TUNING SINGLE CYLINDER TWO - STROKE ENGINE OR PERFORMANCE

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This report is presented in
Partial fulfillment of the requirements for the
Degree of Bachelor of Mechanical Engineering (Automotive)

Faculty of Mechanical Engineering
Universiti Teknikal Malaysia Melaka

MAY 2010

I/We* have read this thesis
and from my/our* opinion this thesis
is sufficient in aspects of scope and quality for awarding
Bachelor of Mechanical Engineering (Automotive)

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**Line which is irrelevant*

ACKNOWLEDGEMENT

In general, I hereby would like to express my appreciation to those involved either directly in accomplishing my PSM 1. This project would not have been possible without the support of many peoples. Special thank to my supervisor, Mr. Faizul Akmar Abdul Kadir for given me all the support and encouragement throughout this project. Special thank to UTHM lecture, En. Suzuirin for given support during the dyno testing. And finally, thank goes to my family and numerous friends who have endured this long process with me and always offer valuable support and love all these while. May all the support and knowledge given enable me to gain more significant experience and precious understanding on engineering field in the future.

ABSTRAK

Expansion chamber adalah system ekzos yang digunakan untuk menala enjin dua lejang. Kepentingan merekabentuk expansion chamber yang sesuai adalah ntuk mendapatkan kuasa maksimum pada enjin disamping dapat mengurangkan pengeluaran hasil pembakaran yang boleh mencemarkan alam sekitar. Enjin dua lejang tidak mempunyai injap atau lejang ekzos untuk mengeluarkan hasil pembakaran seperti enjin empat lejang. Maka, campuran yang memasuki silinder tersebut akan menolak gas yang sudah terbakar keluar melalui lubang ekzos. Proses ini kurang efisien kerana masih terdapat sedikit gas yang sudah terbakar masih menduduki silinder tersebut dan kemungkinan juga sebilangan daripada campuran yang baru memasuki silinder tadi keluar melalui lubang ekzos yang terbuka sebelum pembakaran berlaku. Maka, *expansion chamber* akan digunakan untuk mengawal aliran yang berlaku di dalam enjin dengan mengawal tkanan yang berlaku pada paip sistem ekzos tersebut. Rekabentuk *expansion chamber* akan mempengaruhi mempengaruhi tekanan bendalir tersebut. Expansion chamber direka mengikut diameter dan panjang yang berbeza bergantung kepada jenis enjin yang diuji mengikut proses empirikal. *Expansion chamber* akan diuji dengan menjalankan eksperimen menggunakan ujian *dyno* untuk mendapatkan prestasi dan kuasa maksimum.

ABSTRACT

Expansion chamber is an exhaust system used for power tuning in two strokes engines. The important of designing appropriate expansion chamber is for power tuning in two stroke engine to ensure the engine to produce more power output with a reduction of polluted emission as well. The two stroke engine does not utilize an exhaust stroke or complicated valve to emit the burnt gases from cylinder like four stroke engine. The incoming mixture charge is used to help push the burnt gases out of the exhaust port. This is not an efficient process since some of the burnt gases remained in the cylinder and may be some of the new mixture charge escaped through the open exhaust port. Thus expansion chamber enhances and control the flow through the engine by using pressure pulse. The design of an expansion chamber will have an effect on the pressure movement. The design was base on different cross section and length, depending on the requirement of the type of engine. Expansion chamber will be design using empirical design process. By experimentation using 'test dyno', result obtained will be used to ensure better engine performance.

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LIST OF SYMBOLS

LT = Overall Length of the Pipe [mm]

LP1 = Length of the Head Pipe [mm]

LP2 = Length of the Diffuser Section [mm]

LP3 = Length of the Dwell Section [mm]

LP4 = Length of the Convergent Section [mm]

LP5 = Length of the Stinger [mm]

Dx = Diameter of the Exhaust [mm]

D1 = Diameter Head Pipe [mm]

D2 = Diameter Diffuser Section [mm]

D3 = Diameter Dwell Section [mm]

D4 = Diameter Convergent Section [mm]

RP = Reflection Period [^{0}C]

EP = Exhaust Opening Period [^{0}C]

RPM = Revolution per Minute [rev/min]

A_0 = Local Speed Of Sound

P = Pressure []

P = Density []

g = Gravity Acceleration [m/s^2]

h = Height [mm]

T = Time [mm]

k1 = Flange Diameter Ratio

k2 = Mid Section Diameter Coefficient

k2 = Tail Pipe Diameter Coefficient

CHAPTER 1

INTRODUCTION

This project involved with the design and fabrication of an expansion chamber which will be use to tune a two stroke engine. This is important since constructing an expansion chamber will ensure that the engine is able to breathe correctly and produce efficient power output.

