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Optimization of HHO generator zero current leak cell (ZCLC) model characteristics for improve gas productivity

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ABSTRACT- This paper investigates the current leaked on HHO generator which cause temperature rise resulted in HHO generator become hot, consequently HHO gas production quality decreased. One of the causes of electrical leakage is the erosion of holes in the cell plate electrodes. To overcome the problem, SS316L plate cell used as an electrode without the perforation, intended to suppress the rise in temperature caused by leakage current. This method is called zero current leak cell (ZCLC). Using the ZCLC method the HHO generator can produce optimal HHO gas [1], so gas production (liters per minute) is relatively stable compared to dry cells on hollow plate and has a composition of 67.6% of H_2 gas and 32.4% O_2. Test results on the dynamometer showed a positive effect on performance and engine emissions [5], with engine speed 1737rpm at 8A constant current produce the gas flow rate HHO 3.2lpm and can reduce gas CO and CO_2 up to 130ppm and 5.5%.

1. INTRODUCTION

With the increasing development of transportation technology and depleting of fossil fuel, hence the need for fuel, either in the form of oil or gas becomes a necessity that must be met by the government in the framework of energy stability. New Energy and Renewable Energy continue to be pursued by the Government in order to address the above needs by socializing the use of energy-saving and environmentally friendly technology.

Hydrogen is one of the energy that pertained to a new energy transportation fuel as a candidate of the most promising future. Various research on fuel cell vehicles sourced from hydrogen by the world's leading automotive industry since more than 50 years ago began to show a bright spot in the utilization of hydrogen-based fuel cell as a vehicle fuel. If the results of this study provide positive expected outcomes by the end of this decade will be an era of fuel cell cars throughout the world. At that point there will be a surge in demand of huge quantities of hydrogen [1].

This study discusses the hydrogen production process by using water as a medium in the process of electrolysis. The purpose of this study is to obtain optimal results as the fuel economy of the engine both for a motor vehicle, generator sets as well as for another industrial engine. The new Energy from gaseous hydrogen is providing opportunities for development in developing countries for energy economist and environmentally friendly [4].

HHO generator developed at this time is still in development stage and have many weaknesses in particular to the influence of heat generated from the HHO generator. It is disrupting the volume and quality of HHO gas production. Therefore, it will greatly affect the performance of the engine. The heat generated from the HHO generator due to the leakage current that occurs through the holes in the stainless-steel plate cells move from one room to another. Studies have been conducted to resolve the leakage electric current with zero current leak cell (ZCLC) method [1].

Aim of this research to determine the actual change in engine performance that can be credited to the use of the HHO generator. The objectives of this research to measure the performance of a stationary engine (attached to a dynamometer) at a variety of engine loadings under its normal fueling arrangement, to repeat the same performance measurements when the HHO gas mixture from the HHO generator is used to supplement the fuel/air mixture, to measure the associated engine operating parameters affected by the combustion process, i.e. CO and CO_2 emissions, exhaust gas temperature, torque, rotational speed and to measure the HHO generator performance parameters, i.e. gas flow rate and current draw.

2. METHODOLOGY

Following pre-start checks the engine is started and run for 20 minutes under partial load to achieve normal operating temperatures through the system. The HHO generator is powered up and run for 20 minutes to ensure consistent temperature through the HHO generator body and to check the consistency of gas flow. Instruments are checked for consistency of readings until all are at a steady state.

The engine is run at 90% throttle for a range of torque loadings, i.e. 0 Nm, 20 Nm, 40 Nm, 60 Nm, 80 Nm and 100 Nm, and the engine speed is allowed to fluctuate. For each torque loading the engine is run for

10 minutes, first on diesel fuel alone and then supplemented with the gas mixture from the HHO generator at 3L/min. After 3 minutes settling time, instrument readings are taken every minute and then averaged and recorded. The engine test rig records total revolutions and the time so that an actual RPM can be calculated over a given period [3,5].

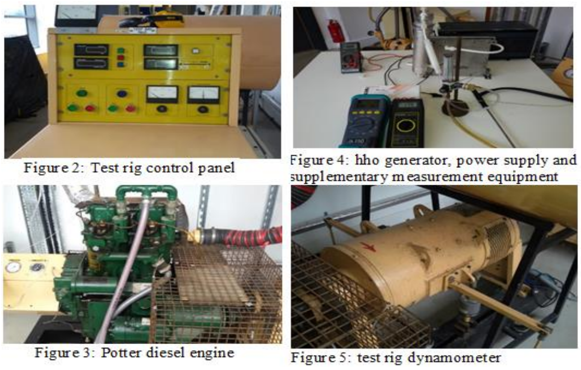

Figure 1 Testing equipment and set up.

The stationary engine is a Potter 2-cylinder diesel engine rated at 18kW at 1800 rpm, driving a dynamometer which can be loaded to a maximum of 100Nm. The engine-dynamometer rig incorporates control systems for managing and recording engine speed and torque. The exhaust gas emissions are sampled using a Kane 250 analyzer and the HHO generator flow rate is measured with a BOC oxygen specification gas flow meter. The power supply for the HHO generator is drawn from a 14V 10A DC lab rectifier and other measurements are taken using standard hand-held digital meters [5].

