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MODIFICATION OF MOTORCYCLE WITH HYDROGEN MIXTURE AND EFFECT ON EMISSION

Razali H.[1], Sopian K.[1], Mat S.[1] and Ibrahim S.[2]
[1]Solar Energy Research Institute, University Kebangsaan Malaysia, UKM Bangi, Selangor Darul Ehsan, Malaysia
[2] Curriculum Development and Evaluation Section, Department of Polytechnic Education Putrajaya, Malaysia
E-Mail: razalihalim@yahoo.com

ABSTRACT

Carbon monoxide is one of the emission gases produced by vehicle exhaust fumes that can have negative effects on human health and the environment. Reducing the production of carbon monoxide in exhaust fumes of vehicles is part of this study by using hydrogen as an alternative fuel. Hydrogen in this research is generated by a chemical reaction (AL + HCl). Hydrogen by means of a mixture of gasoline and hydrogen (G+H2) is used to operate an old motorcycle with performance benchmarks and monitoring. The methodology in this study uses the chassis dynamometer and gas analyzer as the main apparatus. The procedure of testing is at specified operating motorcycle conditions (L0, L1, L2) at the maximum speed of the motorcycle. The overall average results of this study showed a reduction of carbon monoxide by 33 %. It proves the use of hydrogen (AL + HCl) in the stoichiometric ratio helps combustion when the oxygen content in the air and fuel mixture is not adequate especially for vehicles using gasoline as a fuel. This study has shown that using hydrogen as a supplement fuel for gasoline engine is a better alternative in controlling air pollution which has become an increasingly critical aspect for the local and international motoring industry.

Keywords: hydrogen, aluminium, hydrochloric acid, internal combustion engine, emission control.

INTRODUCTION

The upgrading of the gasoline engine to hydrogen internal combustion engine ($G+H_2$), is part of the development of Green Car Fuel (GCF) [1-3]. There are changes in the use of hydrogen as a fuel especially in the diversified usage of hydrogen in internal combustion engine (ICE) [4-6] chemical reaction process of hydrochloric acid (HC1) and aluminium would be an efficient method in generating hydrogen which makes it cheaper to apply. This is an advantage to this study, namely through the choice of 100% use of hydrogen as fuel, or by a mixture of not more than 15% hydrogen with gasoline in the combustion chamber. This study focuses on reduction DOF carbon monoxide (CO) before and after using different specific fuel consumptions (sfc) which is gasoline and hydrogen. As we know, a gas pollutant CO, is a side product from the incomplete combustion of the mixture of fuel and compressed air in the combustion chamber. Combustion imperfections are often caused by lack of oxygen in the fuel compression ratio. The oxidation of carbon atoms fuel (Gasoline) to carbon dioxide (CO_2) cannot be complete due to lack of oxygen atoms. Creep fire from the spark plug also cannot meet all the space in the combustion chamber due to lack of oxygen to support combustion. This often happens when the engine temperature is below working temperature (80°C), especially when starting the engine to heat up the engine in the cold condition. Initial operation of the engine in the morning with humid temperatures causes a higher production of CO than normal [7-9]. Apart from the incomplete combustion factors, the existence of CO and engine temperature, the other factors such as the occurrence of a leak in the injector, the fuel pressure is too high making it difficult for fuel oxidation with oxygen, as well as very high engine temperature also affects the presence of CO. When the engine temperature is too high it will eliminate the element of water (H_2O) and the entry of oxygen into the combustion chamber becomes unbalanced, carbon monoxide and NOx will be generated as poisonous gases [10-12].

EXPERIMENTAL DETAIL

This study describe the production process of hydrogen through chemical reaction**,** interpretation of reaction rates, the chemical activity via aluminium and hydrochloric (Al + HCl) acid to produce hydrogen as a fuel, and effect of specific fuel consumption (sfc) for internal combustion engine between ($G + H_2$) and gasoline (G) application regarding chassis dynamometer test, based on load condition (L0), load 1 (L1) and load 2 (L2) such as show on the Table-1.

Table-1. Specification of engine testing based on load consideration through chassis dynamometer.

Testing load test	Specification	Emission testing
L0	It means the engine is moving at a maximum speed on a flat road with no load imposed on it.	At the same time, tests on the fuel flow rate (mass flow rate) and pollution (gas analyzer) were also performed
L1	The engine is moving at a maximum speed on hilly roads or at 1 ampere load imposed on it.	
L2	Equivalent to moving the engine at a maximum speed over hilly roads or at 2 ampere load imposed on it.	

