DESIGN AND DEVELOPMENT OF MOTORED ENGINE
FOR TWO-STROKE SPARK IGNITION (SI) ENGINE

MOHD FIKRI AZRI BIN MAT SAAD

UNIVERSITI MALAYSIA PAHANG
DESIGN AND DEVELOPMENT OF MOTORED ENGINE FOR TWO-STROKE SPARK IGNITION (SI) ENGINE

MOHD FIKRI AZRI B MAT SAAD

Report submitted in partial fulfilment of the requirements for the award of Bachelor of Mechanical Engineering with Automotive Engineering

Faculty of Mechanical Engineering
UNIVERSITI MALAYSIA PAHANG

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SUPERVISOR’S DECLARATION

We hereby declare that we have checked this project report and in our opinion this project is satisfactory in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering with Automotive Engineering.

Signature : 
Name of Supervisor : Nik Mohd Izual bin Haji Nik Ibrahim
Position : Lecturer Faculty of Mechanical Engineering
Date : 12 November 2008

Signature :
Name of Panel : Devarajan A/L Ramasamy
Position : Lecturer Faculty of Mechanical Engineering
Date : 12 November 2008
STUDENT'S DECLARATION

I hereby declare that the work in this report is my own except for quotations and summaries which have been duly acknowledged. The report has not been accepted for any degree and is not concurrently submitted for award of other degree.

Signature : 
Name : Mohd Fikri Azri bin Mat Saad
ID Number : MH 05031
Date : 12 November 2008
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ABSTRACT

The two stroke engines have been around for more than a century and have survived so far, primarily in portable applications. From the beginning, two stroke engines have suffered from poor fuel economy and high fuel emissions compared to the larger, heavier, but more efficient than four stroke design. The scavenging process in the two-stroke engine has direct influence on engine performance on their combustion process and remains one of the important strategies towards improvement of fuel efficiency and reduction of pollutant. The new of engine test rig was design and fabricate for motoring concept a single cylinder 30.5 cc two strokes spark-ignition. Then measurement installation was done to the test engine. It will be the platform for further study in investigation the in-cylinder characteristic whiles the scavenging process for motored condition. The result of this project is a new engine test rig with motored condition for two-stroke spark ignition (SI) engine with instrument installation for data measurement.
ABSTRAK

Enjin dua lejang telah lama digunakan lebih daripada satu abad dan sehingga kini masih lagi digunakan, terutamanya dalam penggunaan yang mudah dan pada skala yang kecil. Sejak dulu lagi, enjin dua lejang telah bermasalah dari segi penggunaan bahan bakar yang tidak cekap dan pencemaran yang tinggi berbanding dengan besar, berat tetapi lebih cekap daripada enjin empat lejang. Proses pertukaran gas ekzos yang telah terbakar dengan campuran udara dan bahan bakar yang baru dalam enjin dua lejang telah mempengaruhi prestasi enjin secara langsung melalui proses pembakaran dan menjadi satu rancangan yang penting dalam penambah baikan penggunaan bahan bakar dan pengurangan pencemaran. Satu platform atau pelantar penguji enjin dua lejang satu silinder berkapasiti 30.5cc pembakaran melalui percikan api dengan konsep menggerakkan enjin menggunakan motor telah dibina. Kemudian pemasangan peralatan pengukuran dibuat kepada enjin. Ia akan menjadi pemangkin kepada kajian yang lebih mendalam mengenai sifat di dalam silinder sewaktu proses penggantian gas ekzos yang telah terbakar kepada campuran udara dan bahan bakar yang baru diantara lubang masukan dan ekzos di masa hadapan. Hasil kajian ialah sebuah pelantar penguji enjin dua lejang satu silinder pembakaran melalui percikan api dengan konsep menggerakkan enjin menggunakan motor beserta dengan pemasangan peralatan dan sensor bagi mengambil data.
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LIST OF SYMBOLS

\( \rho_a \)  \hspace{1cm} \text{Density of air}

\( SE_v \)  \hspace{1cm} \text{Scavenging efficiency}

\( TE_v \)  \hspace{1cm} \text{Trapping efficiency}

\( CE_v \)  \hspace{1cm} \text{Charging efficiency}

\( SR \)  \hspace{1cm} \text{Delivery (scavenging) ratio}

\( V_{ta} \)  \hspace{1cm} \text{Volume of delivered air retained}

\( V_{ex} \)  \hspace{1cm} \text{Volume of trapped cylinder charge}

\( V_{cy} \)  \hspace{1cm} \text{Trapped volume x ambient density}

\( V_{as} \)  \hspace{1cm} \text{Volume of delivered air per cycle}
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<td>IC</td>
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CHAPTER 1

