

Using HHO Cell for improving electric productivity of the Diesel generator

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Abstract— In the current conjuncture of clean energy sources variation, energy security issues, and the current political crisis drive to increasing requirement on electric an opposed reducing amounts of fuel consumption in vehicles and power plants. Actually, the widespread use of HHO cells in engineering applications has become very noticeable for the good results of this technology, especially to be additional energy resource. By using Hydrogen HHO cell combined with Diesel generator as an auxiliary energy resource for saving energy through increasing electric productivity, reflected to decreasing fuel consumption in time operation. According to results, there is reduction of fuel consumption for a diesel generator with a power capacity equal to 16 kW reaches 25.7 % which was reflected by increasing the productivity and running time operation to produce electricity more than 3.15 hours compared without HHO cell installation with 2.34 hours operation time, where became rate increase in electric production equal 34.6%.

Keywords— HHO cell, Dry cell, diesel engine, energy saving, increase productivity

I. INTRODUCTION

Looking for reliable, clean, and efficient source of energy became the main concern and one of the big serious challenges of the countries as a result of fluctuation oil prices, reduction in the fossil fuel resources , and the problems emissions by these resources in atmosphere [1]. Also, Electric companies have crisis particularly the provide electric energy for commercial and industrial field result of going short on gas and oil supply recently [2].

In addition, Many Telecom operators in united states forced to review and find solutions to provide extended runtime in critical areas of their network after Hurricane Katrina. That forced operators to expose that lead acid batteries typically only deliver to eight hours of backup for a location, where operators need extended runtime. So, a diesel generator was generally the only choice as energy supply for long running time operation [3-10]. Hydrogen is perfect fuel for HHO cells because of its great reactivity and no emission in its characteristics.

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In addition, diesel is one of the greatest hydrogen storage systems, because of its very high volumetric hydrogen density 100 kg H_2/m^2 and gravimetric density 15% H_2 [4-8].

II. LITERATURE REVIEW

Gagge, J. [3]. was offered to operator's new approaches and solutions for extend runtime requirements by using a proton exchange membrane fuel cell (PEMFC) and premium lead acid batteries to get long runtime at the location by station that capacity 5 kW, where give operators over 48 hours of backup and in some cases reach to over 160 hours and comparing that with diesel generator embedded with 30 kW that is normally found in sites throughout these applications.

Also, Roh, Gilltae, et al [5]. have encouraged researchers to improve an electric propulsion system using HHO cell with the goal of decreasing emissions from ships by combined a diesel engine generator with power source consists of a molten carbonate fuel cell (MCFC), and suggested the capacities of which are 100 kW, 30 Kw, and 50 kW, respectively. The results shown reduction in CO₂ emissions of the hybrid system between 70%~74% compared with the case of the diesel generator alone operation for each scenario. This study confirmed the success of using a ship with a fuel-cell-based hybrid power source.

Bose and Maji [6]. Explained that, when injected 27.8L/min of hydrogen and EGR gas into a 5.2kW, diesel engine running at 1500r/min under various loads. Break Specific Energy Consumption (BSEC) was reduced 64% and 36%, NOx emissions increased 70% and 90% at 20% and 40% load respectively due to hydrogen injection, so the efficiency of the diesel engine increased.

Yilmaz et al. [7]. used HHO mixture for increasing the combustion in diesel engine, it reduced diesel consumption

an average of 14% through the range of speeds tested, with the highest achievements in economy at the upper engine speeds.

III. OBJECTIVE OF THE RESEARCH

The aim of the experimental study is the possibility of using Hydrogen HHO cell combined with Diesel generator as an auxiliary energy resource for saving energy, increasing electric productivity through developing hydrogen cells to meet the main goal effectively by reducing the amount of fuel consumption which reducing emissions.

IV. METHODOLOGY AND APPROACHES

This section will be showing the design and manufacture of a hydrogen production HHO cell for operating and tested on a 6200cc generator that runs on diesel fuel.

