SUPERVISOR DECLARATION

"I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering (Automotive)"

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AN ASSESSEMENT OF CYLINDER DEACTIVATION IMPLEMENTATION USING A RACE SYTYLE EXHAUST MANIFOLD

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This report is submitted in accordance with requirement for the Bachelor of Mechanical Engineering (Automotive)

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DECLARATION

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

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This thesis is special

for

Dearest Dad & Mom

Raja Tajuddin Bin Raja Othman & Zaini Bt Abd Aziz

For they were the one who encourage me to finish this thesis

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ABSTRACT

The phenomenon of pumping losses often associated with weakness of engine breathing and usually occurred during part load. Cylinder Deactivation System (CDS) is one of the technology used to improve engine breathing and thus improving fuel efficiency and reducing emission. Cylinder deactivation system not only require cutting and ignition to desired cylinder but it also important to have the correct amount of oxygen content for combustion on active cylinder. The aim of this thesis is to propose a new concept to reduce the vehicle emission and fuel consumption by implementing using 4-2-1 race style exhaust. This thesis will his thesis will try tracing the new concepts of use cylinder deactivation system with implementation using race style exhaust 4-2-1. Several experiments will be carried out to get some output as the initial data to this concept, for example emission gas and engine vibration. The experiment also will be conducted into several modes, for example, running on all cylinder active, running at cut off one cylinder and running at cut off two cylinders. At the end of this experiment, it will show the initial positive result that this system is relevant to be implemented.

ABSTRAK

Fenomena mengepam kerugian sering dikaitkan dengan kelemahan pernafasan enjin dan biasanya berlaku pada bahagian beban. Silinder penyahaktifan sistem (CD) adalah salah satu teknologi yang digunakan untuk memperbaiki pernafasan enjin dan sekali gus meningkatkan kecekapan bahan api serta mengurangkan kadar pelepasan. Silinder penyahaktifan sistem ini bukan sahaja memerlukan pemotongan pancitan bahan api dan pencucuhan silinder yang dikehendaki, tetapi ia juga penting untuk mempunyai jumlah kandungan oksigen yang baik untuk pembakaran yang betul pada silinder yang aktif. Tujuan tesis ini adalah untuk mencadangkan satu konsep baru untuk mengurangkan penggunaan bahan api dan pelepasan kenderaan dengan menggunakan 4-2-1 gaya ekzos. Tesis ini akan cuba mengesan konsep-konsep baru menggunakan silinder penyahaktifan sistem dengan pelaksanaan menggunakan gaya ekzos 4-2-1. Beberapa eksperimen akan dijalankan untuk mendapatkan output beberapa sebagai data awal konsep ini, untuk contoh pelepasan gas dan enjin getaran. Percubaan juga akan dijalankan dalam beberapa cara, contohnya, berjalan pada semua silinder aktif, berjalan di nyahaktif satu silinder dan berjalan pada dinyahaktif dua silinder. Pada akhir eksperimen ini, ia akan menunjukkan hasil positif yang awal bahawa sistem ini adalah relevan untuk dilaksanakan.

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ppm	=	Particle per Million
cm^3	=	centimeter cubic
λ	=	lambda

LIST OF ABBREVIATION

1	CO_2	=	Carbon Dioxide
2	CO	=	Carbon Monoxide
3	NO	=	Nitrogen Oxide
4	UK	=	United Kingdom
5	EEV	=	Energy Efficient Vehicle
6	NAP	=	National Automotive Policy
7	CDS	=	Cylinder Deactivation System
8	RPM	=	Revolution per Minutes
9	ECU	=	Engine Control Unit
10	MIVEC	=	Mitsubishi Innovate Valve Timing Control
11	VTEC	=	Variable Valve Timing and Lift Electronic Control
12	MAA	=	Malaysian Automotive Association
13	HC	=	Hydrocarbon
14	g/km	=	Gram per Kilometre

15	UTeM	=	Universiti Teknikal Malaysia Melaka
16	SI	=	Spark Ignition
17	OBD	=	On-Board Diagnostic
18	O_2	=	Oxygen
19	BDC	=	Bottom Dead Center
20	TDC	=	Top Dead Center
21	IC	=	Internal Combustion

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CHAPTER I

INTRODUCTION

1.0 INTRODUCTION

Transport give a huge number on producing greenhouse gases such as Carbon Dioxide (CO_2). The CO_2 emissions of a car are directly proportional to the quantity of fuel consumed by an engine. Today's on-road vehicles produce over a third of the carbon monoxide (CO) and nitrogen oxides (NO) in our atmosphere and over twenty percent of the global warming pollution. In the United Kingdom (UK), The Climate Change Act (2008) set a long-term legally binding framework for greenhouse gas reduction. The Act requires the UK Government to reduce greenhouse gas emissions by at least 34% by 2020 and 80% by 2050 from 1990 levels in the UK. Based on that, The European Union (EU) introduces stricter limits on pollutant emissions from light road vehicles, particularly for emissions of nitrogen particulates and oxides through EURO 6. Table 1 shows European emission standards for passenger cars. Realizing the importance of reducing environmental pollution, the automotive industry has introduced Energy Efficient Vehicle (EEV). In Malaysia, under the National Automotive Policy (NAP) 2014 government seriously wants to become an EEV hub. Based on this vision, about 85% of vehicles produced in Malaysia in 2020 will be EEVs. Ongoing research is done to increase car production rates based on EEV.