INTRODUCTION

1.1 PROJECT BACKGROUND

The scavenging process in the two-stroke engine has direct influence on engine performance on their combustion process and remains one of the important strategies towards improvement of fuel efficiency and reduction of pollutant. Purpose of this study is to understand the flow mechanism thoroughly of an engine design where gas flow motions in a two stroke engine directly control the performance characteristic of the engine. During experiment setup, measurement installation to collect the parameters was done. Further study need investigate the in-cylinder characteristic while the scavenging process for motored condition through experiment testing, the different variation of pressure was collected and applied to the scavenge port pressure, exhaust port pressure and in-cylinder pressure at 1000 rpm, 1200 rpm, and 1400 rpm. The new of an unfired engine test-rig was developed include the data acquisition system (DAQ) and sensors for data collection.

1.2 PROBLEM STATEMENT

To improve the performance and durability of such an engine, crankcase pressure, volume and temperature are some of the important parameters to optimize. Investigation of the pressure histories have been done with reference to pressure fluctuations, backflow, list approximation, ring sticking, crankcase volume, crankcase temperature, cylinder barrel temperature, engine speed and physical parameters of the engine [1]. Scavenging process is required in two-stroke engines in assuring the appropriateness of combustion. But it will result in the short-circuiting of
fresh charge (flow directly from the engine’s transfer to the exhaust port) which is
suffered from poor fuel economy and high unburned hydrocarbons emission
compared to the larger, heavier, but more efficient than four-stroke design. The
scavenging process in the two-stroke engine has direct influence on engine
performance on their combustion process and remains one of the important strategies
towards improvement of fuel efficiency and reduction of pollutant [2] [3].

From the previous study in motored concept [3], there is not clear and only a
few technical paper study about the motored concept of an unfired for two-stroke
engine. So that, this research will study more deeply and detail with combine the
result from other previous research in motoring concept.

1.3 OBJECTIVES

The objective of this project is to design and fabricate of new engine test rig
for motoring concept (unfired condition) a single cylinder 30.5 cc two-strokes spark-
ignition (SI) engine and measurement installation.

1.4 SCOPES

The Scopes of the project are:

i. Literature review about two-stroke engine.

ii. Design, fabrication and development of motoring engine testing for two-
stroke engine.

iii. The instrumentation for scavenging measurement was installed at the engine
model.

1.5 THESIS ORGANIZATION

Chapter 2: The review of recent works is important to provide the understanding of
two-stroke engine and technologies such as the scavenging systems, motored and
firing testing conditions. The other previous technical papers and journal which are
published will assist the author in motored condition testing development. Besides,
there are several books on two-stroke engines which will provide first hand knowledge in designing engine test rig especially in motored condition.

Chapter 3: This chapter will explain the methodology of this research including design and fabrication of engine test for two-stroke engine. Besides that, it also explains the experiment setup, instrumentation installation and measurement.

Chapter 4: This chapter will explain about result of the engine test rig including the engine test rig parts and the measurement equipment. It also explains the experiment procedures and conditions.

Chapter 5: This chapter will conclude and summarize overall the project. Recommendations for the future works are also presented in this chapter.
CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

The objective of this chapter is to describe detail of literature review done regarding to the research, investigation of motored engine performance test for two-stroke (SI) engine. In this chapter, fundamental of internal combustion engine and two stroke engine was discussing deeply based on research done. Including type of two-stroke engines and classification based on scavenging process.

2.2 INTERNAL COMBUSTION ENGINES

The internal combustion (IC) engines date back to 1876 when Nicholas A. Otto first developed the spark-ignition engine and 1892 when Rudolf Diesel invented the compression-ignition [4]. An engine is a device which transforms one form of energy into another form. Normally, most of the engines convert thermal energy into mechanical work and therefore they are called ‘heat engines’. Heat engines can be broadly classified into two categories [5].