The HHO cell is designed especially for this experiment with current stabilizer to avoid increasing the current that due to damage in battery and dynamo is designed especially for this experiment and first time to used. In addition it contains two fluid separations to avoid operation fluid to engine.

A. A HHO cell installation

It has two glass plates that are resistant to breakage, and a plastic insulator to isolate the cell. Also, it is made of 19 plate wear-resistant stainless steel L316 with ten mounting screws between the plates of the cell, as shown in the Figure 1.



(b)





(c)

Fig. 1. part of installation of a HHO cell , (a) fluid epration 1 (b)fluid sepration 2, (c) HHO cell lyers

In addition, it contains an electrical transformer, plastic tubes with 2 tanks to keep water, and the catalyst as shown in Figure 2. Also, it contains the following equipment:

- Tubes for connecting to the cell.
- Insulators for mounting crews.
- Electrical connection wires.
- Cut-out (interrupter) current stabilizer

• Distilled water, and adding Sodium hydroxide as catalyst as a solution 5%.



Fig. 2. HHO cell fully assembled for testing a HHO cell

B. The Experiment on diesel generator

First, it was assembled the parts of the HHO cell and put the catalyst inside the cell in the required ratio with taking into account the operation of the cell on a voltage of 12 volts, and never putting a HHO cell in an unsuitable place resulting to effect on working of the cell by vibration and heat. After that, it was connected the hydrogen tubes out of the cell to the generator, installing an external fuel tank with a capacity of 20 liters, to determine the amount of fuel consumption before and after the installation of a HHO cell .

In the first case, the experiment worked with an installed HHO cell on the generator without any electric load on the generator, and stay working until was an empty tank. After that, make operation under full electric load with connecting HHO cell by the generator. Also, use the experiment without an installed HHO cell, any electric load on the generator, and stay working until was an empty tank. Finally, make operation under full electric load without connecting HHO cell by a generator. For each state, it makes sure registration the readings from the time operation, amount of fuel consumption, amount of withdrawal current from the HHO cell, and the temperature of the fuel cell. Also, make sure that the temperature does not rise in the HHO cell. In these experiments, by knowing the amount of rate of capacity produced for the generator which was 16 kW, it can be found the rate of increase in electric production, and percentage of decrease for saving fuel consumption production by kWh through determine time operation as explained in Table 1.

Determine electric production

 $Load_{p/case} = C_{power} \cdot t_{Diesel} \qquad [4] \qquad (1)$

Where $C_{power} = Power$ of generator,

t_{Diesel} =time of operation the diesel generator

Determine Rate of increase in electric productivity

$$R_{elec} (\%) = \frac{\text{Load}_{p/\text{case}} \text{ HHO cell-Load}_{p/\text{case}}}{\text{Load}_{p/\text{case}}} \times 100 \ [4]$$
(2)

• Determine Present decrease in saving fuel consumption

$$\mathbb{R}_{\text{FC}}(\%) = \frac{\text{Save}_{f/case} - \text{Save}_{f/case} \text{ with fuel cell}}{\text{Save}_{f/case}} \times 100 [4]$$
(3)

TABLE I. TH	HE INFORMATION DATA	FOR EACH CASE EXPERIMENT
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Case 0	Operation without electric load consumption by generator		Operation with electric load consumption by generator		
Data	Installed without HHO cell	Installed with HHO cell	Installed without HHO cell	Installed with HHO cell	Unit
Operation time	3.01	3.34	2.34	3.15	hr.
Current withdraw by HHO cell	-	4.1	-	4.3	Amp
Rate power capacity	16	16	16	16	kW
Fuel consumption	20	20	20	20	1
HHO cell temperature	30	30	30	30	°C
Ambient temperature	28	28	28	28	°C
Generator temperature	88-90	88-90	88-90	88-90) °C
Frequency	50	50	50	50	Hz
Voltage	220	220	220	220	Volt

V. RESULTS AND DISCUSSIONS

The results of experiments showed on a diesel generator, increasing in time operation from 3 hours operated to 3.34 hours without electric load with increasing in generator operation time to 30 minutes more compared without a HHO cell installation as shown in Table II.