3. RESULTS AND DISCUSSION

3.1 Results

The results are recorded in Table 1 and graphs of important comparisons are given subsequently.

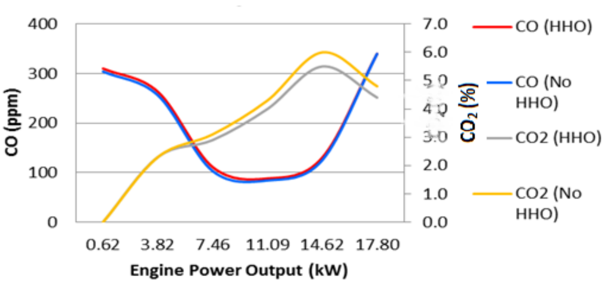

Figure 2 Changes in emissions due to HHO Generator use.

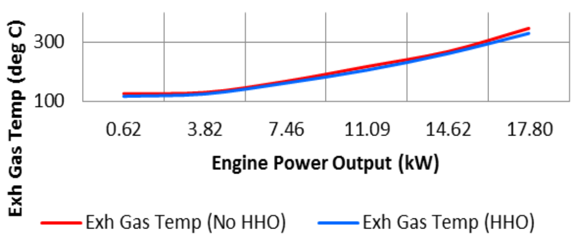

Figure 3 Changes in exhaust gas temperature due to HHO generator use.

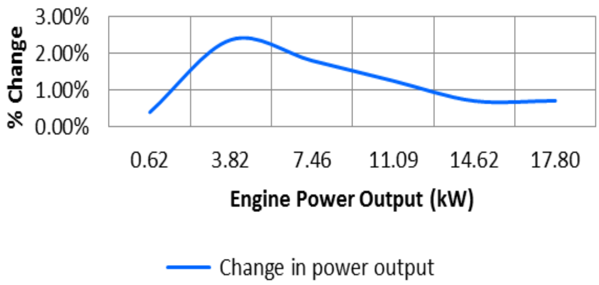

Figure 4 The percentage change in power output due to HHO Generator use.

3.2 Discussion

HHO gas generated by the HHO generator is very useful for improving the performance of the engine. The impact of HHO gas on the engine are consistently far greater in both gasoline and diesel engines. In testing an HHO generator to gasoline and diesel engines shows reduction in exhaust emissions of CO and CO_2 emissions as shown in Figure 2. The low exhaust gas temperature as shown in Figure 3 indicates a more efficient combustion process. The percentage of changes across various engine output (kW) with the use of HHO cell is shown in Figure 4.

The fuel consumption can be measured directly, but a mechanism for the flow of fuel to the injectors may not be changed substantially and the machine will only receive a supply of any fuel available, including additional HHO gas. By using HHO gas, there will be also efficient use of fuel in the engine [4].

4. CONCLUSIONS

In conclusion, it was observed that the use of HHO generator in internal combustion engine have positively affected the engine performance. It also has a measureable effect on the engine operating parameters. The effects are beneficial in term of engine performance and exhaust emissions.

Further work needed to evaluate the HHO generator on a more sophisticated test rigs which allow more extensive parameters to be measured. Further study would also focus on new generation of HHO generator to overcome some of the issues addressed in this study.

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Table 1 Test results

Start Time	Lapsed time (s)	Engine speed (rpm)	Total revs	Calculated rpm	Rads/s	Torque (Nm)	Power (W)	% Change in power	Dyno Load (A)	HHO flow (LPM)	HHO Load(A)	CO ppm	CO_2%	Exh T (ºC)
10.24	600	1863	18631	1863.1	195.1	3.2	0.62		0	0.0	0.0	304	0.0	125
10.45	600	1870	18704	1870.4	195.9	3.2	0.63	0.39%	0	3.0	7.9	310	0.0	116
10.57	606	1814	18330	1814.9	190.1	20.1	3.82		10	0.0	0.0	256	2.3	129
11.05	600	1814	18128	1812.8	189.8	20.6	3.91	2.37%	10	2.9	8.1	263	2.3	124
11.24	555	1772	16431	1776.3	186.0	40.1	7.46		21	0.0	0.0	103	3.1	167
12.11	540	1783	16035	1781.7	186.6	40.7	7.59	1.80%	21	3.0	8.0	111	2.9	161
12.27	480	1751	14096	1762.0	184.5	60.1	11.09		35	0.0	0.0	84	4.3	217
12.38	420	1754	12324	1760.6	184.4	60.9	11.23	1.25%	35	3.1	8.1	88	4.0	205
12.51	300	1738	8717	1743.4	182.6	80.1	14.62		46	0.0	0.0	125	6.0	268
13.03	353	1737	10252	1742.5	182.5	80.7	14.73	0.70%	46	3.2	8.1	130	5.5	261
13.16	309	1715	8897	1727.6	180.9	98.4	17.80		60	0.0	0.0	340	4.8	347
13.31	163	1720	4712	1734.5	181.6	98.7	17.93	0.71%	60	3.1	8.1	340	4.4	330