An expansion chamber is designed by varying its diameter (cross section) and length. It is used to enhance power output produced by increasing the volumetric efficiency of the two stroke cycle engine.

1.0 Background

Basically after completing one revolution for each cycle, burnt gases and fresh mixture (unburned gases) will pull out from the cylinder. These high pressure gases which exit through the cylinder initially flows in the form of a wave front and subsequently enter a pipe called expansion chamber which is already occupied by gas from previous cycle. The gas from the previous cycle will be pushed ahead and this will cause a wave front. Although gas flow itself stops, the wave still goes on by passing the energy to the next downstream until it reaches the end part of the pipe.

However if the wave encounter any changes in cross section or temperature, it will reflect a part of its strength in the opposite direction it travel which practice the wave dynamics principles. Thus, expansion chamber will be designed by using this basic principal since its diameter (cross section) and length are varied as away to push back the fresh mixture back into the cylinder at the desired times in the cylinder.

Good chamber work by giving lots of power over a wide rpm-range. Thus, the cross section of an expansion chamber influences the power output since the power is tuned when the reflected wave is out of phase with the primary wave at the exit of the exhaust valve.

1.1 Objective

The objective of this project is to design and fabrication of an expansion chamber to obtain maximum power of a two- stroke engine at a desired speed range.

1.2 Scope

These project scopes consist of the following:

- To find a suitable two-stroke engine.
- To tuned the engine using the expansion chamber.
- To produce rig for dyno testing.
- To study the effect of suggested expansion chamber on engine power (experimental)

1.3 Problem Statement

In two stroke internal combustion engine, each outward stroke of the piston is a power stroke. As a way to achieve this operating cycle, a fresh charge of air and fuel must be supplied to the engine at high pressure to displace the burned gases from the previous cycle. The combination of process between intake and exhaust process that clear the cylinder of burned gases and fills it with the fresh mixture (of air and fuel) is called scavenging process. This is essential in having a smooth running internal combustion engine.

As the piston moves from top to the bottom dead center, uncovering the intake ports, the burned gases are pushed into the exhaust port by the incoming flow of fresh mixture (air and fuel). This is not an efficient process since some of the burnt gases remaining in the cylinder and some of the fresh air or fuel charge escape through the open exhaust port. At this point in time, the opening just begins to form, and as a result the flow in the combustion chamber changes dramatically. As the piston drops down and begin its return motion back to TDC the burned gases are pushed into the exhaust duct.

Thus by modifying the exhaust system such as modifying the exhaust gas velocity (by changing exhaust tube diameters and length) it can detract from the “ideal” scavenging effects, and reduce fuel consumption as well as increase the power output.

CHAPTER 2

LITERATURE REVIEW

2.1 Engine review

Engine is defined as the machine that converts the chemical energy released through combustion of a certain fuel, into a mechanical energy. This mechanical energy is used to drive a certain vehicle.

The definition highlights important facts about the engines. First, an engine is a machine; hence a mechanism exists where more than one mechanism of operation may occur. The two most famous mechanisms of actions are the two-stroke and four-stroke engine. The main difference between these two engines is the stroke. This leads to distinguishable efficiency for each kind. Four-stroke cycle has four piston movements over two engine revolutions for each cycle compared to two-cycle which has two piston movements over one revolution for each cycle.

2.2 Engine Characteristic

The two-stroke type of internal combustion engine is typically used in utility or recreational applications which require relatively small, inexpensive, and mechanically simple motors (chainsaws, jet skis, small motorcycles, etc). The four-stroke internal combustion engine is the type most commonly used for automotive and industrial purposes today (cars and trucks, generators, etc). The characteristic feature of the two stroke engine is its means of operation. In a two-stroke engine, every stroke leaving top dead center is an expansion stroke. In a four stroke engine, there is only one working stroke against three negative strokes (induction, compression, and discharge).

