Study the performance of single cylinder spark ignition engine for gasoline and compressed natural gas

M.Z.Yunus[1,*], M.T. Musthafah[1,2], M.Z. Akop[1,2]

[1)] Faculty of Mechanical Engineering, Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia.
[2)] Centre for Advanced Research on Energy, Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia.

[*]Corresponding e-mail: zcykko_10@yahoo.com

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ABSTRACT – Due to the unsteady oil prices, shortage continuity of fossil fuel and an emission crisis, automobile manufactured was motivated to find the solution for improve the efficiency of fuel. One of the factors that influence the performance of vehicle engine is the type of fuel used to complete the combustion. In this paper the study about combustion of mixture inside the cylinder is applied. Two types of fuel are tested that is gasoline and compressed natural gas (CNG) in four stroke single cylinder spark ignition (SI) engine. Based on the result, shows that CNG produce 6% lower of pressure compared to gasoline during power stroke. In addition the gasoline also leads in power and torque respectively on average by 15.8% and 16.3 %.

1. INTRODUCTION

Internal combustion engine is most widely used engine in automotive field to convert the chemical energy into the useful mechanical movement to move the vehicle. A lot of alternative fuels have been introduced to replace the usage of current primary fuels that are gasoline and diesel in other to enhance the output performance of the engines. One of the alternative fuels that are most frequently used in automotive industries is a CNG. The increased use of Natural Gas Vehicle (NGV) can be seen through the growth statistics released by the International Association for Natural Gas Vehicles which show an average growth of 22.9 percent for the past decade since 1991 until 2011[1]. Accordingly, the present studies explore about several advantages of CNG applied on the SI engine. Kowalewiez and Wojtyniak [2] in their studies stated that CNG have highest knock resistance due to high octane number that is 130. Moreover, Maji et al. [3] found that CNG delivered 3 to 5 percent higher thermal efficiency and also reduce the specific fuel consumption into 15 percent compared gasoline. Furthermore, according to an investigation by Amitabh et al. [4] it was proved that CNG produced 60% reduction of hydrocarbon and NOx emission also much lowered than gasoline.

The aim of this paper is to show the performance of the CNG fuel in spark ignition (SI) engine compared with the conventional fuel that is gasoline.

2. METHODOLOGY

The study is based on the experimental data collection. The analytical analyses were done by applying appropriate mathematical theories.

2.1 Engine parameter

The experiment was conducted using a modified engine manufactured by Subaru. The engine is rated at 5.0 HP and is suitable for small commercial used. The general specification of the engine is stated in **Table 1.**

Table 1 Engine Specification

Technical Data	Specification
No of cylinder	1
Bore	67.4 mm
Stroke	52 mm
Connecting rod length	91 mm
Compression ratio	6.3
TDC clearance height	0.4 – 0.6 mm

2.2 Experimental Setup

Figure 1 illustrates the setup of the experiment for collecting the data. Two series of experiment are conducted where the speed of the engine is run in range of 2000 rpm until 4000 rpm. For first series it involved of gasoline while the second is CNG. The data of the engine are detected by crank angle sensor and pressure sensor transmitted to data acquisition and collected inside the computer. The combustion analyzer software was applied to manage the data collection and data analysis.

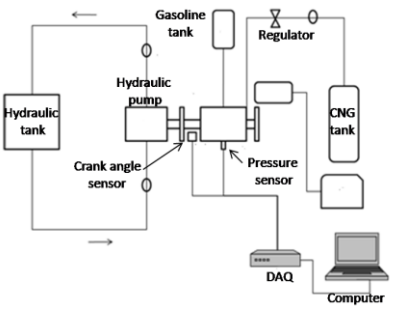

Figure 1 Experimental setup for performance of engine test

3. RESULTS AND DISCUSSION

The performance of the engine is illustrated in Figures 2 to 4 based on the experiment conducted.

