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Experimental Case Study on the Impact of the Implementation of Hydrocarbon Crack System with Bioethanol or RON 92 Gasoline as an Addition on the Performance of a Toyota Corolla Twincam AE92

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Abstract

The heightened interest in retro-classic cars has driven a number of owners to modify their cars to achieve engine performance and fuel efficiency matching that of later model cars. This research was carried out by utilizing a Toyota Corolla Twincam Liftback AE92 that still uses an engine with carbureted system of 1600cc displacement. The engine was then equipped with a HCS or Hydrocarbon Crack System filled with bioethanol or RON (Research Octane Number) 92 gasoline as comparison. The experiment shows a major torque increase of 33.9% when using bioethanol or 31.7% when using RON 92 gasoline as compared to when the HCS was not installed.

Keywords: HCS, bioethanol, performance, dynotest

INTRODUCTION

With the heightened interest in retro-classic cars, there is more research and experiment being done to maximize the performance of the retro cars. It is well understood that retro cars have some deficiencies in their engine design that include lower torque or higher fuel consumption compared with the later models, which in the long run will not be advantageous [1]. Several kinds of alternative fuels have also arisen and are designed to either enhance performance or lower unit purchase price; one of which is Bioethanol made of *molasses.* Subsequently also several methods to propel the fuel efficiency have also been introduced to the market, one of which is the HCS or *Hydrocarbon Crack System.* This research is aimed to analyze comparison between engine's performance in their original state against the engine that had been modified by installing the HCS filled with Bioethanol and RON 92 fuels.

BASIC THEORY

Hydrocarbon Crack System

Hydrocarbon Crack System (HCS) is a system that breaks the atomic bond between *Carbon* (C) and *Hydrogen* (H_2) by utilizing a catalyst heat transfer. This process utilizes exothermic heat dissipated by the car such as the exhaust pipe manifold, engine block or the radiator's hot water steel pipe [2]. The heat from the internal combustion engine basically originated from the engine block as well as from the exhaust pipes that could well reach the temperature of 400°C. In such case, the heat catalyst will break the atomic chains of the hydrocarbon fuel in vapor state. HCS is an effective power supplement on motorized vehicles such as a car or motorcycle which will act as fuel saver. The hydrocarbon utilized is the RON 92 gasoline ($C_{10}H_{24}$). The HCS only requires 1 liter of fuel and will be able to save 10% to 30% depending on the opening of its adjuster valve and the engine characteristics. The higher the octane, the greater the additional power output from the engine.

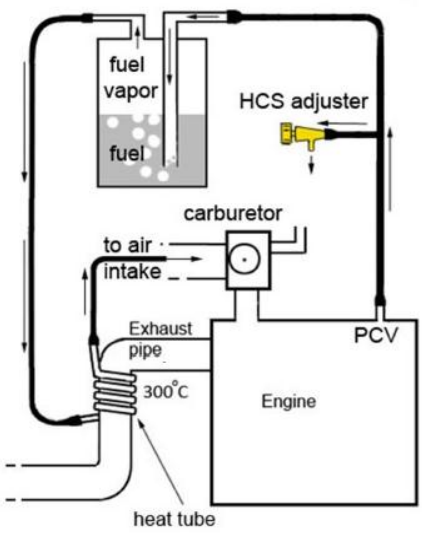

Figure 2.1: HCS Methodology [3]

As can be seen in above figure, the vapor within the HCS storage bottle came from the hydrocarbon additive (which in this research is either bioethanol or RON 92 gasoline) will vaporize and flow through the rubber hose and passing the heat transfer catalyst at a temperature of approximately 300°C. The heat reaction will break the atomic bond of the additive vapor of *hydrocarbon* into *hydrogen* and *carbon* which then will flow to the combustion chamber and improves the combustion efficiency [3].

In the utilization of this HCS system, the fuel additive vapor contains *hydrogen* and *carbon* that will dissolve from the exothermic heat transfer. This process is aimed to maximize the volume of burned *hydrogen* to increase the engine power output and to decrease the imperfect combustion residue (which in this case is the CO).