The two-stroke engine is simple in construction, but complex dynamics are employed in its operation. There are several features unique to a two-stroke engine. First, there is a reed valve between the air-fuel intake and the crankcase (air-fuel mixture enters the crankcase and is trapped there by the one-way reed valve). Next, the cylinder has no valves as in a conventional four stroke engine (intake and exhaust are accomplished by means of ports - special holes cut into the cylinder walls which allow fuel-air mixture to enter from the crankcase, and exhaust to exit the engine). These ports are uncovered when the piston is in the down position.

2.3 Principle of Two Stroke Engine

In the two stroke engine, an ignited charge exerts pressure on the piston crown whilst a fresh charge is drawn through the carburetor into the crankcase via inlet port I (Figure1).

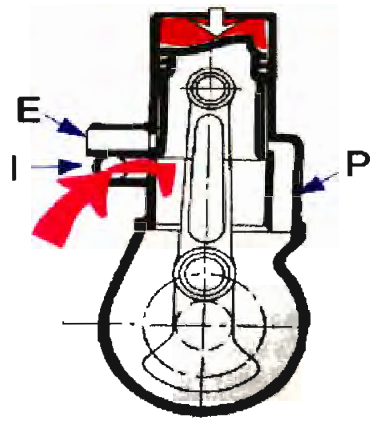


Figure 1: combustion

During the exhausting phase, the piston moving down partly uncovers the exhaust port E allow the combustion gases to start to discharge (Figure 2). The downward movement of the piston also compresses the fuel air mixture in the crankcase.

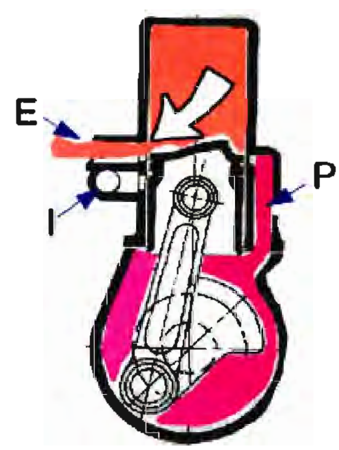


Figure 2: Exhaust

At the end of the first stroke the exhaust port are fully open and the fuel inlet port P is now open allow the compressed fuel mixture to enter the cylinder above the piston (Figure 3). The piston crown is so shaped that the mixture is deflected upwards above the residue of the escaping exhaust gases. The fuel mixture helps to sweep out the exhaust gases.

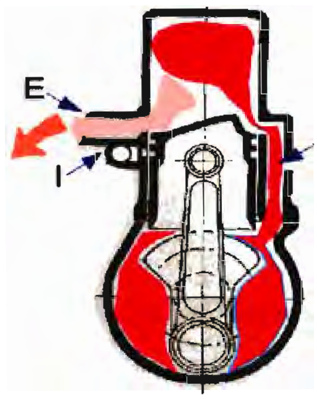
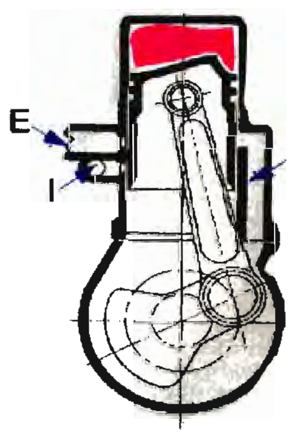


Figure 3: Charging



During the upward compressing stroke, the piston covers the transfer ports, compresses the charge and creates a small vacuum in the crankcase. At the end of the upward stroke (inner dead centre) ignition occurs resulting in the ignited charge expanding and exerting pressure on the piston (Figure 4).