(i) Internal Combustion Engines (IC Engines)
(ii) External Combustion Engines (EC Engines)

Internal Engines are two types, first Rotary engines and second Reciprocating engines. The most widely used ones are the reciprocating internal combustion engines [6]. In internal combustion engine, the heat engine that converts chemical energy in a fuel into mechanical energy. Chemical energy of the fuel is first
converted to thermal energy by means of combustion or oxidation with air inside the engine [4] [19]. This thermal energy raises the temperature and pressure of the gases within the engine. This expansion is converted by the mechanical linkages of the engine to a rotating crankshaft. One end of a connecting rod is attached to the bottom of the piston by a joint, the other end of the rod clamps around a bearing on one of the throws, or convolutions, of a crankshaft, the reciprocating motions of the piston rotate the crankshaft, which is connected by suitable gearing to the drive wheels of the automobile which is the output of the engine [2] [3] [5] [20].

The advantages of reciprocating engines are absence of heat exchanger in the passage of working fluid, its component work at an average temperature which is much below the maximum temperature of the working fluid in the cycle. Therefore the weight to power ratio is less. The main disadvantage is problem of vibration caused by the reciprocating components [5] [21] [22].

The most common internal-combustion engine is the piston-type gasoline engine used in most automobiles [23]. They are several type of cylinder arrangement which is in-line engine, V-engine, W-engine, radial and opposed piston [2] [4]. The IC engine are used in many application and various sector such as automobile, truck, locomotive, light aircraft, marine, power generator and many mores [24].

Besides, there are two categories for the internal engine design, which are spark ignition (SI) engine and diesel engine. Spark ignition engine is an engine which the combustion process in each cycle is started by use of a spark plug. Diesel engine is also called as compression ignition (CI) engine which the combustion process starts when the air-mixture self ignites due to high temperature in the combustion chamber caused by high compression [5] [25].

2.2.1 History Of Two-Stroke Engines

The two stroke engine is as old as the concept of the heat engine. Which has served mankind for over 460 years. George Medhurst, an English engineer in 1800 was the first to propose a two stroke engine with a controlled cyclic repetition of the
working processes. The two-stroke cycle is hardly new concept, in fact all internal combustion engine developed before Nicolaus Otto inverted the four-stroke cycle engine in 1876 operated on two-stroke cycle [1]. The idea to build a two-stroke engine goes back to the year 1879 and the short-circuit loss of fresh charge has been known since two-stroke engines were first made by Sir Dugald Clerk in 1879. [2] [3] [5] [7] [8].

2.3 TWO-STROKE ENGINE

In two stroke engine, there is one important process that known as scavenging. Various different scavenging systems have been designed. Today, three main categories are generally accepted which: loop scavenging, cross scavenging and uniflow scavenging [9] [10] [11]. A two stroke engine is one which completes its cycle of operation in one revolution of the crankshaft or in two strokes of the piston [26] [27]. In this engine the functions of the intake and exhaust processes of the four-stroke engine are taken care of by the incoming fresh charge which is compressed either in the crankcase or by means of a separate blower while the engine piston is near the bottom dead center [4] [5]. The engine piston needs only to compress the fresh charge and expand the product of combustion. Since a two-stroke engine will have twice as many cycles per minute as a four-stroke engine, the power output of this engine also depend upon the number of kilograms of air per minute available for combustion [4] [28].

For the crankcase scavenged engine, as the piston moves down, it first uncovers the exhaust port, and the cylinder pressure drops to atmospheric level as the combustion product escape through these ports [3] [4] [5]. Further, downward motions of the piston uncover the transfer port, permitting slightly compressed mixture or air (depending upon the type of the engine) in the crankcase to enter the engine cylinder [8] [12] [29] [30].

The top of the piston and the port are usually shaped in such a way that the fresh air is directed towards the top of the cylinder before showing towards the exhaust ports. This is for the purpose of scavenging the upper part of the cylinder of
the combustion products and also to minimize the flow of the fresh fuel-air mixture directly through the exhaust ports [5] [13] [14]. The projection on the piston is called the deflector [10].

As the piston returns from bottom center, the transfer ports and then the exhaust ports are closed and compression of the charge begins. When the exhaust slot is uncovered near the end of the power stroke, immediately followed with an intake process of compressed air or air-fuel mixture [15]. Motion of the piston during compression lowers the pressure in the crankcase so that the fresh mixture or air is drawn into the crankcase through the inlet reed valve [5] [16] [17]. Ignition and expansion take place in the usual way, and the cycle is repeated. Due to the flow restriction in the inlet reed valve and the transfer ports the engine gets charged with less than one cylinder displacement volume [2] [5] [8] [18].