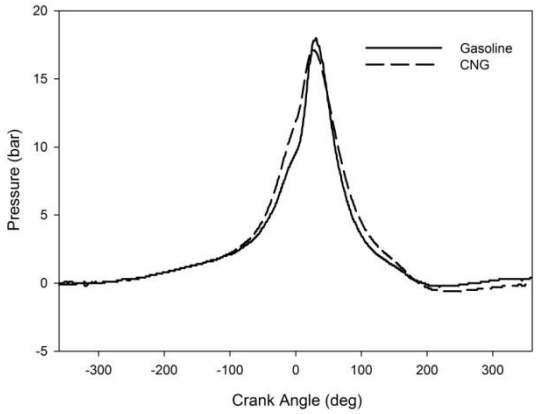

Figure 2 Comparison of cylinder pressure between gasoline and CNG with variation of engine speed

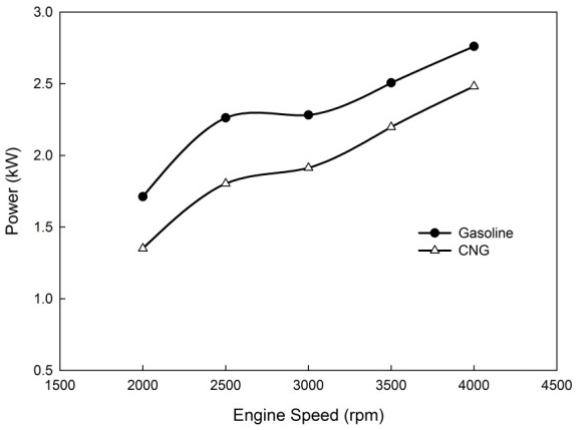

Figure 3 Comparison of power output between gasoline and CNG

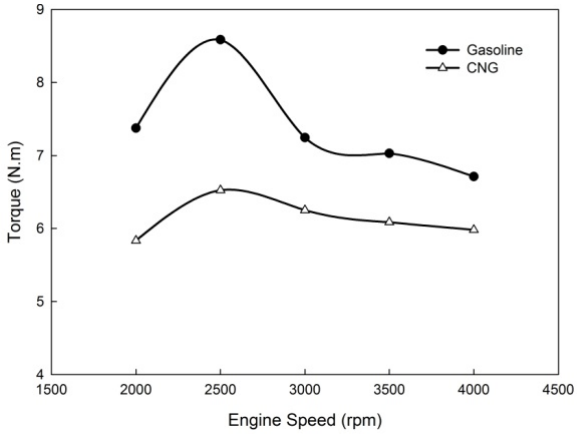

Figure 4 Comparison of torque output between gasoline and CNG

Figure 2 shows the behavior of the pressure inside the cylinder for full cycle process for both fuels. It shows that the highest resulting pressure is with gasoline with value of 18 bar while for CNG, the pressure is only 17 bar. These occurred due to the influence of different fire propagation produced after the ignition of the spark plug.

This situation contributed to the production of higher power output for gasoline as compared to CNG as shown in Figure 3. This happened because the CNG displaced more intake air due to the state of the fuel in gaseous form, as a result more fuel occupied the space during intake system and hence the stoichiometric is not achieved. Moreover, based on Figure 3 it can be stated that the higher the engine speed the higher the power produced by the engine.

The relationship between torque outputs of the two tested fuels is plotted in Figure 4. The curves show that the maximum torque is occurred at 2500 rpm for both fuels and fall back with respect of engine speed. Besides, the great difference between gasoline and CNG occurred at lower speed of engine and same as power graph, the gasoline curve always lead the CNG curve.

4. CONCLUSIONS

Based on the experimental investigation, single cylinder engine that consumes CNG experience lower pressure during power strokes compared to gasoline with a different almost 6 percent. The power output of the gasoline is averagely leading in all range of speed by 15.8 percent. Other than that, the usage of CNG as a fuel shows a cutback from 10 to 24 percent compared to gasoline. Overall, the results of this study provide a reference guide for combustion system design and development of the engine for CNG. Further research should be conducted to enhance CNG performance in order to compete with the gasoline.

5. ACKNOWLEDGEMENT

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