THE CHARACTERISTIC OF THE IN-CYLINDER FLUID FLOW OF 1.6L PETROL ENGINE

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DECLARATION

I declare that this project report entitled "The Characteristic of The In-Cylinder Fluid Flow of 1.6l Petrol Engine" is the result of my own work except as cited in the references.

Signature	:	………………………………..
Name	:	Amir Izzuddin Bin Wahab
Date	:	………………………………..

APPROVAL

I hereby declare that I have read this project report and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering.

Signature	:	………………………………..
Supervisor's Name	:	Dr Ahmad Kamal Bin Mat Yamin
Date	:	………………………………..

DEDICATION

I would like to dedicate my project to my beloved mother and father, who gave me never ending affection, love, encouragement and pray of day and night throughout this Final Year Project.

ABSTRACT

The main objective of this project is to study the effect of the Discharge of Coefficient, Swirl and Tumble in the inlet manifold on the block engine performance of 1.6 liter 16 Valve DOHC MIVEC engine. This project was conducted to investigate the behavior of engine air breathing performance between Discharge of Coefficient, Swirl and Tumble. This experiment was tested by opening valve lift with different adapter to show the different behavior of air flow. The experiment has been done on cylinder 2 of the engine at 25" H_20 test pressure. Also, this experiment using Superflow® SF-1020-SB flowbench machine. In this study, an experiment approach has been performed in order to investigate the flow distribution of intake port that will affect the performance of the engine when the valves lift ratio increases. The discharge of coefficient mostly affected by the boundary layer, surface roughness and flow separation. The swirl flow was performed with asymmetric valve lift with 2 cases. The difference in valve lifting is 0.17cm. The tumble flow was measured by lifting in half and full lifting. Results from all experiments were recorded and have been discussed in this report. Discharge of Coefficient (Cd) increases gradually with valve lift ratio (L/D). Swirl test in this engine showed that the fluid motion does not swirl and there is also no swirl at the engine design. Tumble flow shown the zig zag trend on the graph. Head orientation at 120-degree was produced high speed of tumble.

ABSTRAK

Objektif utama projek ini adalah untuk mengkaji kesan Pelepasan Pekali, Pusaran dan Guling dalam kemasukan yang berlipat ganda ke atas prestasi blok enjin 1.6 liter 16 injap DOHC MIVEC. Projek ini adalah untuk mengkaji tingkah laku prestasi pernafasan udara enjin di antara Pelepasan Pekali, Pusaran dan Guling. Eksperimen ini diuji dengan membuka injap menggunakan penyesuai yang berbeza untuk menunjukkan kelakuan aliran udara yang berlainan. Eksperimen ini telah dijalankan ke atas silinder yang ke-2 enjin Mivec pada tekanan 25" H_20. Di samping itu, eksperimen ini menggunakan mesin *flowbench* Superflow® SF-1020-SB. Dalam kajian ini, pengagihan aliran bahagian pengambilan yang akan menjejaskan prestasi enjin apabila nisbah angkat injap meningkat. Pelepasan pekali kebanyakannya terjejas disebabkan oleh lapisan sempadan, kekasaran permukaan dan pemisahan aliran. Aliran putaran telah dilakukan dengan menggunakan dua cara ketidakselarian injap. Perbezaan pengangkat injap ialah 0.17cm. Aliran guling diukur apabila diangkat secara separuh dan secara penuh. Hasil keputusan dari semua percubaan telah direkodkan dan dibincangkan dalam laporan ini. Pelepasan Pekali (Cd) meningkat secara ansuran dengan nisbah angkat katup (L/D). Ujian putaran dalam enjin ini menunjukkan pergerakan bendalir tidak berputar dan juga tiada putaran yang berlaku pada reka bentuk enjin. Aliran guling menunjukkan bentuk zig zag pada graf. Pada sudut 120-darjah aliran guling menghasilkan aliran yang paling tinggi

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Special thanks to all my peers, my late mother, beloved father and siblings for their moral support in completing this degree. Lastly, thank you everyone who had been to the crucial parts of realization of this project.

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CHAPTER 1

INTRODUCTION

1.0 Introduction

The first part of this chapter consists of the project background and aim of the project. The next part focus on the detailed problem statement that lead to the research. The objectives of the project were stated at the next part of the chapter. The objectives that helped the researcher to finish the research or project.

1.1 Project Background

This thesis focuses on the intake system flow which are pressure drop, swirl and tumble using flow bench machine or more specifically the Superflow® SF-1020-SB Flow bench machine. For this experiment, the block engine of 1.6 L 16 valve DOHC MIVEC engine has been choosing to analyze. The main function of the experiment is to determine the behavior of air flow intake system of engine. Swirl and tumble motion of the air can be determined using the swirl meter.

