusaran. Projek akhir ini adalah dibincangkan mengenai analisis masalah di atas melalui pemodelan menggunakan simulasi computer oleh perkakas lembut SolidWork. Mengunakan simulasi SolidWork ini adalah sangat tepat kerana perancangan masih dalam peringkat konsep rekabentuk, jadi sebagai kalau di ambil keluar fizikal yang dimodelkan, memerlukan dana besar dan bersangkut paut masa yang cukup panjang.

Kata-kata Kunci : Injap masukan, Pusaran,Sirip , SolidWork

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LIST OF SYMBOLS

ω	Width valve seat
π	Phi
ρ	Density
θ	Valve seat angle

LIST OF ABBREVIATIONS

CNG	Compressed Natural Gas
EX	Exhaust
IN	Intake
LB	Long Bend
SB CCW	Side Bend Counter Clock Wise
SB CW	Side Bend Clock wise
SF	Straigth Fin

CHAPTER 1

INTRODUCTION

1.1 Background

Nowadays, the alternative fuel has been growing due to concerns that the reserves of fossil fuel all over the world are finite and at the early decades of this century will run out completely. The vehicle manufacturing researchers have to find other alternative for replacing the current fuel for the vehicle as the future preparation.

Compressed Natural Gas (CNG) is one of the alternative fuel that find that can be use as the vehicle fuel to replacing the gasoline (petrol) or diesel fuel. This alternative fuel was having advantages in environment and air pollution control. The exploitation of full potential of CNG as an alternative fuels is means of reducing

exhaust emissions. CNG will be coming in the transport sector widely in several years from now on. In this project the engine used is diesel engine with single cylinder that will convert to the CNG engine.

This project is about the sequential or trans-intake valve-injection system, a high speed gas jet is pulsed from the intake port through the open intake valve into the combustion chamber, where it causes effects of turbulence and charge stratification particularly at engine part load operations. To increase the turbulent in the combustion chamber, this project are propose the new design of the intake valve with improving by adding fin on the side of the valve to make the input mixture swirl and form the turbulent in the combustion chamber. The valve will be redesign to increase the intake flow rate and get more complete combustion in combustion chamber.

1.2 Problem Statement

In CNG engine have low of volumetric efficiency. This problem cause the low energy density and low of air-fuel intake and low of fuel mixing that will produce low of power in the combustion chamber. The problem will be base on this lack ability of the engine that need to improvement. This project is to improve and increase the volumetric efficiency, air-fuel mixing and turbulent flow into the combustion chamber.

This project is about to improve the air-fuel intake flow. As velocity increase and generate more swirl flow to insist the development of the turbulent flow in the combustion chamber. Therefore the complete combustion will be occurring.

For that, the improvement will be simulating in the related software to modeling and analyze the data. The suggested software to model and to analyze the data is SolidWork, Cosmos FloWork. Therefore, a study has to carryout of the result that can come out the problem.

1.3 Problem Aim and Objective

To develop the computational model of intake valve swirl for sequential injection CNG engine flow.

1.4 Project Scope

In order to archive the research objective stated above, the following scopes of work have been defined:

1. Identify the literature review of the project.
2. Intake valve designed using fin for swirl flow.
3. The computational design is using SolidWork and Cosmos FloWork software.
4. Intake valve swirl will be developed in several types.
5. Analysis the effect of intake valve fin in CNG engine performance using simulation.

1.5 Thesis Structure

Thesis structure is briefly explanation to every chapter in this thesis. The structure of the thesis is as below:

1. Chapter 1

This chapter discuss briefly on the project background, problem statement, project objective, and project scope. The main purpose of this chapter is to give early understanding of the overall project.

2. Chapter 2

This chapter includes all the information acquired regarding on the project which includes the quotes and summary from the journals, reference books and other types of article review. All of the information including the principles, explanations and parameters related to this project were shown in this chapter for future reference.

3. Chapter 3

All the methodologies are discuss clearly in this chapter and was illustrated in flow chart for better understanding.

4. Chapter 4

All the data collected will be further to result analysis. The data was interpreted and will be analyze detail. The simulation test result will be discussed and analyzed.

5. Chapter 5

This chapter is the conclusion for the whole project and determines whether this project had achieved its objectives as stated in chapter 1. Further work such as design improvement also has been discussed in this chapter for future project development.

