

## **Performance Enhancement of a Conventional Motorcycle to a Racing Motorcycle without Affecting the Mileage by Using HHO Generator**

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### **Abstract**

The paper deals with the aspect of increasing the speed of the conventional motorcycle by keeping the related performance consideration. A working model has been developed to support the idea of this conversion. As the gears are very important components, performance can be easily modulated by designing the number of gears in the gear box. An engine of 223cc, 17 hp with a top speed of 125 kmph has been chosen. The material for gear design, on the basis of strengths considerations, steel grade 1 hardened is chosen. This material provides the system with a great safety factor on both gears for bending and wear. The shaft diameter was kept same as of stock. To make the assembly and order easier, both bearings were selected equal, although considerations show that for one of the bearings a smaller size could have been chosen. The HHO generator produces HHO which combines with the petrol and air in the combustion chamber. The modifications carried out on the conventional motorcycle have increased the performance of the vehicle. The speed of the vehicle increased till 170 kmph with the changed gear ratios. This could be done on a low budget. The vehicle gives a better mileage too for street ride as well as highway ride.

**Keywords:** Racing motorcycle; performance; mileage; HHO generator.

## 1. Introduction & Objective

Fuel economy is a major area of interest for the public and policy makers. Fuel economy is directly related to CO<sub>2</sub> emissions which constitute a greenhouse gas that traps the earth's heat and contributes to the potential for global warming. Therefore, it is of great importance to increase the fuel economy to the extent of the current level of technology limits. Many scientists and researchers tried to develop new technologies to achieve low fuel consuming cars and vehicles. Some came up with the utilization of alternative fuels, some improved the engine designs and some invented new ways to power the vehicles. This study presents a hydrogas system, basically a hydrogen generator by the electrolysis of water in a four stroke SI engine of a motorcycle.

Hydrogen is a clean burning fuel that is practically inexhaustible. Hydrogen is proved as a successful add-on fuel to improve performance and combustion characteristics of other fuels like gasoline, ethanol [Bohacik et. al (1996), Collier et. al. (1996) and D' Andrea et. al (2004)]. Ali Can Yilmaz et al. (2010) conducted experimental studies on the effect of Hydroxy (HHO) gas on the performance and emission in CI engines and found that the HHO system addition to the engine without any modification resulted in increasing engine torque output by an average of 19.1%, reducing CO emissions by an average of 13.5%, HC emissions by an average of 5% and SFC by an average of 14%.

The objective of the present study is to convert a conventional motorcycle to a high performance motorcycle with racing capabilities. A working model of the project has been developed to support the idea of this conversion. The reason behind this conversion is to allow riders and engineers to modify a conventional motorcycle into a high performance racing motorcycle with little modifications without affecting the mileage, which is required for everyday road travelling too. This ensures the usage of the vehicle in road as well as track. The motive is to increase the performance of the vehicle by introducing gear reduction and also with an HHO generator.

## 2. Experimental Study and Methodology

The vehicle used for the present study is a Year 2009 make of Hero Honda model "Karizma 225". The engine is air-cooled, 4 stroke single cylinder OHC. The displacement is 223 cc. The stock engine delivers a maximum power of 13.124 KW (17.60 HP) @ 7000 rpm. It delivers a maximum speed of 125 kmph and a torque of 18.35 N m @ 6000 rpm. The bore x stroke dimension is 65.5 x 66.2 mm with a compression ratio of 9.0:1. The vehicle uses the advanced microprocessor ignition system with a multi-plate wet clutch. The gear box is a 5 speed constant mesh. The kerb weight of the vehicle is 150 kg.

### 2.1 HHO Generator

HHO Generator is a device in which water is converted to hydrogen and oxygen gases simply and safely through electrolysis powered by a battery. The principle behind this process is that when water is introduced with electrical current/voltage [preferably DC] it has a tendency to become excited and divides into its primary elements of Hydrogen

and Oxygen. The produced Hydrogen and Oxygen are now in a gaseous state from the liquid water.



The idea behind the HHO generator incorporation in the engines is that a small concentration of hydrogen gas can increase the speed of the flame front, the leading edge of the burning gases in the combustion chamber. In turn, this would allow an engine to be run in a lean condition, allowing a higher compression ratio, thereby increasing the efficiency (by around 10%).

**2.2 Working of HHO Generator**

The overall electrolysis reaction is  $\text{H}_2\text{O} \rightarrow \frac{1}{2} \text{O}_2 + \text{H}_2$ . However, reaction at each electrode differs between the anode and cathode. Hydrogen production is at the Cathode. The reaction is  $2 \text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2$ . Oxygen production is at the Anode. The HHO combines with the petrol and air in the combustion chamber and is burnt. Once burnt, it converts back to the form of  $\text{H}_2\text{O}$  [water]. It absorbs the inner heat from the engine normally at 350 - 450<sup>0</sup>F and turn into super-heated DRY steam. Then it's pushed out during the exhaust stroke and out the tail pipe. The reaction by combustion is  $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$ . The Fig. 1 shows the HHO generator attached with the motorcycle in the present study.