Continuous development in automotive technology playing an important role to ensure the production of the vehicle meets the EEV specification. A lot of aspects that become a focus to produce an EEV. A world more focusing on the method used to achieve higher engine efficiency like, by improving engine breathing. Application of valve, variable valve timing & lift, force induction and cylinder deactivation allowing to run at wider

CDS currently not a new technology in automotive industry. It's included as one of the technology used in modern car especially passenger car. CDS is selectively disabled some of the cylinders in an internal combustion engine to improve fuel economy and reduce CO_2 emissions when the full power of the engine is not required. When the power requirements of the engine are low, the engine does not run at its peak performance level. CDS effectively decreases the displacement of the engine by closing the intake and exhaust valves and cutting fuel injection for a particular cylinder. The pistons in the deactivated cylinders compress the trapped gases and are pushed back down, thus expending zero networks. The remaining cylinders compensate for the loss in power due to the inactive cylinders by operating at a higher combustion pressure. As a result, for a given load on the engine, the throttle valve is more open (wide open throttle), allowing the cylinder mean effective pressure to be closer to the optimal level and increasing the efficiency of the engine. The basis of the system is built to overcome the phenomenon of pumping losses. When the throttle air intake is minimal and the intake of air to the cylinders is more difficult. Not only is more force required to overcome the internal vacuum, but the cylinders do not completely fill with air. With less air in the cylinder, the combustion pressure is reduced. This situation is commonly referred to as pumping loss and can significantly reduce the efficiency of the engine.

The implementation of cylinder deactivation today more about changing the valve train of the engine by variable the camshaft profile of the engine. On this day, the researchers believe there is still room which can be improved to increase the efficiency of energy use. In this study, the focus would be directed to the use of a cylinder deactivation system with using 4-2-1 race style exhaust. Relevant use of this exhaust is to change the position of the oxygen sensor of the read signal voltage to each cylinder to a cylinder only. With this, the engine computer units will not accept signal the excess oxygen in the engine combustion process. This system also, expected to promote the same result as the previous system.

Table 1.0 European emission standards for passenger cars (Category M*), g/km

Tier	Date	CO	THC	NMHC	NO_X	$HC+NO_X$	PM	P[#/km]
Diesel								
Euro 1	July 1992	2.72	-	-	-	0.97	0.14	-
Euro 2	January 1996	1.0	-	-	-	0.7	0.08	-
Euro 3	January 2000	0.64	-	-	0.50	0.56	0.05	-
Euro 4	January 2005	0.50	-	-	0.25	0.30	0.025	-
Euro 5a	September 2009	0.50	-	-	0.180	0.230	0.005	-
Euro 5b	September 2011	0.50	-	-	0.180	0.230	0.005	6×10^{11}
Euro 6	September 2014	0.50	-	-	0.080	0.170	0.005	6×10^{11}
Petrol (Gasoline)								
Euro 1	July 1992	2.72	-	-	-	0.97	-	-
Euro 2	January 1996	2.2	-	-	-	0.5	-	-
Euro 3	January 2000	2.3	0.20	-	0.15	-	-	-
Euro 4	January 2005	1.0	0.10	-	0.08	-	-	-
Euro 5	September 2009	1.0	0.10	0.068	0.060	-	0.005	-
Euro 6	September 2014	1.0	0.10	0.068	0.060	-	0.005	6×10^{11}

1.1 PROBLEM STATEMENT

Cylinder Deactivation System (CDS) is one of the methods used to increase engine breathing at part load by allowing the throttle to open wider. Using 4-2-1 race style exhaust manifold to implement CDS does not require and modification at the top of the engine especially camshaft profile.

1.2 AIM

To assess a new approach of CDS applied to a small SI engine using a race-style 4-2-1 exhaust manifold.

1.3 OBJECTIVES

The objective of this research is to investigate the implementation of a cylinder deactivation system using 4-2-1 race style exhaust on small SI engine. At the end of this study, there is a few objective need to accomplish:

- To measure the pollution emissions and oxygen content during idling at different modes of CDS.
- To measure the engine vibration during idling at different modes of CDS.