RESEARCH AND METHODOLOGY

The thesis uses an experimental case study of research and methodology on the impact of HCS utilization with bioethanol additive that has almost absolute content at 99%. The experiments were conducted based on the following:

1. Engine without the HCS,
2. Engine with HCS with RON 92 gasoline fuel as the additive, and
3. Engine with HCS with the almost absolute content (99%) bioethanol as the fuel additive

All cases have similar volume being filled into the HCS storage bottle. And each case will undergo similar openings of the HCS adjuster valve.

The parameters to be observed are as below:

a. Power Output:

The power output was tested utilizing the Dastek Dynamometer. The data was collected from the average engine power output as recorded on the corrected engine rotation speed. The test was carried out with full throttle. The power output recording was taken when the engine rotation was constant and stabilized.

b. Torque:

The engine torque test was carried out using the same Dastek Dynamometer. The numbers were collected from the averaged torque readings as recorded at the stable engine rotation speed after correction. The testing was carried out at full throttle. The torque data was recorded within the condition of stable and constant engine rotation.

c. Fuel Consumption:

The fuel consumption testing was carried out at the same route which was at the inner city toll road, at the averate

speed of ± 60 km/hour with engine rotation speed increment carried out in stages and was held at 2500 rpm.

Test Equipments

Dynamometer

The equipment used ws a Dastek Dynamometer with below specifications:

Max Speed (*Continuous*) : 200 km/h

Max Tractive Effort : 4500 N *continuous* (0-120 km/jam)

Max Power : 1500 kW *continuous*

Overload Condition *120% for 10 seconds every minute

Overload Force *120% = 5400 N (0 – 120 km/h)

Overload Power *120% = 180 kW (0 – 120 km/h)

** Limited due to customers maximum supply rating*

Vehicle Inertia Range : 454 – 2722 kg

Roller Diameter : 318.2 mm (12.53")

Operating Temperature Range : + 5 ºC to + 40 ºC

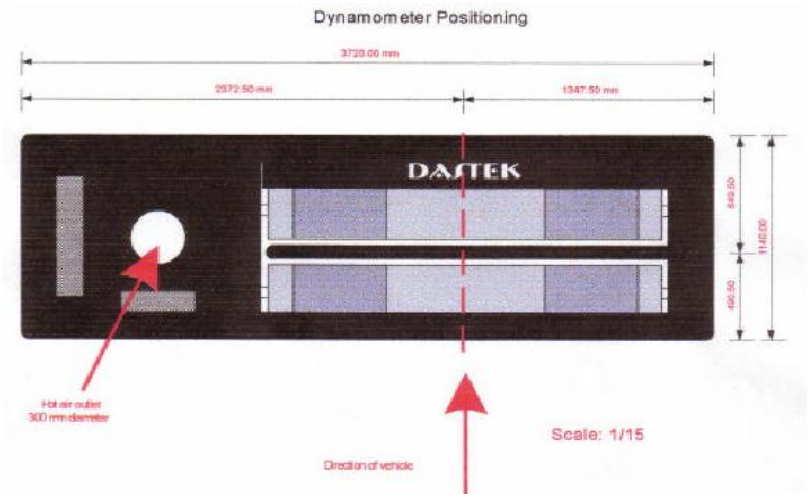

Figure 3.1. The geometry of Dastek *Chassis Dynamometer* [9]

HCS Container

The HCS tube container material is made from aluminum with 4mm wall thickness, where on the top section it has a filling hole for the HCS additive fluid which was the RON 92 gasoline or bioethanol as used in the experiment.