Note: Chassis dynamometer test specification using generated DC electricity is equal to L0 = 0 Ampere, Ampere L1 = 1, L2 = 2 Ampere).

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EXPERIMENTAL PROCEDURE

Chemical activity via aluminium and hydrochloric acid (Al +HCl)

The experiments aim to produce hydrogen through chemical activity between aluminium (Al) and hydrochloric acid as part of renewable energy sources. It is very beneficial to use in internal combustion engine as it increases the combustion efficiency of either the SI or compression ignition (CI) engine. Referring to Table-2, the chemical reaction between Al with dimension of cylindrical diameter 25cm, length 80 cm and an average weight of 110 grams, with 250 ml of HC1 in the mixture was observed in the catalyst which is made of PP (polypropylene) with dimension size 0.125m (D) x 0.320m (H) x 0.280m (W). Chemical activity will become active after 3 seconds, continue to be active up to10 minutes, begin to decrease in activity as time approaches 14 minutes, and the activity will become linear (zero mole H_2) after 14 minutes. Within this 14 minutes reaction process the weight of Al will be reduced from 110 grams to 90 grams. On average, 20 grams of Al parsed with 250 ml of HCl acid, will produce 0.7412 mole of hydrogen. Overall findings: 1 kilogram of aluminium with 1 litre mole HCl will produce an equivalent of 37.06 to 108 grams of hydrogen. This result is 3.5% less in the production of hydrogen compared to the findings of [13] whereby 1kg of aluminium produced 112 grams of hydrogen [13] . During the reaction process between the acid and the surface of Al, the temperature of this activity is between 250 ° C to 300 ° C in order to produce a high temperature wet hydrogen containing water (H_2O). Thus an evaporation process should be done to separate out the hydrogen before storing it in the tube whilst under pressure 10 bar. Next, a second evaporation process will be carried out in the tube tank. As the mass of water (H_2O) is heavier than hydrogen, water silt sediments will be created at the bottom of the storage tube, and hydrogen being lighter will be at the top. This process can reduce the occurrence of corrosion processes in the combustion chamber which can damage the engine. This process is an alternative method which is simple and inexpensive, that depends on the strength of the acid used. This reaction process is a compilation of eroded and eroded nature of the acid HCl with Al metal to produce hydrogen in chemical activity [14-16]

The generation of hydrogen is produced through a combination of aluminium with hydrochloric acid during a chemical reaction. The presence of air (O_2) and water (H_2O) was produced wet hydrogen. The hydrogen gas was transferred into the cylinder tube and compressed by a vacuum pump before the pressurized hydrogen released into the ICE combustion chamber.

Figure-1 illustrates the hydrogen onboard production. It shows how the experiment uses hydrogen generation model through a chemical reaction between acids and aluminum to produce hydrogen gas as an alternative energy for spark ignition engines (motorcycles). As gasoline is the existing fuel in the fuel system of motorcycles, these models are operated onboard and act as a energy source or alternative fuel by blending hydrogen with gasoline (G + H_2). The selection of fuel-based energy source or blended fuel (G + H_2) is controlled by valve control switch options. As this study's focus is on hydrogen as the source of energy, the system operates with two main switches. The first switch serves to activate the circuit for the magneto ignition system (spark plug), and the second switch is to activate the pressure regulator and vacuum pump. At the same time an aluminum sheet is passed through the catalyst lever either manually or automatically to produce hydrogen.

Table-2. The average amount of hydrogen generated based on chemical reaction between Aluminium and HCl.

Weight Al before reaction (gram)	Weight Al after reaction (gram)	HCl	Time (s)	Rate of reaction (%)	Result
1105 g	905g	1 litre	111.28	30%	1000 g (Al) + 1 litre (HCl) = 37.06 mole (H_2), 108 gram H_2