1.6 Summary

This project is proposed for the new design of the intake valve in the intake port flow of the internal combustion compartment part. The design was simulate by SolidWork and Cosmos FloWork software that suggested from the supervisor of this project. The analysis is narrow to increase the flow rate in the intake port flow of the mixture to the combustion chamber to increase the swirl and produce more turbulent for the better complete combustion of the fuel mixture.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter explain about the basic principle in the internal combustion engine, four- stroke operation, the intake valves operation, part with new improvement and importance process in the combustion engine which taken from the journals, reference books, and other related resources.

2.2 Internal Combustion Engine

2.2.1 Historical Perspective

The history of internal combustion engine is started by Abū al-'Iz Ibn Ismāʹīl ibn al-Razāz al-Jazarī from 1136-1206. He described a double-acting reciprocating

piston pump with a crank-connecting rod mechanism. After that at 17th century the english inventor Sir Samuel Morland used gunpowder to drive water pumps, essentially creating the first rudimentary internal combustion piston engine. At 1806 the Swiss engineer François Isaac de Rivaz built an internal combustion engine powered by a hydrogen and oxygen mixture. In 1860 Belgian Jean Joseph Etienne Lenoir (1822–1900) produced a gas-fired internal combustion engine similar in appearance to a horizontal double-acting steam beam engine, with cylinders, pistons, connecting rods, and flywheel in which the gas essentially took the place of the steam. This was the first internal combustion engine to be produced in numbers. Then until now so many improvement and modern engine type was built by the investor. When comparing the modern versus historical pistons engines, the first piston engines did not have compression, but ran on an air-fuel mixture sucked or blown in during the first part of the intake stroke. The most significant distinction between modern internal combustion engines and the early designs is the use of compression and, in particular, in-cylinder compression.[2][10]

2.2.2 Classification of internal combustion engines

Internal Combustion Engine is refer to the small amount of high energy fuel enter in the combustion chamber have ignited and incredible amount of energy release.[2] All internal combustion engines depend on the exothermic chemical process of combustion: the reaction of a fuel, typically with the oxygen from the air, although other oxidizers such as nitrous oxide may be employed. Also see stoichiometry. The most common m3odern fuels are made up of hydrocarbons and are derived mostly from petroleum[2][10] These include the fuels known as diesel fuel, gasoline and petroleum gas, and the rarer use of propane gas. Most internal combustion engines designed for gasoline can run on natural gas or liquefied petroleum gases without major modifications except for the fuel delivery components. Liquid and gaseous biofuels, such as ethanol and biodiesel (a form of

diesel fuel that is produced from crops that yield triglycerides such as soybean oil) can also be used. Some can also run on hydrogen gas.[2][4][5][10]

The purpose of internal combustion engine is the production of mechanical power from the chemical energy contained in the fuel. In internal combustion engines, as distinct from external combustion engines, this energy is released by burning or oxidizing the fuel inside the engine. The fuel-air mixture before combustion and the burned products after combustion are the actual working fluids. The work transfers which provide the desired power output occur directly between these working fluids and the mechanical components of the engine. The internal combustion engine is subjected of spark-ignition engines (sometimes called Otto engines, or gasoline or petrol engines, though other fuels can be used) and compression-ignition or diesel engines. Because of their simplicity, ruggedness and high power/weight ratio, these two types of engine have found wide application in transportation (land, sea and air) and power generation. It is fact that combustion takes place inside the work producing part of these engines that make their design and operating characteristics fundamentally engines different from those of other types of engines.[2][6][10]

In this internal combustion engine analysis the project is using the compressed natural gas engine as the alternative fuel. This project is use diesel engine that converts to Compressed Natural Gas engine. The modification is only in replacing fuel from diesel fuel to CNG fuel and also using spark plug to ignite the air-fuel mixing in the combustion chamber.