Figure 4: Compression

2.4 Advantages and Disadvantages of Two Stroke Engine

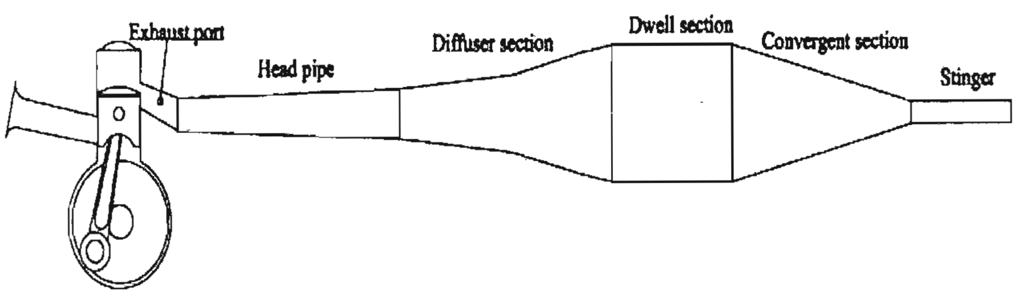
There are advantages and disadvantages of having a two-stroke engine. The advantages are, two-stroke engines don't have valves, which simplifies their construction and lowers their weight. Two-stroke engines fire once every revolution (four-stroke engines fire once every other revolution). This gives the two-stroke engine a significant power boost. Two-stroke engines can work in any orientation, which can be important in something like a chainsaw. A standard four-stroke engine may have problems with oil flow unless it is upright, and solving this problem can add complexity to the engine. These advantages make two-stroke engines lighter, simpler and less expensive to manufacture. Two-stroke engines also have the potential to pack about twice the power into the same space because there are twice as many power strokes per revolution. The combination of light weight and twice the power potential gives two-stroke engines a great power-to-weight ratio compared to many four-stroke engine designs.

However, the disadvantages are, the two-stroke engine doesn't use fuel efficiency, thus high fuel consumption is need in a few miles. Also, because the two-stroke engine is sloppier about how it expels exhaust and takes in fuel almost at the same time, it produced a lot of pollution. Moreover, it may decrease the power output at certain speed required since the combustion process is incomplete. It also does not last long, since there is a lack of dedicated lubrication system.

2.5 Introduction to Expansion Chamber

In a two stroke engine the exhaust pipe is very important since it acts as a tuning tool besides help to transfer the heat far from the engine. An expansion chamber is an exhaust system used on a two stroke engine system to enhance its power output by improving its volumetric efficiency. It was called expansion chamber because of the way the pipe expands in the center. A two stroke engine has a very strong exhaust pulse that occurs as the as the piston passes the flat top of the exhaust port. The quick pressure pulse moves quickly down the pipe and creates a shock wave as it exits the end of the pipe. The function of expansion chamber in a two stroke engine is similar to the tuned pipe used in four stroke engine.

Without the expansion chamber, a large amount of power producing fuel and air would escape from the exhaust port because the exhaust port must be opened when the fresh fuel/air charge rushes into the combustion chamber. Four strokes do not need expansion chamber like two stroke type because of the valves are sealed at the exhaust pots during the intake cycle. Moreover, the use of the expansion chamber is to reduce exhaust emission in a simple two stroke engine with crankcase compression and homogeneous charging. Besides, the engine power output increased and the fuel consumption and noise are also reduced:



2.6 The Theoretical Background of Tuned Exhaust Pipe on Two Stroke Engine

The two stroke engine does not utilize an exhaust stroke to evacuate the burn gases from the cylinder like a four stroke engine. the incoming air of fuel charge is used to help by pushing the burnt gses out of the exhaust. This is not a efficient process since some of the burnt gases remaining in the cylinder and some of the fresh air of fuel charge escape through the open exhaust port. Thus, expansion chamber enhances and control the flow through the engine by using negative and positive pressure pulse.

By continuing the discussion, after the exhaust blow down, an extremely high energy pulse of exhaust gas enter the head pipe when the piston begins to open the exhaust port.

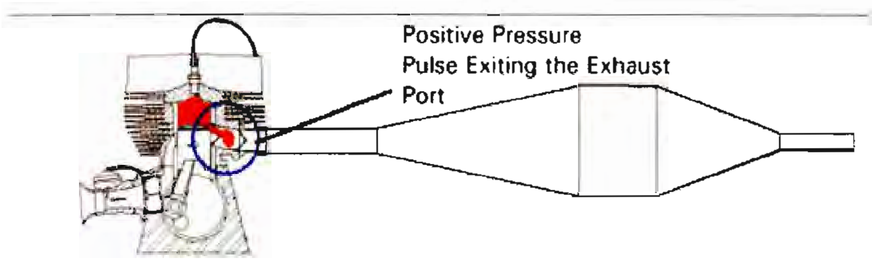


Figure 2.5.2: Energy pulse enter the header pipe

Then the compression wave occurred resulting from this sudden released of cylinder pressure. It travels down the exhaust pipe at the local speed of sound and remain unchanged until it reaches the beginning of the divergent cone of diffuser of the expansion chamber. From the perspective of the sound waves, upon reaching this junction, the diffuser appears almost like an open-ended tube in that part of the energy of the pulse is reflected back up the pipe. As pipe diameter expands, it reflects a negative pressure wave back towards the engine. the negative pressure assists the mixture coming up through the transfer ports, and at the same time draws some of the mixture out into the exhaust header. Meanwhile, the original pressure pulse is still making its way down the expansion chamber, although a considerable portion of its energy was given up in creating the negative pressure waves. The angle of the walls of the cone determines the magnitude of the returned negative pressure, and the length of the cones defines the duration of the returning waves.