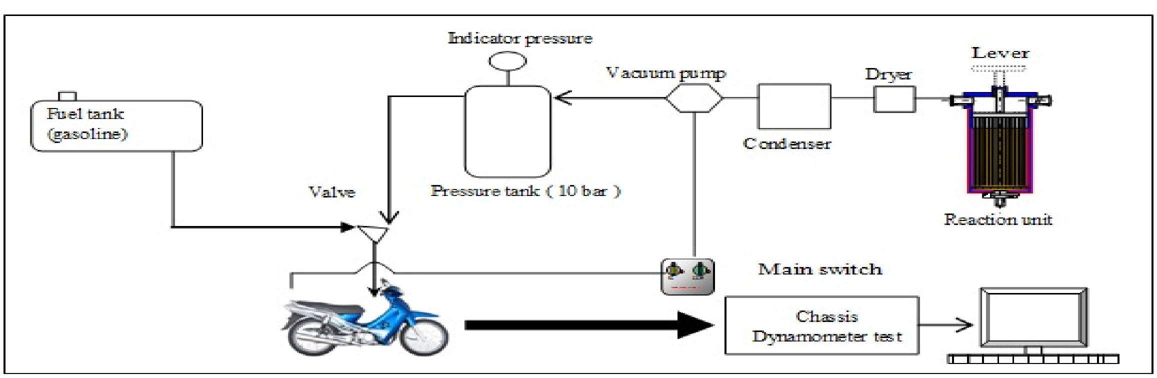

Figure-1. Hydrogen onboard production.

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RESULTS AND DISCUSSION

Carbon monoxide

Table-3 shows the difference between the readings of carbon monoxide with the use of (G + H_2) compared to the use of just gasoline by loading tests L0, L1 and L2.

A decrease of 41.1% CO for engine (G + H_2) compared to gasoline (G) during loading L0. When workloads increase, (G + H_2) is still able to maintain combustion performance improvement and a reduction of between 12.6% and 45% release of CO into the air than current gasoline engines. Overall achievement in the reduction of CO in the exhaust gas is a 32.9% reduction for all engine operation conditions (L0, L1, and L2).

The result show the involvement of hydrogen improves the performance of combustion by helping to complete combustion despite a lack of oxygen mixture ratio in the oxidation of hydrocarbon fuels. Table-4 and Figure-2 show the comparison of data between another researchers about the achievement of pollution reduction after using hydrogen as an alternative fuel for ICE engine.

Table-3. The differences of produced hydrocarbon in between engine (G + H2) with engine (G) through the load test L0, L1 and L2.

Load Test	Carbon Monoxide (CO)				
Level of test	Gasoline + H_2 (%)	O_2 ppm (G+H_2)	Gasoline (%)	O2 ppm (G)	Percentage ± (%)
L0	3.45	15.97	5.86	11.70	-41.1
L1	4.64	11.49	5.31	12.63	-12.6
L2	3.43	7.75	6.26	11.43	-45.2
Total value	3.83	11.72	5.81	11.92	-32.9

Table-4. Achievement of pollution reduction after using hydrogen as an alternative fuel for ICE engine.

Item	Results	Average Results	Comparison
Carbon Monoxide (CO)	L0 = - 41.1% L1 = - 12.6% L2 = - 45.2%	- 33 %	77 % - 95 % 89% 42%

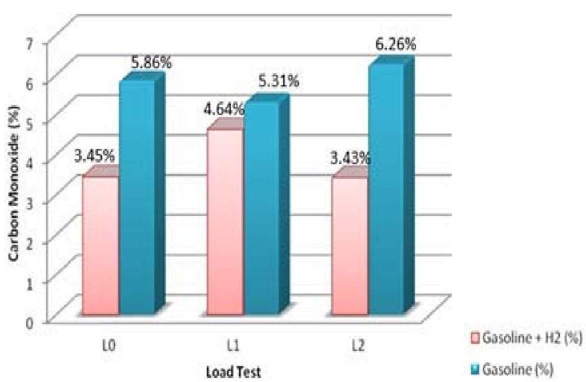

Figure-3. The differences of produced carbon monoxide in between engine (G + H2) with engine (G) through the load test L0, L1 and L2.

CONCLUSIONS

Combustion performance from the use of hydrogen generated through chemical activity between aluminium and hydrochloric acid that can be applied as an alternative fuel source for internal combustion engine. Applications of a mixture of hydrogen with petrol (G+H_2) can be used to increase the combustion performance and emissions control especially for old motorcycle condition. Results from the combustion of petrol, air and hydrogen (G+H_2) in the emission control for carbon monoxide reduce 41% (L0), 12% (L1) and 45% (L2). This result was able to improve the quality of combustion compared to the normal fuel consumption. The total reduction of CO achieved 33 % for the engine (G + H2) with an average value of 3.83% compared to the engine (G) with an average value of 5.81%.

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