The term Internal Combustion Engine is almost always used to refer specifically to reciprocating piston engines, Wankel engines and similar designs in which combustion is intermittent. However, continuous combustion engines, such as jet engines, most rockets and many gas turbines are also internal combustion engines. [1] This engine is use four stroke engine. The four stroke engine refer to intake, compression, combustion and exhaust strokes that occur during two crankshaft rotations per working cycle of Otto Cycle and Diesel engines. [3][4] The four steps in this cycle are often informally referred as “suck, squeeze (or squash), bang, blow.”The four strokes of the internal combustion engine are as follows (and in

order): Intake, Compression, Power, and Exhaust. These four strokes require two revolutions of the crankshaft. The process continuously repeats itself during the operation of the engine.[3][9]

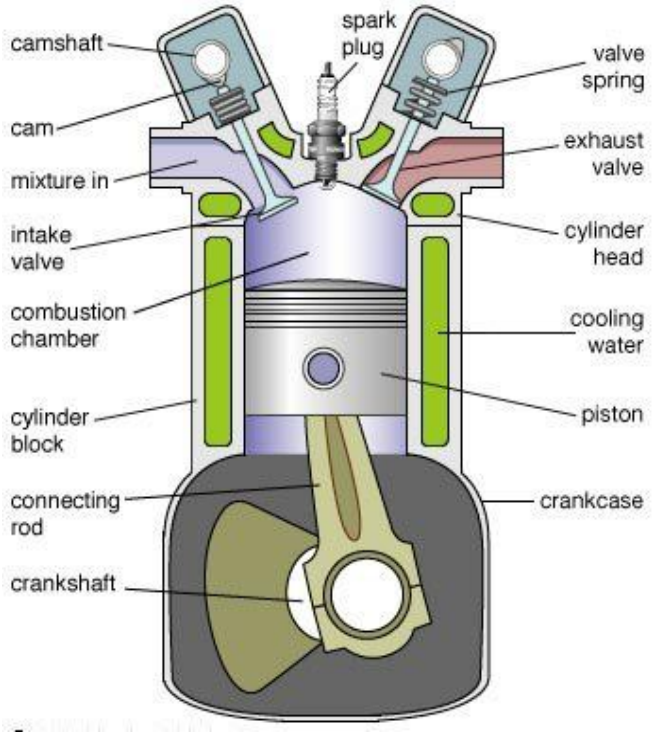

Figure 2.0: Internal combustion engines

2.3 Compressed Natural Gas

Compressed Natural Gas is one of the alternative fuel that found that can be use as the vehicle fuel to replacing the gasoline (petrol), diesel, or propane fuel. This alternative fuel was having advantages in environment and air pollution control. It is considered to be an environmentally "clean" alternative to those fuels and it is much safer than other motor fuels in the event of a fuel spill. In that case natural gas is lighter than air, so it disperses quickly when leaked or spilled. The exploitation of

full potential of Compressed Natural Gas as an alternative fuels is means of reducing exhaust emissions. It is made by compressing natural gas (which is mainly composed of methane (CH_4)), by about 75%. It is stored and distributed in hard containers, at a normal pressure of 200–220 bar (20–22 MPa), usually in cylindrical or spherical shapes to maintain equal pressure on the walls of the containers. Compressed Natural Gas will be coming in the transport sector widely in several years from now on. In this project the diesel engine with single cylinder will converted to the Compressed Natural Gas engine[1][3][4][8][13].

2.4 Intake Valve

Valve is the part of the component that has the mechanism to open and close the entry of air, which in this case is in combustion chamber. Every cylinder has two valve, intake valve and exhaust valve respectively. The mechanism of the valve is:

Valve

a. Material **:**

   It's made from the hard metal with other element, like coal substance, silicone, chrome nickel, wolfram. For intake valve is made by combining the chrome nickel and exhaust valve made by silicone compound.

b. Used :

   1. To open and close the gas/air entry and to throw out the exceeded burned gases in the relative time.
   2. Avoid the compression leaking and combustion explosion.

c. Valve requirement :