Nowadays, internal combustion engine is a one of the important aspect to make a vehicle. A day to days, development of the internal combustion engine very high demand on our industry. This is because, every company of the engine is chasing each other to make the top in industry. Internal combustion engine is a mixing of air and fuel in the cylinder to provide a homogeneous charge to make some power to the engine. The perfect of mixing between air and fuel, temperature rising to make the high power during combustion and the combustion in the manifold. In the spark ignition of combustion engine, there are 4 working principles of engine which are intake – compression – expansion – exhaust.

There are many characteristics of the in-cylinder fluid flow in the engine manifold. Which are pressure drop, swirl and tumble. First, pressure drop is created by the suction air in the piston when the piston push down. This behavior is very dependent on engine speed and load, flow resistance of different element in the system. Second, swirl flow is a parallel rotation to the cylinder axis. It will be generated by parallel flow rotation through the cylinder to the intake flow of the engine. Swirl flow will be effected by 3 components which are intake manifold, valve ports and the piston surfaces. Lastly, tumble flow is air flow circulating direction in the cylinder. This flow behavior will be generated turbulence flow by little effect on the tumble process. This flow can be light the engine combustion when it completes near the end of the compression stroke. This flow is very dependent on the shape of the piston surface, location of the piston cavity, orientation of the intake manifold, compression ratio and engine speed.

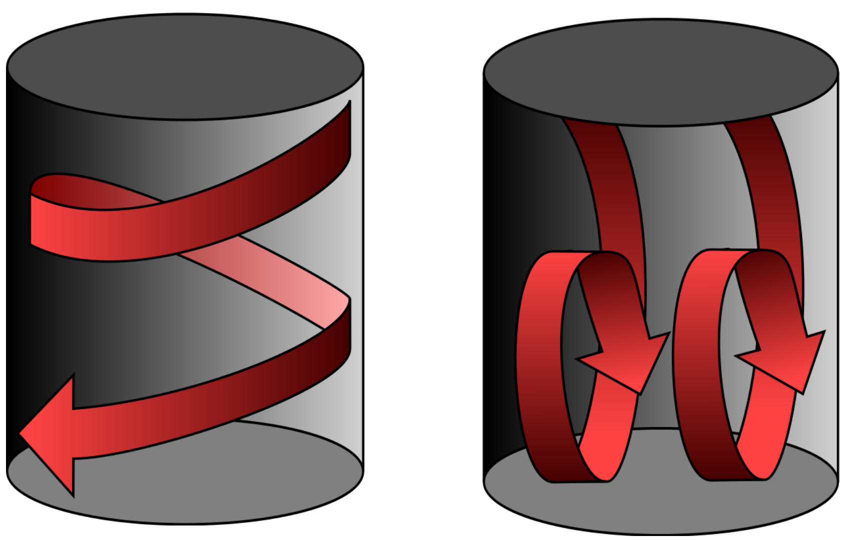

Figure 1.1: Swirl and Tumble motion

Air flow is an important part in the combustion chamber. Behavior of the engine is depending on the air flow motion in the manifold. The Discharge of Coefficient (C_d) is a ration of actual discharge to ideal discharge. Discharge of Coefficient (C_d) are widely used to monitor the flow efficiency through various engine components and are quite useful in improving the performance of these components. Since the value of C_d is higher, the efficiency is increase and more efficient the air flow in the manifold.

Mixture of the fuel and air is important in the combustion. The behavior of the combustion is depending on the mixing of fuel and air. The mixture of them makes the swirl and tumble motion during the combustion. Since the mixture between fuel and air is well, the combustion of the engine will be more efficient and make the power on the engine performance.

In the large displacement engine, it has high value of combustion between small displacement engine. It is because large displacement has two valves of intake port and exhaust port. It will be more efficient between one valve of intake port and exhaust. The fluid flow characteristic between small and large displacement also different. This study to investigate the air flow, swirl and tumble motion of a large displacement engine and get the exact value using the flow bench machine.

1.2 Problem statement

Car intake system allows the car to breathe easier and create more power in the engine. The flow efficiency of the intake system can give more power of the engine. This project has three of the objectives to be achieved, first is to analyze the pressure drop in Mivec intake system, second is to analyze the swirl behavior in intake system and the last is to analyze the tumble behavior in intake system.