TABLE II.	The results of CO_2 emission reduction rates for
	EXPERIMENT DIESEL GENERATOR

Data	Operation without electric load consumption by generator		Operation with electric load consumption by generator		
Case	Installe d without HHO cell	Installed with HHO cell	Installed Witho ut HHO cell	Installed with HHO cell	Unit
Operation time	3.01	3.34	2.34	3.15	hr.
Electric Production load	48.16	53.44	37.44	50.4	kWh
Fuel consumption	6.64	5.99	8.55	6.35	<i>l/</i> hr
CO ₂ Emissions	17.54	15.80	22.56	16.72	Kg CO ₂ /h r

Reduction of CO ₂ emission and fuel consumption	9.91%	25.7%	
Rate of increase in productivity	11.0%	34.6%	

Figure 3 shown increasing the operating time in the diesel generator with full load cover demand from 2.34 hours without a HHO cell to 3.15 hours with HHO cell installation comparing operation without electric load consumption by generator.



Fig. 3. Increasing the operating time by Diesel generator experiment

Actually, by increases in the time operation, the amount of electrical production from 37.4 kWh to 50.4 kWh during the HHO cell worked as shown in Figure 4 which was improved the electricity produced with less fuel consumption.



Fig. 4. Increasing the amount of electrical production by diesel generator

Fuel consumption through operation time became less consumption for diesel inside the tank because adding H₂ as auxiliary fired with a fuel inside internal combustion making save in diesel consumption as shown in Figure 5, which was results shown reducing in fuel consumption from 6.64 l/hr to 5.99 l/hr by using a HHO cell on generator during operation without electric load consumption by generator, however, it was decreasing in fuel consumption too through the operation with electric load consumption by generator from 8.55 l/hr without installed HHO cell to 6.35 l/hr with HHO cell on generator installation when the diesel generator operation with electric load consumption by the generator.

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Fig. 5. results reducing in fuel consumption by diesel generator experiment

Because fuel consumption through operation time became less consumption for diesel inside, that reflected on by reducing Emissions too, which was results shown in Figure 6 reducing in emissions 17.45 Kg CO₂ e/hr to 15.8 Kg CO₂ e/hr during operation without electric load consumption by generator, and from 22.56 Kg CO₂ e/hr to 16.72 Kg CO₂ e/hr with HHO cell on generator installation when the diesel generator operation with electric load consumption by the generator.



Fig. 6. results reducing in CO2 emissions by diesel generator experiment

In fact, a HHO cell became an auxiliary supply for fuel to get a rate of increase in electricity produced 11 % in operation without electric load, and 34.6 % in the electric load as the same amount of diesel fuel consumption used. However, the results shown improve in emission, and fuel computation by reducing fuel consumption followed that directly decreasing in number of emission from 9.91 % in first case during operation without electric load consumption by generator and to 25.70% during operation with electric load consumption by generator.



Fig. 7. results reduction rate for fuel consumption and CO_2 emissions faced on increase in electricity produced by diesel generator experiment

VI. CONCLUSIONS

The results of experiments showed on a diesel generator, increasing in time operation from 3 hours operated to 3.34 hours without electric load with increasing in generator operation time to 30 minutes more compared without a HHO cell installation. On the other hand, increasing the operating time for the diesel generator from 2.34 hours without a HHO cell to 3.15 hours with HHO cell installation, which is increases the amount of electrical production from 37.4 kWh to 50.4 kWh during the HHO cell work. In fact, a HHO cell became an auxiliary supply for fuel to get a rate of increase in electricity produced 11 % in operation without electric load, and 34.6 % in the electric load as the same amount of diesel fuel consumption used where the reduction ratio of fuel consumption, and emissions for diesel generator became 25.7% result of saving fuel consumption by HHO cell from 8.55 L/hr to 6.35 L/hr.

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