   1. Light weight and have valve seat with 45^0 or 30^0 on the side.
   2. High strength and high vibration to hold out.

3. Long life time in using and the valve seat is closed to the cylinder head seat.

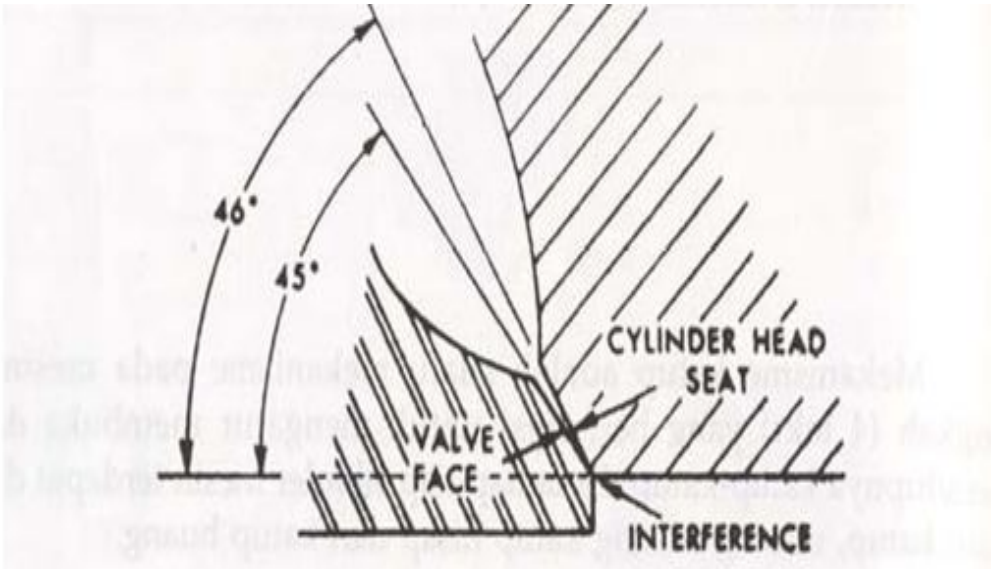

Figure 2.1: Valve place

d. Type of valve

Intake valve:

The valve used as the door of the air/gases enters for supply the machine from the intake port. The valve plate is built in fine plate in order that lightening the swirl load on pivot roof.

Exhaust valve:

The valve used as the door to throw out the exceeded gases from the internal combustion chamber to the exhaust port. The valve plate is build in thick at intake valve in order that can endure heat and not easy to change the shape.

The Difference of intake valve and the exhaust valve:

Intake Valve:

1. Usually valve diameter is bigger than exhaust valve.
2. Have IN marked.
3. Have attraction to the magnet.

Exhaust Valve:

1. Usually the valve diameter is smaller than intake valve.
2. Have EX marked.
3. Not attract to the magnet because of the large amount of nickel compound.

Mechanism of valve parts:

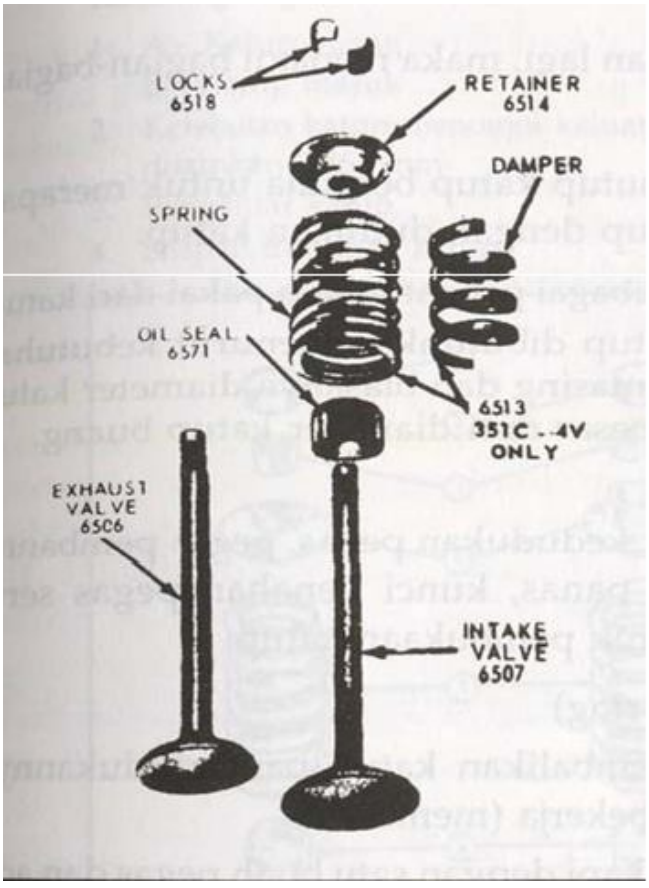

Figure 2.2: Valve parts