Proceedings of UNISEL Bestari Research Projects 2016, Ed(s): Setyawan Widyarto, et.al.,
Shah Alam: FIIT-UNISEL Publisher, ISBN: 978-983-3757-29-9

# DEVELOPMENT OF MIX FUEL SYSTEM FOR TWO-STROKE INTERNAL COMBUSTION APPLICATION

**Suziati Salleh[1], Nadya Abdullah[2], M. Emran Rusli[3], M.Faisal A. Waduth[4]**

[1]*Faculty of Engineering/Mechatronics, Universiti Selangor, Malaysia*
E-mail: suziati@unisel.edu.my
[2]*Faculty of Engineering/Mechatronics, Universiti Selangor, Malaysia*
E-mail: nadya@unisel.edu.my
[3]*Faculty of Engineering/Mechatronics, Universiti Selangor, Malaysia*
E-mail: emran_rusli@unisel.edu.my
[4]*Faculty of Engineering/Mechatronics, Universiti Selangor, Malaysia*
E-mail: faisal@unisel.edu.my

**Abstract**

***Most of the internal combustion engine (ICE) is operated by consuming petrol fuel. However, the price of petrol nowadays is inconsistently trending. A switch over to a new innovation is much needed. Water fuel cell is one of the alternative methods in order to generate gas for ICE by helping during combustion. The aim of this project is to study hydroxy gas ratio for burning process in the engine that can reduce petrol consumption and develop the mix fuel system using hydrogen and petrol for two-stroke ICE. The two methods to obtain hydrogen gas are from the electrolysis process or direct injection into hydrogen gas cylinder. After the gas is inserted into the air intake of the engine, it is mixed with the petrol in the engine's intake manifold. The gas mixtures burn in the combustion chamber in order to rotate the crankshaft. The percentage of petrol saving and the effect of hydroxy gas are presented and discussed at the end of this report.***

*Keywords*: **Two-stroke internal combustion engine, water fuel cell, hydroxy gas, electrolysis process.**

## 1 INTRODUCTION (11pt bold)

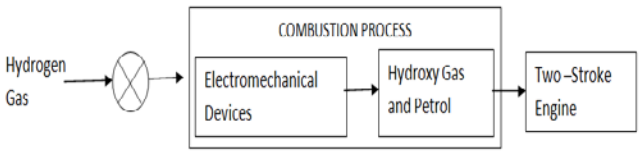
Nowadays, petrol seems like a major problem throughout the world, such as source insufficiency and cost inconsistency. Researchers extremely explore projects that are concerned to find alternatives in order to produce clean energy that will be able to fulfill the needs of the world. Renewable energy is necessary in order to reduce the petrol consumption for the engine application from now onwards. For example, electrolysis water is one of the types of renewable energy that is cheap and can be easily found and developed at any place.

*Defining Hydrogen*

Generally, hydrogen is the simplest and lightest element on earth. Thus, hydrogen contains more energy per weight as compared to other chemicals. Hydrogen contains high percentage of water ($H_2O$). Hydrogen can burn and form explosive mixture in air and it reacts violently with oxidants. Other than that, hydrogen is able to convert the chemical energy to mechanical energy. It can be applied to internal combustion engine burning process or with oxygen mixture to act as fuel cell for an electric motor [3]. Therefore, hydrogen has the potential to act as fuel or as energy carrier for the fuel cell application that is able to provide twice as more efficient as compared to gasoline engines [3]. Hydrogen fuel cell can be used to provide electricity for heating and cooling application for home or business use with high efficiency and environment friendly. In order to apply hydrogen in existing internal combustion engine system, the main concern is the hydrogen facilities, supply and storage system.

## 2 PROCESS PLANT

The process plant, as shown in Fig. 1, can be divided into three categories which are input, output, and the combustion process. With combination of all categories, the system runs with the mixture of hydroxy gas and petrol inside two-stroke internal combustion.




The input of this system is hydrogen gas. The initial pressure can be detected by the pressure gauge outside the cylinder. It has been modified and attached to the flowrate gas instrument to measure the flowrate of hydrogen gas injected

to the engine. The output of the project is the hydroxy gas being injected into the engine and petrol at the same time.

On the other hand, the combustion process is divided into hydroxy gas and petrol. Hydroxy is injected into the intake air as secondary process to assist combustion while petrol is injected into the combustion chamber as primary fuel.