1.3 Objectives of the project

The objectives of the project are:

a) To investigate the cylinder head Discharge of Coefficient (C_d) at range of inlet valve lift
b) To analyse the Swirl motion and Tumble motion of combustion air at a range of inlet valve lift

1.4 Scopes of Project

a) Study the detailed of intake port cylinder head of a Mithubitsi Mivec 1.6L engine.
b) Operate the Superflow® SF-1020-SB Flowbench machine to determine the air flow through the intake port, determine the coefficient of discharge (C_d), swirl and tumble readings.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Chapter 1 discussed about an explanation of introduction to background of study, detailing of motivation for engine performance and improvement of the Automotive industry to achieve this. The air flow that occurring in an internal combustion engine perfected with the some of the uniqueness technology automotive was also introduced in this chapter.

The introduction strategies presented, identifying the relevance of the previous work. The flow through the valves will be explained further because the intake valve has an influence on of the retrieval system before entering the cylinder. In-cylinder air flow behavior is discussed and considering the pressure drop, swirl and tumble flow. For measurement and analysis, the air flow behavior in combustion engine was reviewed. It is highlighted where the existing understanding may be extended.

2.2 Variable Valve Timing

Internal combustion engine has two valves to control the intake flow and exhaust flow that control the combustion chamber respectively. Each industry of automotive has different of Variable Valve Timing (VVT) like as Mitsubishi named is MIVEC (Mitsubishi Innovative Valve timing Electronic Control system), Honda named is V-TEC (Variable Valve Timing & Lift

Electronic Control) and others. Every technology of Variable Valve Timing (VVT) used has a advantages itself and capacity to increase the power and torque output of the engine performance.

It was discovered as early as the 1992's that it may advantage to enhance performance, economy and emission has been improved. In 1924 Csandy and Woydt [1] claim to use the inner and outer cam to file a patent for a method of varying the timing. Variable Valve Timing (VVT) was related that all of the system or technology with the same objective to achieve the best performance due the timing of the intake and exhaust depend on the engine cycle location. Valve opening and closing, maximum lift and minimum lift and some system are related on parameter of interest the behavior.

Butcher.D stated that he best tuning of engine design is a crucial part of parameter to seek the further develop the efficiency of their engines.

Figure 2.1: Mivec engine

2.3 Flow bench

Flow bench is a device used to test internal combustion of engine and other components. Before passed to public, various industrial and commercial devices must be checked by manufacturer. For example, in the design phase the flow-bench engine is used to measure the amount of air that can pass through various components (intake and exhaust port, intake and exhaust valves, etc.) related to the Internal Combustion Engine. Total horsepower that the internal combustion engine that can be produced is limited by the amount of air that can be passed and out of the combustion chamber. A flow bench can also be used to evaluate any component that is used to flow a gas such as air filters manifolds, carburetors, exhaust manifold, intake manifold, valve, etc. Flow bench such as that described by Wayne Helmer, it can be used for the study of many other types of fluid mechanics problems and can be a valuable teaching tool in engineering education.

Characteristic diameter and valve lift (L/D) can be specified by ratio and the actual dimension in decimal inches or mm. Almost of the experiment used valve head diameter. Normally engines have an L/D ratio from 0.0 up to a maximum of 0.35. Valve should be set at L/D (0.05, 0.10, 0.15, 0.20, 0.25, 0.30, 0.35) for flow testing.

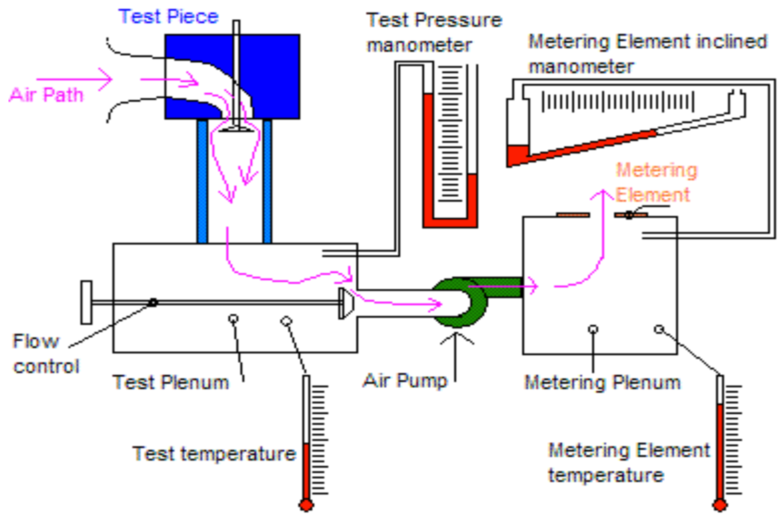

Figure 2.2: Typical Flow Bench schematic

Figure 2.3: SuperFlow SF-1020 SB

2.4 Pressure Drop

One of the very crucial part is cylinder head for automotive engine because it can affect the performance of the engine behavior, fuel assumption and emission of engine. The major of the research area in SI engine is a designing and developing of intake port. Power output and emission are depending on the thermodynamic properties of cylinder. Intake air motion should be increased in the combustion in order to achieve higher thermal efficiency and better emission control. The design of cylinder head is a one of the important aspect to deliver the air fuel mixture to the combustion.