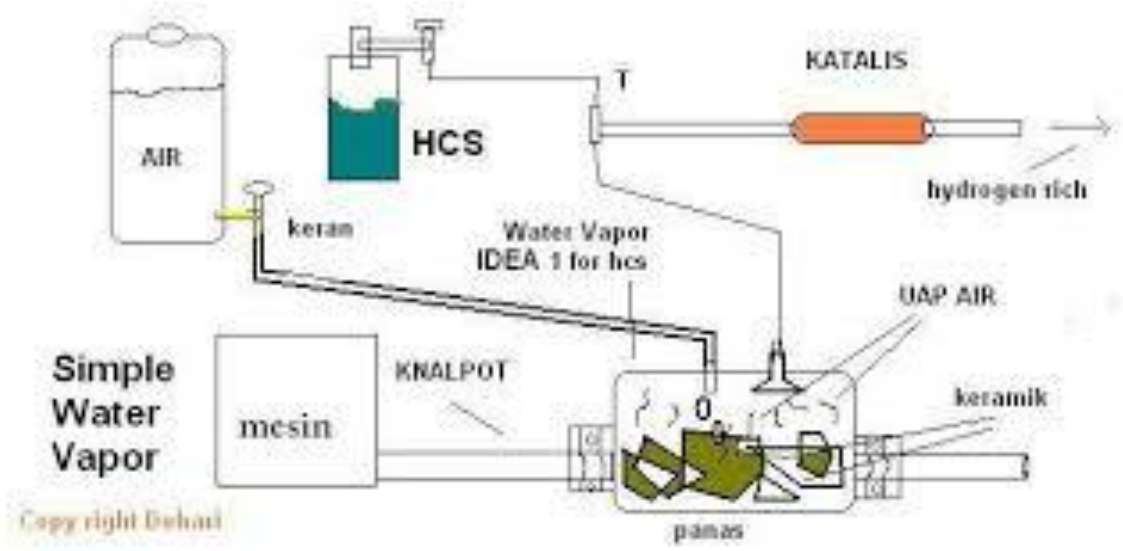

Figure 3.2. Schematics of HCS installation [10]

Test Engine

The vehicle used for the experiment was a 1988 Toyota Corolla Twincam (AE92) with an engine of 4AF DOHC 1600cc as per the following specifications :

Table 3.1 Car Specifications

Car type	4 *stroke engine DOHC*
Dimension	4374 mm x 1656 mm x 1260 mm
Weight	1086 kg
Diameter	81 mm
Langkah	77 mm
Volume	1600 cc
Compression ratio	9,5 : 1
Stasioner	700 rpm
Cooling	Water to air (radiator)
Ignition system	CDI

Figure 3.1.4 The placement of the HCS Container

Bioethanol used in this experiment was the bioethanol from molasses, made from fermented sugar cane with chemical formula of C_2H_5OH. Bioethanol is a carbon chain compound gathered from vegetation extract that has components of sugar, patty, cellulose through biological process.

RESULT AND DISCUSSION

In the following is the data achieved from the experiment when the car was tested utilizing HCS with bioethanol and RON 92 gasoline separately.

Results of Power Output Testing

Table 4.1 Power Output Test Result

RPM	Without HCS BHP	HCS-RON 92-10 degrees opening BHP	HCS-RON 92-20 degrees opening BHP	HCS-RON 92-30 degrees opening BHP	HCS- Bioethanol- 10 degrees opening BHP	HCS-Bioethanol -20 degrees opening BHP	HCS- Bioethanol-30 degrees opening BHP
2500	21,30	21,40	22,40	24,70	24,30	24,90	26,50
3000	23,30	24,00	24,40	26,00	25,90	29,00	30,30
3500	23,00	24,80	30,30	29,00	26,10	30,10	30,80