1.4 SCOPE

- Conduct an experiment by applying cylinder deactivation system at idling (1000 RPM)
- Conduct an experiment by applying cylinder deactivation system during no load

CHAPTER II

LITERATURE REVIEW

2.0 INTRODUCTION

This chapter will give focus on the development of the technology of the cylinder deactivation system and will further explore the problems encountered regarding this system. This chapter as well, it will give focus on technologies that lead to a reducing fuel consumption, improved performance of the vehicle and carbon dioxide emissions as well. To better understand this system, a few small headings will explain about some of the systems and components that are closely related to the cylinder deactivation system.

The rapid development of the automotive industry gives a lot of negative impact on the environment. The increasing number of vehicles over a year and the rate of the number of production vehicles a year also began to show negative effects on the environment. The release of harmful gas emission also has a negative impact on human health. In an effort to save the environment, automotive industry indeed needs to contribute ideas in dealing with this problem.

2.1 INTERNAL COMBUSTION ENGINE

Internal combustion engines date back to 1876 when Otto first developed the spark-ignition engine and 1892 when Diesel invented the compression-ignition engine. Since that time these engines have continued to develop as our knowledge of engine processes has increased, as new technologies became available, as demand for new types of engine arose, and as environmental constraints on engine use changed. Internal combustion engines are seen every day in automobiles, trucks, and buses. The name internal combustion refers also to gas turbines, except that the name is usually applied to reciprocating internal combustion (I.C.) engines like the ones found in everyday automobiles. There are basically two types of I.C. ignition engines, those which need a spark plug, and those that rely on compression of a fluid. Spark ignition engines take a mixture of fuel and air, compress it, and ignite it using a spark plug. Figure 2.0 shows a piston and some of its basic components. The name `reciprocating' is given because of the motion that the crank mechanism goes through. The piston-cylinder engine is basically a crank-slider mechanism, where the slider is the piston in this case. The piston moves up and down by the rotary motion of the two arms or links. The crankshaft rotates which makes the two links rotate. The piston is encapsulated within a combustion chamber. The bore is the diameter of the chamber. The valves on top represent induction and exhaust valves necessary for the intake of an air-fuel mixture and exhaust of chamber residuals. In a spark ignition engine a spark plug is required to transfer an electrical discharge to ignite the mixture. In compression ignition engines the mixture ignites at high temperatures and pressures. The lowest point where the piston reaches are called bottom dead center (BDC). The highest point where the piston reaches are called top dead center (TDC). The ratio of BDC to TDC is called the compression ratio.

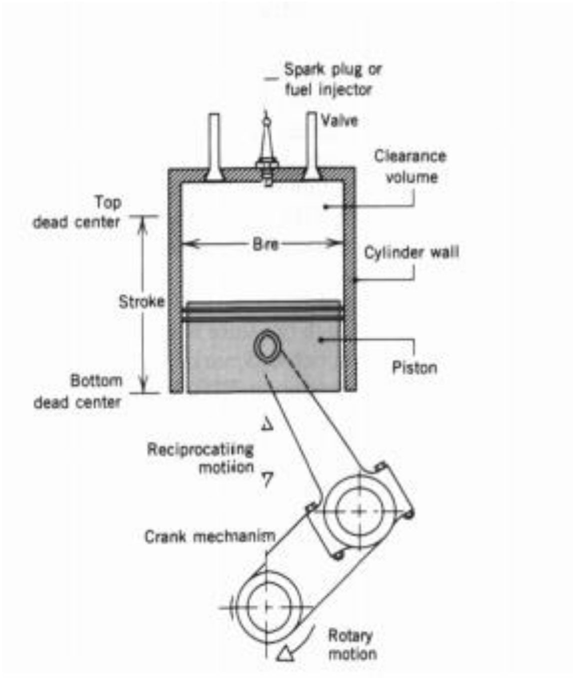

Figure 3.0: Piston

2.2 CYLINDER DEACTIVATION SYSTEM

One of the ways manufacturers can minimize fuel consumption is to downsize the engines they offer. A cylinder's volume can only be restricted to a certain extent, however, if the thermodynamically ideal volumetric capacity of 400 to 500 cm^3 per cylinder is to be retained. In practice, downsizing therefore frequently leads to a reduction in the number of cylinders. "Temporary downsizing" in the form of cylinder deactivation offers an attractive compromise, since this allows an engine to shift its operating mode to achieve the specific consumption figures it is rated for, especially when low loads and operating speeds are encountered. At the same time, the driver still has a sufficiently powerful engine at his or her disposal that ensures the same level of driving pleasure and comfort with regard to acoustics and vibration characteristics. It is not practical to also disengage the moving parts of the crank drive during cylinder deactivation. Deactivating the valve stroke sequence, on the other hand, can be realized with a comparably moderate outlay. The following options are available for this purpose:

- Switchable bucket tappets
- Switchable finger followers