Port and valve design determine the Discharge of Coefficient (C_d) of the port and consequently the volumetric efficiency of the engine. Discharge of Coefficient (C_d) describes the behavior of all real flows contract in area as they pass through any restriction in engine. Amount of air entering the combustion chamber are determining the performance of the engine. The more air was entering the combustion chamber, the higher of the performance of engine and improve its quality.

$$C_d = \frac{TestFlow}{PotentialOrificeFlow}$$

2.5 Swirl

Organized rotation of the charge about the cylinder axis is a usual define of swirl. Swirl is created by bringing the intake flow into the cylinder with an initial angular momentum. Friction occurs during the engine cycle, intake generated swirl through the compression, combustion and expansion process create some decay in swirl motion flow. Mohiuddin [2] claims that swirl is used in diesels and some stratified-charge and the injected fuel and to speed up the combustion process in Spark Ignition (SI) engines.

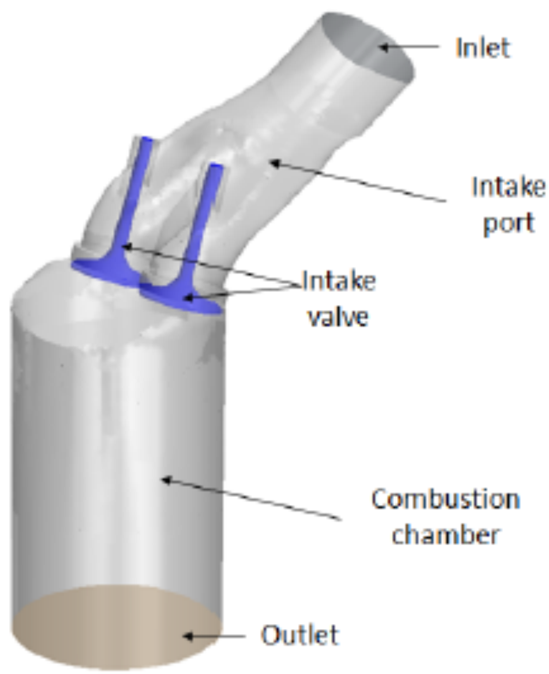

Figure 2.4: In-cylinder simulation

Swirl is also crucial for efficient soot oxidation in the late-cycle mixing controlled combustion phase. For twin port design, the swirl asymmetry is initiated by the asymmetrical orientation of intake ports. There exists a great interest in predicting the flow asymmetry in the late compression stroke. It can help deciding the optimum injector location for minimum asymmetrical mixture preparation. Swirl is a rotational motion of a bulk mass in the cylinder and also make shaping and contouring the intake manifold, valve port and piston face. Swirl air flow enhances air fuel mixing and helps to spread the flame during combustion occur described by Aizad Sazrul [3].

Prior the inlet of air entering the intake cylinder, it has a few methods that was applied for generating of swirl motion in Internal Combustion Engine. Swirl flow was widespread in Compression Ignition (CI) engine because the more of air flow is allowed entering in-cylinder and the air quickly mixing between the injected fuel. Swirl also can be found in Spark Ignition (SI) engine to enhance the combustion and improve mixing of the air and fuel injected. [4]

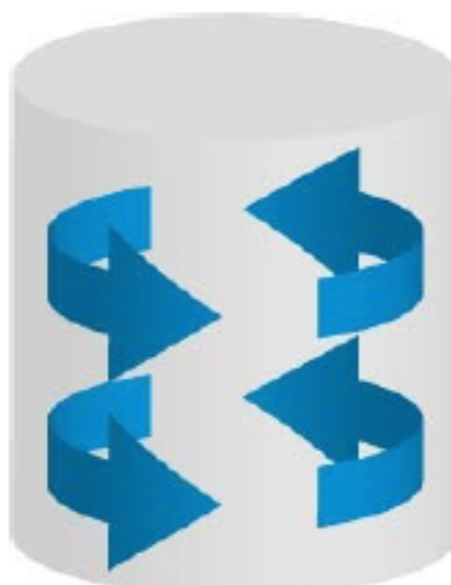

Figure 2.5: In-cylinder swirl motion