**Fig. 1.** HHO generator attached with motorcycle.

**2.3 Engine Gear Box Calculation – Existing Model**

The Karizma uses a 5 speed constant mesh gear box manual transmission. The details of the gears in the main shaft gear, counter shaft gear, gear ratio in the existing model gear box is mentioned in Table 1.

**Table 1:** Gear ratio of old gearbox (before modification)

	No. of teeth on main shaft gears	No. of teeth on counter shaft gears	Gear ratio = Driven Gear / Driving Gear
1st Gear	13	36	2.769:1
2nd gear	18	31	1.722:1
3rd gear	19	24	1.263:1
4th gear	22	22	1:1
5th gear	27	22	0.8148:1

The Overall gear ratio ( $G_0$ ) is calculated  $G_0 = G_1 \times G_2 \times G_3 \times G_4 \times G_5 = 2.76 \times 1.7 \times 1.2 \times 1.1 \times 0.814 = 5.04:1$

#### 2.4 Engine Gear Box Calculation – Modified Model

For the modified model, the number of teeth on the gear has to be designed such that the gear ratio of the gears on the main shaft and the counter shaft should give maximum desired speed.

Target speed = 165 kmph    Power output = 17.6 hp    Rotational velocity = 7000 rpm

By considering normal condition based on the Indian road conditions,

$N = 7000$  rpm

$P = 17.6$  hp (13.124 kW)

Reduction required = (Wheel diameter x engine rpm)/ (target speed x 336)

Rpm = (mph x final gear ratio x 336)/wheel diameter)

Final Gear Ratio =  $G_1 \times G_2 \times G_3 \times G_4 \times G_5 = 3.025$

The details of the gears in the main shaft gear, counter shaft gear, gear ratio in the modified model gear box is mentioned in Table 2. The Fig. 2 shows the disassembly of the existing gear box and assembly of the modified gears in the gearbox.

**Table 2:** Gear ratio of old gearbox (after modification)

First Gear: Keeping the first gear ratio same as per the stock engine as we need the initial torque

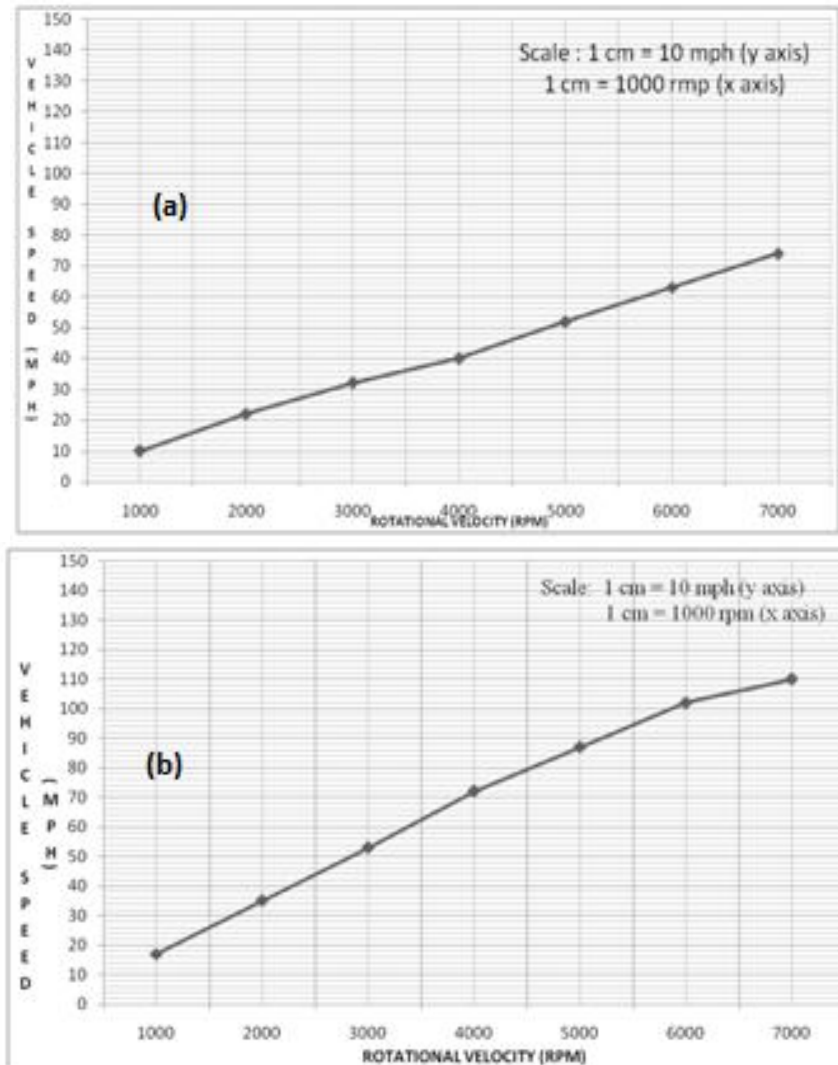
	No. of teeth on main shaft gears	No. of teeth on counter shaft gears	Gear ratio = Driven Gear / Driving Gear
2nd gear	18	26	1:1.44
3rd gear	19	24	1:1.263
4th gear	22	18	1:0.818
5th gear	27	20	1:0.740