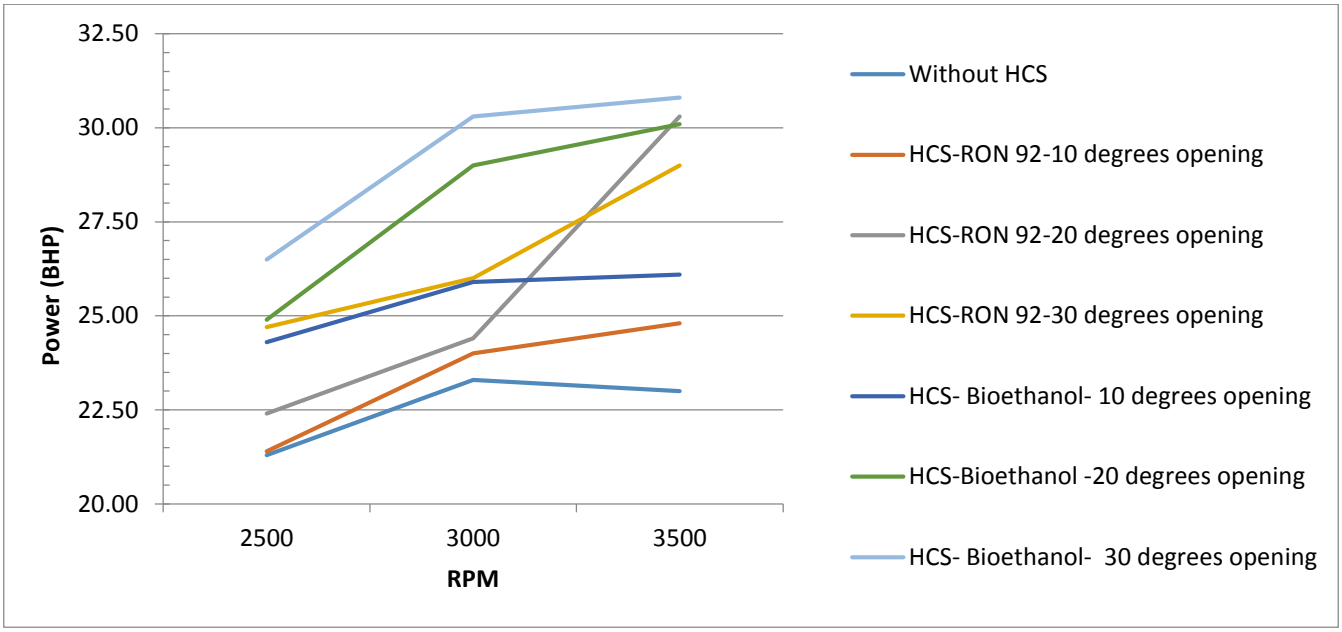

Figure 4.1 Power (BHP) vs RPM Chart

Table 4.2 Power Output Result Percentage

RPM	Without HCS	HCS-RON 92-10 degrees opening	HCS-RON 92-20 degrees opening	HCS-RON 92-30 degrees opening	HCS- Bioethanol-10 degrees opening	HCS-Bioethanol -20 degrees opening	HCS- Bioethanol-30 degrees opening
2500	0	0,47%	5,16%	15,96%	14,08%	16,90%	24,41%
3000	0	3,00%	4,72%	11,59%	11,16%	24,46%	30,04%
3500	0	7,83%	31,74%	26,09%	13,48%	30,87%	33,91%

Based on Figure 4.1, it can be seen that the experiment indicates that with HCS it will have a bigger power output compared with the case without HCS. The HCS with RON 92 gasoline additive on 10degrees opening at 2500rpm yields an increase of power output at 0.47 % compard to Non-HCS case. The HCS with RON 92 gasoline on 10 degrees opening at 3000rpm has power output of 3,00% compared to the non-HCS case. The HCS parameter with RON 92 gasoline on 10 degrees opening rpm 3500 yields a power output increase of 7,83% compared to the non HCS case.

The HCS with RON 92 gasoline 20 degrees opening rpm 2500 yielded a power output increase 5,16% compared to the non-HCS case. The HCS with RON 92 gasoline 20 degrees opening 3000 rpm yielded a power output increase of 4,72% from the non HCS case. The HCS with RON 92 gasoline on 20 degrees opening and 3500 rpm yieleded power output increase of 31,74% from non HCS case.

The HCS with RON 92 gasoline 30 degrees opening on 2500 rpm yielded a power output increase of 15,96% from the non HCS case. The HCS case with RON 92 gasoline with 30 degrees opening on 3000 rpm yielded a power output increase of 11,59% from the HCS case. For HCS case with RON 92 gasoline with 30 degrees opening on 2500 rpm yielded a power output increase of 26,09% from the non HCS case.

HCS case with bioetanol with 10 degrees opening on 2500 rpm 2500 yielded a power output increase of 14,08% from the non HCS case. The HCS case with bioetanol on 10 degrees opening and 3000 rpm yielded a power output increase of 11,16% from non HCS case. The HCS with bioetanol with 10 degrees opening on 3500 rpm yielded a power output increase of 13,48% from the non HCS case.

The HCS with bioetanol on 20 degrees opening and 2500 rpm yielded a power output increase of 16,90% from non HCS case. The HCS with bioetanol on 20 degrees opening and 3000 rpm yielded a power output increase of 24,46% from non HCS case. HCS with bioetanol with 20 degrees opening and 3500 rpm yielded a power output increase of 30,87% from the non HCS.