TABLE 1: The Petrol Combustion Vs Time

| PETROL COMBUSTION VS TIME | | | | | |
|---|---|---|---|---|---|
| Amount of Petrol (ml) | Load (g) | Operating Time (min) | | | Average operating Time (min) |
| | | No. of Trials | | | |
| | | 1st | 2nd | 3rd | |
| 50 (50 g) | 0 | 4.42 | 4.49 | 4.36 | 4.42 |
| 100 (98 g) | | 8.51 | 9.2 | 9.3 | 9.00 |
| 150 (145g) | | 12.2 | 13.32 | 13.5 | 13.01 |

| PETROL COMBUSTION VS TIME | | | | | |
|---|---|---|---|---|---|
| Amount of Petrol (ml) | Load (g) | Operating Time (min) | | | Average operating Time (min) |
| | | No. of Trials | | | |
| | | 1st | 2nd | 3rd | |
| 50 (50g) | 277 | 3.14 | 3.54 | 3.42 | 3.37 |
| 100 (98g) | | 7.10 | 7.1 | 7.3 | 7.17 |
| 150 (145g) | | 11.1 | 11.14 | 11.24 | 11.16 |

| PETROL COMBUSTION VS TIME | | | | | |
|---|---|---|---|---|---|
| Amount of Petrol (ml) | Load (g) | Operating Time (min) | | | Average operating Time (min) |
| | | No. of Trials | | | |
| | | 1st | 2nd | 3rd | |
| 50 (50g) | 554 | 3.54 | 4.21 | 4.5 | 4.08 |
| 100 (98g) | | 7.55 | 8.53 | 8.45 | 8.18 |
| 150 (145g) | | 12.10 | 12.2 | 12.3 | 12.2 |

***Analysis of Petrol Consumption of Engine***

Table 1 shows the petrol consumption for two stroke combustion engine. Total 50 milliliters (ml) of petrol is used for each testing. After 50 ml petrol was filled in the oil tank, the engine will be started and the time will be recorded until the engine is fully stopped. Amount of fuel is added another 50 milliliters (ml) and varies with the load of the engine.

From the data in table 1, shows that with zero loads, the motor operated at full consumption of petrol and took about 4 to 14minutes to complete the rotary motion. By increasing the load where a piece of blade is added to the shaft, with the same set amount of petrol, the time operating turn out to be faster from 3 to 11 minutes. But there is no big influence on the time taken with additional pieces of blade on the shaft.

Several outcomes can be deduced that:

i. Volume of petrol consumption is linearly proportional to the time of operating, and

ii. As the load increases, the petrol burning up getting faster and shorten the operating time, but

iii. Less effect on the time taken after additional another load on the shaft.

The flow rate of the petrol flowing into the chamber can be calculated using this theory: $Q = V/T$

Where $V$ is the volume and $T$ is the time taken.

***Analysis of Petrol Consumption of Engine with hydrogen***

Some modification has been done at the air intake of the grass cutter to allow hydrogen gas to be injected.

TABLE 2: The Petrol Combustion with $H_2$ Vs Time

| PETROL COMBUSTION VS TIME | | | | | | |
|---|---|---|---|---|---|---|
| Amount of Petrol (ml) | Amount of $H_2$ (L) | Load (g) | Operating Time (min) | | | Average operating Time (min) |
| | | | No. of Trials | | | |
| | | | 1st | 2nd | 3rd | |
| 50 (50g) | 3.65 | 0 | 7.3 | 7.1 | 7.4 | 7.27 |
| 100 (98g) | 6.2 | | 12.37 | 12.43 | 12.48 | 12.43 |
| 150 (145g) | 7.3 | | 14.5 | 14.3 | 14.21 | 14.34 |

Table 2 shows the operating time taken with varies load and amount of hydrogen usage. With an empty load and the same amount of petrol used in table 1, 3.65 litre hydrogen gases injected to the air intake for combustion. The result shows that longer time were taken to complete the rotary motion. By injecting 6.2 litres of hydrogen and 7.3 litres of hydrogen into 100ml and 150ml petrol respectively, it was convinced that an extra time can be utilized.

| PETROL COMBUSTION VS TIME | | | | | | |
|---|---|---|---|---|---|---|
| Amo-unt of Petrol (ml) | Amo-unt of $H_2$ (L) | Load (g) | Operating Time (min) | | | Average operating Time (min) |
| | | | No. of Trials | | | |
| | | | 1st | 2nd | 3rd | |
| 50 (50g) | 3.16 | 277 | 6.33 | 6.24 | 6.31 | 6.29 |
| 100 (98g) | 5.7 | | 11.32 | 10.12 | 10.3 | 10.58 |
| 150 (14g) | 6.23 | | 12.47 | 12.45 | 12.1 | 12.34 |