**Fig. 2:** Engine disassembly and installation of new gears in the modified gear box.

### 3. Results and Discussions

The engine gear box is modified with based on the calculation of new gear ratio. Also, the engine is supplemented with HHO produced by HHO generator, which combines with the petrol and air in the combustion chamber. The parameters such as rotational velocity, torque and vehicle speed are monitored before and after the modification of the gears in the gearbox and the results are discussed here.

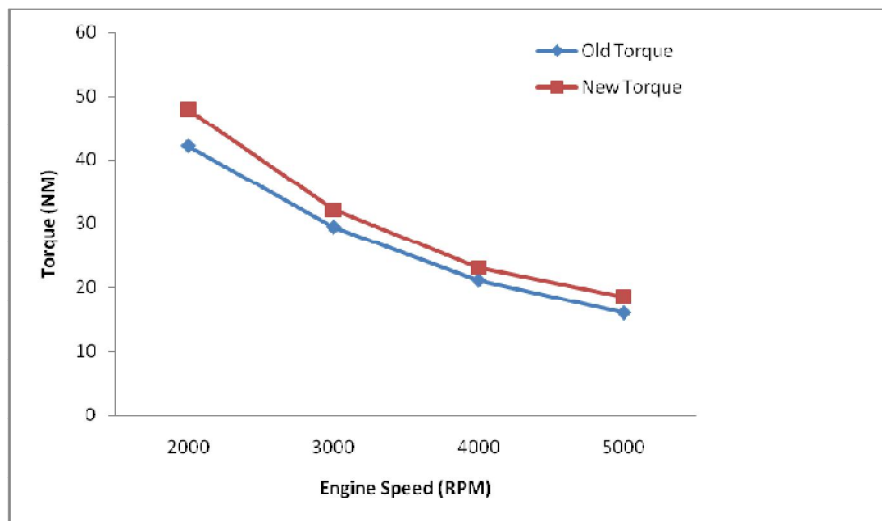


**Fig. 3(a) and 3(b):** Variation of vehicle speed with rotational velocity - before and after modifications.

The new speed of the modified motorcycle is calculated based on the formula,  $\text{Speed} = (\text{Tyre Radius} \times \text{Rotational Velocity}) / (168 \times \text{Gear Ratio}) = 123.76 \text{ mph}$  (approx. 125 mph) = 175 kmph. Fig. 3(a) and 3(b) shows the variation of vehicle speed

in mph with respect to rotational velocity in rpm for both before and after modifications. From the Fig. 3(a) and Fig. 3(b), it is clear that the vehicle speed increases based on the new gears in the gear box configuration obtained by modification of gears in the gearbox.

Fig. 4, shows the variation of torque (Nm) with respect to engine speed (rpm). The torque decreases as the engine rpm is increased. The similarity in trend is observed for both old and new configurations. The torque produced in the old configuration is less than the new configuration. This has reflected with increase in speed as seen in Fig. 3(b).



**Fig. 4:** Variation of torque with engine speed - before and after modifications.

#### 4. Conclusion

A working model has been developed to support the idea of converting conventional motorcycle to racing motorcycle meeting the required standards. The modifications carried out on the conventional motorcycle have increased the performance of the vehicle. The speed of the vehicle increased till 170kmph with the changed gear ratios. The reason behind this conversion is to allow bike riders and engineers to modify a conventional motorcycle into a high performance racing motorcycle with little modifications without affecting the mileage, which is required for everyday road travelling. The speed of the vehicle increased till 170 kmph with the changed gear ratios. This could be done on at a low cost. The vehicle gives a better mileage for street ride as well as highway ride irrespective of the fuel consumption in the stock listings.

## **5. Acknowledgements**

The authors acknowledge and appreciate the technical support provided by the lab assistants of the main workshop, Department of Mechanical Engineering, Hindustan University, Padur, Tamilnadu.

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