While HCS with bioetanol on 30 degrees opening and 2500 rpm yielded a power output increase of 24,41% from the non HCS. HCS with bioetanol with 30 degrees opening and 3000 rpm yielded a power output increase of 30,04% from the non HCS. And the HCS case with bioetanol on 30 degrees opening and 3500 rpm yielded a power output increase of 33,91% from the non HCS case.

Torque Test Result

Table 4.3 Torque Test Results

RPM	Without HCS Nm	HCS-RON 92-10 degrees opening Nm	HCS-RON 92-20 degrees opening Nm	HCS-RON 92-30 degrees opening Nm	HCS- Bioethanol-10 degrees opening Nm	HCS-Bioethanol -20 degrees opening Nm	HCS- Bioethanol-30 degrees opening Nm
2500	91,00	91,50	95,70	105,60	103,90	106,40	113,30
3000	83,00	85,50	86,90	92,60	92,20	103,30	107,90
3500	70,20	75,70	92,50	88,50	79,70	91,90	94,00

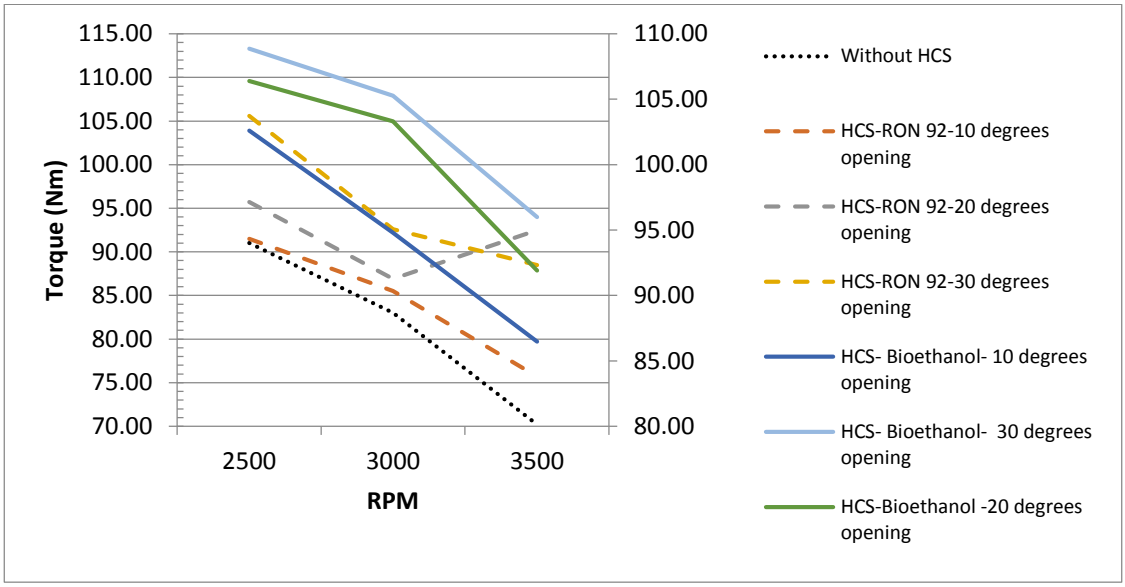

Figure 4.2 Torque (Nm) vs RPM Chart

Table 4.4 Torque Test Results Percentage

RPM	Without HCS	HCS-RON 92-10 degrees opening	HCS-RON 92-20 degrees opening	HCS-RON 92-30 degrees opening	HCS- Bioethanol-10 degrees opening	HCS-Bioethanol -20 degrees opening	HCS- Bioethanol-30 degrees opening
2500	0	0,55%	5,16%	16,04%	14,18%	16,92%	24,51%
3000	0	3,01%	4,70%	11,57%	11,08%	24,46%	30,00%
3500	0	7,83%	31,77%	26,07%	13,53%	30,91%	33,90%

Based on Figure 4.2 it can be seen the result of car testing using HCS could yield a bigger torque compared with the non HCS case. In the HCS case with RON 92 gasoline 10 degrees opening 2500 rpm yielded a torque increase of 0,55 % compared to non HCS. HCS with RON 92 gasoline 10 degrees opening 3000 rpm yielded a torque increase of 3,01% compared to non HCS. In the HCS case with RON 92 gasoline 10 degrees opening 3500 rpm yielded a torque increase of 7,83% compared to non HCS.