Further experiment has been carried out with a single blade. The result also showed a positive outcome where an extra time from 3 to 10 minutes has proven.

| PETROL COMBUSTION VS TIME | | | | | | |
|---|---|---|---|---|---|---|
| Amo-unt of Petrol (ml) | Amo-unt of $H_2$ (L) | Load (g) | Operating Time (min) | | | Average operating Time (min) |
| | | | No. of Trials | | | |
| | | | 1st | 2nd | 3rd | |
| 50 (50g) | 3.75 | 554 | 7.5 | 7.11 | 7.34 | 7.32 |
| 100 (98g) | 7.31 | | 10.51 | 11.53 | 11.4 | 11.04 |
| 150 (14g) | 10.7 | | 14.34 | 14.42 | 14.53 | 14.43 |

To convince the data, double blade has been attached and therefore, the experiment was continued. Finally, the data obtained proportional to the time taken as the hydrogen gas injected into the air intake. An extra time has been recorded from 2 to 3 minutes.

## CONCLUSION

The hydroxy gas is then injected into air intake of the engine as secondary method which is able to reduce petrol consumption for two-stroke internal combustion engine. Currently, hydroxy gas is injected directly into the intake air from the cylinder instead of using electrolysis process. However based from this research a cost comparison can be deduced from this table.

TABLE 2: Price Comparison between Petrol and Hydrogen Injection

| Volume (ml) | Petrol Price (RM) | Time Taken (Minute) | Cost (RM) |
|---|---|---|---|
| 50 | 0.09 | 3.37 | 0.09 |
| 100 | 0.17 | 7.17 | 0.17 |
| 150 | 0.26 | 11.16 | 0.26 |

| Volume of Petrol (ml) | Petrol Price (RM) | Volume of H2 (Litre) | H2 Price (RM) | Time Taken (Minute) | Cost (RM) | Saving cost % |
|---|---|---|---|---|---|---|
| 25 | 0.04 | 2.16 | 0.03 | 3.37 | 0.08 | 9.34 |
| 70 | 0.12 | 2.63 | 0.04 | 7.2 | 0.16 | 5.25 |
| 120 | 0.20 | 2.5 | 0.04 | 11.21 | 0.24 | 4.31 |

Referring to the price comparison table taken at the same time but different ratio of petrol and hydrogen gas may have saved the cost up to 9%.

## REFERENCES

[1] Kai.S., "Fuel Cell Engineering: Toward the Design of Efficient Electrochemical Power Plants," *Journal of American Chemical Society*, vol. 49, pp. 10159-10182, 2010.
[2] Siti M. I. , "Energy Efficient Pathways for the Transportation Sector in Malaysia," *Journal of Green & EnergyManagement*, pp. 04-08, 2011.
[3] Al-Ahmed. A, Hossain. S. , Mukhtar. B. , and Abualhamayel. H. , "Hydrgen Highway:An Overview," presented at the *IEEE International Energy Conference*, Center of Research Excellence in Renewable Energy,King Fahd University of Petroleum and Minerals,Dhahran-31261 Arabia, 2010.
[4] Rajput. R K., "A textbook of automobile engineering," 2 ed. New Delhi: Laxmi Publications, 2007, p. 146.
[5] Ganesan. V. , "Internal combustion engines," ed. New Delhi: Tata McGraw-Hill, 2003, p. 221.
[6] Roffia. S., Conclalini. V., and Paradiii. C. , "The Electrolysis of Water and the Hydrogen-Oxygen Fuel Cell," *Journal of Chemical Education*, vol. 2, p. 40126
[7] Solli. C. , Strømman. A.H. , and Hertwich E.G, "Fission or Fossil: Life Cycle Assessment of Hydrogen Production," *Proceedings of The IEEE*, vol. 94, pp. 1785- 1794, 2006.
[8] Saravanan. K.K. , Dr. Stalin. N. , Ms. Rajalakshmi. S. , and Samuel. G.G. , "Recent trends in renewable energy resources," in I*nternational Conference On Advances In Engineering*, Science And Management, 2012, pp. 586 - 589.
[9] Seo. J. G., Youn. M.H., Park. D.R. , and Nam. I. , "Hydrogen production by steam reforming of liquefied natural gas (LNG) over Ni–Al2O3 catalysts prepared by a sequential precipitation method: Effect of precipitation agent," *International Journal of Hydrogen Energy*, vol. 34, pp. 8053 -8060, 2009.