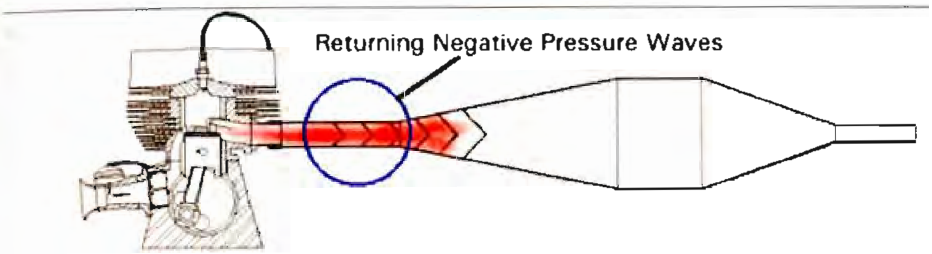


Figure 2.5.3: Negative pressure wave reflects toward the engine

As the original wave continues to travel down the pipe, it encounters the reversing cone (convergent section). The convergent section of the chamber appears like a closed- end tube to the pressure pulse, and as such causes another series of waves to be reflected back up the pipe, except this waves are the same sign as the original (a compression, or pressure wave is returned). Here, the wave is reflected back toward the engine again but it remains a positive pressure wave. Notice that convergent cone has a sharper angle than the diffuser. It is designed as a way to reflect back fresh mixture drowns out into the head pipe back to the cylinder.

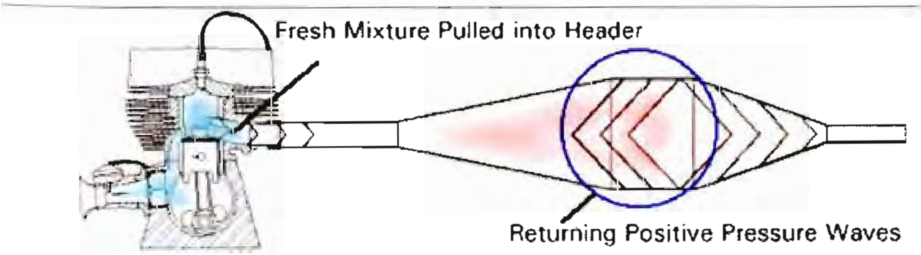


Figure 2.5.4: positive wave reflected back to the exhaust port

This is timed to reach the exhaust port after the transfer port closes, but before the exhaust port closes. The returning compression wave pushes the mixture drawn into the header by the negative pressure wave back into the cylinder, thus supercharging (a bigger charge than normal) the engine. the positive pressure wave stop the new incoming air/fuel charge from escaping out of the exhaust port. The length of the pipe and temperature control the timing of this event.

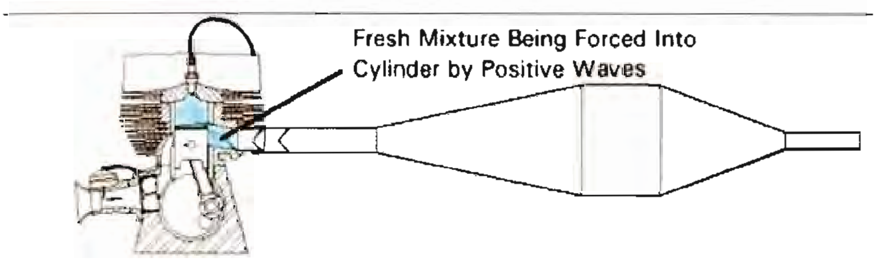


Figure 2.5.5: Negative mixture being forced into cylinder

The length of the pipe between exhaust port and diffuser control the timing of the negative wave. The straight section of the pipe (dwell section) between the two cones exists to ensure that the positive wave reaches the exhaust port at the correct time. There is a rise in pressure combined with the high pressure in the chamber caused by deliberately restricting the outlet with a small tube called a stinger. The stinger restricts flow out of the chamber to cause higher pressure during the compression cycle and empties the chamber during the