In the HCS case with RON 92 gasoline 20 degrees opening 2500 rpm yielded a torque increase of 5,16% compared to non HCS. In HCS case with RON 92 gasoline 20 degrees opening 3000 rpm yielded a torque increase of 4,70% compared with non HCS. HCS case with RON 92 gasoline 20 degrees opening 3500 rpm yielded a torque increase of 31,77% compared to HCS.

For HCS case with RON 92 gasoline 30 degrees opening 2500 rpm yieled a torque increase of 16,04% compared to non HCS. HCS with RON 92 gasoline 30 degrees opening 3000 rpm yielded a torque increase of 11,57% compared with non HCS. HCS with RON 92 gasoline 30 degrees opening 3500 rpm yielded a torque increase of 26,07% compared with non HCS.

HCS case with bioetanol 10 degrees opening 2500 rpm yielded a torque increase of 14,18% compared with non HCS. HCS with bioetanol with 10 degrees opening 3000 rpm yielded a torque increase of 11,08% compared with non HCS. HCS with bioetanol with 10 degrees opening 3500 rpm yielded a torque increase of 25,07% compared with non HCS.

HCS with bioetanol with 20 degrees opening 2500 rpm yielded a torque increase of 16,92% compared with non HCS. The HCS case with bioetanol with 20 degrees opening 3000 rpm yielded a torque increase of 24,46% compared with non HCS. HCS with bioetanol on 20 degrees opening 3500 rpm yielded a torque increase of 30,91% compared with non HCS.

While the HCS case with bioetanol with 30 degrees opening on 2500 rpm yielded a torque increase of 24,51% compared with non HCS. HCS with bioetanol with 30 degrees opening on 3000 rpm yielded a torque increase of 30,00% compared with non HCS. And the HCS case filled with bioetanol with 30 degrees opening on 3500 rpm yielded a torque increase of 33,90% compared with non HCS.

From the experimental data above it can be seen that the utilization of HCS with bioethanol addtivie will provide bigger torque compared with HCS with RON 92 gasoline. This is because that the HCS helped the combustion process since it draws more hydrogen from the additive vapors.

Fuel Consumption Test Results

The experiment measured the rate of fuel consumption by using vehicle's odometer and the pump station's verified flow meter. The fuel consumption test was carried out on similar routes which was the inner city toll road, where the speed average was maintained at ± 60 kph with engine rotation increment done in stages and was held at 2500 rpm. The consumption test data was processed by comparing the distance against the consumed fuel.

Table 4.5 Fuel consumption test results

Average Speed	Distance (km)	Fuel Consumption (litres)	Comparation Ration km/L	Deviation Percentage	Test Conditions
60 kph	36,3	5,16	7,03	-	Without HCS
60 kph	36,4	4,08	8,92	20,93%	HCS with bioethanol 10 degrees opening
60 kph	36,6	4,02	9,1	22,09%	HCS with bioethanol 20 degrees opening
60 kph	36,5	3,96	9,22	23,26%	HCS with bioethanol 30 degrees opening
60 kph	36,4	4,12	8,83	20,16%	HCS with RON 92 gasoline 10 degrees opening
60 kph	36,4	4,18	8,71	18,99%	HCS with RON 92 gasoline 20 degrees opening
60 kph	36,6	4,14	8,84	19,77%	HCS with RON 92 gasoline 30 degrees opening

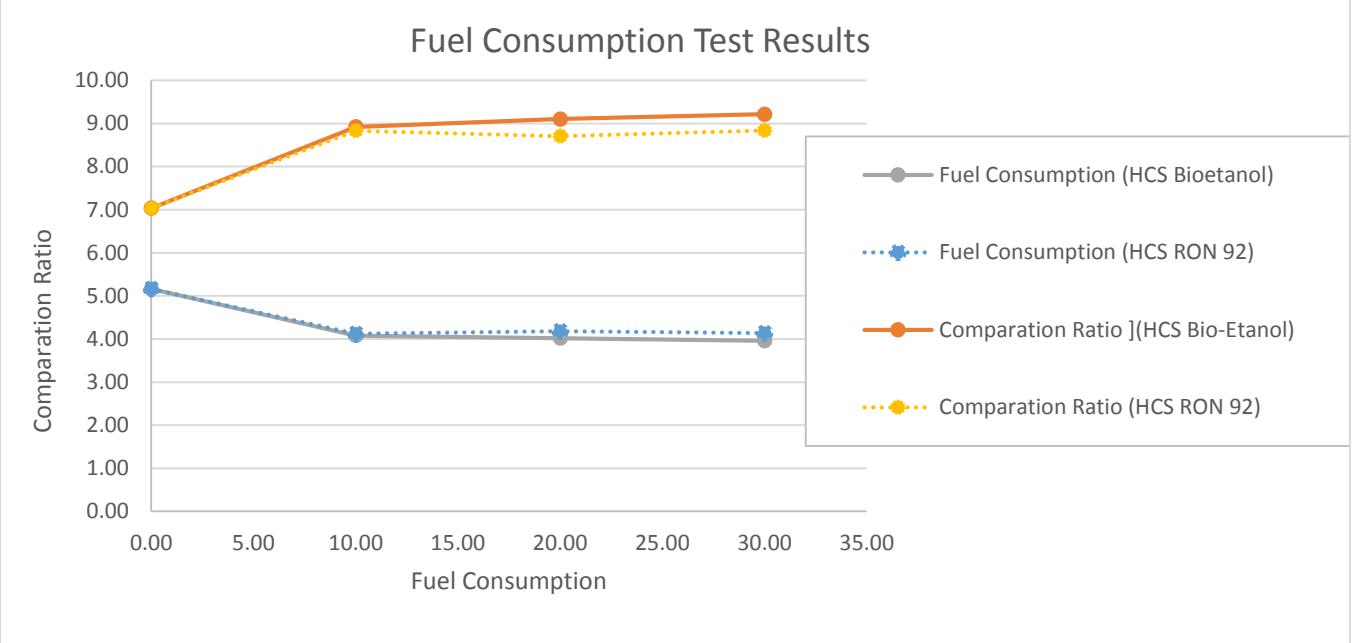

Figure 4.3 Fuel Consumption Test Chart

Based on Figure 4.3 above it can be seen that when HCS additives were utilized, the vehicle experienced a more efficient fuel consumption compared to if it does not use HCS. On HCS with bioethanol opening 10 provided efficiency of 20,93% compared to the car without HCS. On HCS with bioethanol opening 20 provided efficiency of 22.09% compared to the car without HCS. On HCS with bioethanol opening 30 provided efficiency of 23.26% compared to the car without HCS.

On HCS with RON 92 gasoline opening 10 provided efficiency of 20,16% compared to the car without HCS. On HCS with RON 92 gasoline opening 20 provided efficiency of 18,99% compared to the car without HCS. On HCS with RON 92 gasoline opening 30 provided efficiency of 19,77% compared to the car without HCS.

From the test results, it can derived that utilization of HCS filled with bioethanol will yield a larger power compared to HCS with RON 92 gasoline. This is because in the case where HCS is utilized, the ignition is more efficient since it incorporates the hydrogen properties supplied from the additive in the HCS container tube.

CONCLUSION

By carrying out the tests and analysis, it can be concluded from this experiment that both power and torque experienced an increment when utilizing either bioethanol or using RON 92 gasoline filled into the HCS container.

Power increase was averaged as below:

a. HCS with bioethanol
- Opening 10º : 12,91%
- Opening 20º : 24,08%
- Opening 30º : 29,46%

b. HCS with RON 92 gasoline
- Opening 10º : 3,77%
- Opening 20º : 13,87%
- Opening 30º : 17,88%

Torque increase was averaged as below:

a. HCS with bioethanol
- Opening 10º : 12,93%
- Opening 20º : 24,1%
- Opening 30º : 29,47%

c. HCS with RON 92 gasoline
- Opening 10º : 3,8%
- Opening 20º : 13,88%
- Opening 30º : 17,89%

While the fuel consumption increase with bioethanol was averaged at 22,09% and 19,64% with RON 92 gasoline.

The above calculation shows that best result will be obtained from 30º opening with bioethanol RON 92 gasoline as the additive. However to purchase a near absolute bioethanol (99%) is not easy, therefore utilization of RON 92 gasoline as HCS additive is still recommended.

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