Prototype of Disc Brake Dynamometer

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Abstract. *This paper presents the design and test of prototype of Disk Brake Dynamometer of Single-cylinder engine performance standard Brake horsepower with water using the Honda GX-200 four-stroke 196 cm3 gasoline engine, 1-cylinder gasohol 95 fuel. The experiment result showed that the Prototype of Disk brake Dynamometer maximum engine torque was 11.58 Nm at 2500 rpm. The maximum power of engine was 3.29 kW at 3000 rpm and maximum thermal efficiency of engine brake was 25.36 % at 2500 rpm. When being compared the performance of a standard single-cylinder engine performance test with the all-purpose gasoline engine Honda GX-200 1-stroke 4-stroke 196 cm3 gasohol 95, it was found that Maximum engine torque was less than 5.39 %, the maximum engine power was higher than 2.49 %, the maximum fuel consumption of the engine was higher than 10 % and the maximum thermal efficiency of the engine was higher than* 2.39 %.

Keywords: disk-brake, prototype, dynamometer

Introduction

Nowadays, car performance has been increased higher than in the past. The studies for developing and improving the performance of car need a variety of information and tools for testing the performance which can examine the values of car performance. In Thailand, price of gasoline seems to increase higher and higher which directly affect the riders including the farmers, fishermen and those who work in auto mechanic, gasoline and diesel industries. Therefore, the government issued energy saving policy promoting the use of alternative sauces of energy including biodiesel, Gasohol, E10, E20 and E85 for instance [1] which can help reduce cost of fuel and air pollution while the engine has the same quality of performance as other engine using benzyl [2], [3]. Changing the engine to use alternative energy effects on the engine due to fuel heating value decreased. There were research works regarding car engine that focused on adjusting the part of the engine including compression ratio, ignition timing and fuel supply in order to enhance the small engine cars perform as same as using the same fuel.

Generally, electric dynamometer engine can be tested by using generator with installed bearings to support the front and back and then connecting the shaft through the coupling to the engine and measuring force from load cells. Then, measure speed and record the time of fuel consumption by dividing the brake engine power with the fuel rate [4] to calculate the torque and brake heat efficiency.

For this reason, the author was interested in creating a prototype horsepower test using brakes with a working principle using disc brakes installed with bearings for the front and back to investigate the performance of small engines in order to investigate the torque, power, engine speed, specific fuel consumption rate and brake heat efficiency. The findings will be used as a guideline for obtaining more efficient performance, useful information and better understanding of different types of fuel. In addition, this can be advantageous information regarding engine modifications and engine performance to be applied for developing electronic fuel control engines as well as the engine using ethanol as alternative fuels in the future.

Prototype of Disk brake Dynamometer Test

Before the Experiment

1) Place the dynamometer on the floor and adjust the support frame to a level, then connect the fuel pipe from the engine to the fuel tank.
2) Connect the tachometer signal to the control panel.
3) Connect the engine throttle cable from the control panel to the engine.
4) Connect the power supply and switch on.
5) Adjust the accelerator to the bare operating position and start the engine.
6) Wait about 5 minutes to warm the engine to the operating temperature.

Testing Methods

1)Adjust the engine accelerator to the desired position, for example 75 percent of the full open position (full throttle) and at the same time gradually increase the load. (Increasing the disc brake friction) until the desired speed

2) Wait until the operating conditions are stable. Then record data such as engine speed (rpm), torque (N-m) and record the weight of fuel every 15 seconds, 3 times.

3) Adjust the load for various engine speeds

4) Wait until the operating condition is stable and record data according to item 3.4.2.2

5) Repeat step 3.4.2.3 at increased load so that the engine speed is reduced in steps of 200 rpm until both rpm reduced to 1400 rpm or the engine starts to stop.

6) Repeat steps 3.4.2.1 to 3.4.2.5 at the position of other accelerators.

Switch-off process

1) Adjust the accelerator to the idle position.

2) Return the load adjuster to the empty machine operating position.

3) Switch off and cut off the power supply.

Equations

1) Determination of specific brake fuel consumption (Brake Specific Fuel Consumption) is the amount of fuel consumed per unit of time for the braking power of the engine. This can be obtained from the equation :

$$Bsfc = \frac{\dot{m}_f}{BP}$$

Where

Bsfc = Specific brake fuel consumption (Kg. per kilowatt-hour)

$\dot{m}_f$ = Fuel depletion rate that is depleted (Kilograms per hour)

BP = Braking power (kilowatt)

The rate of fuel consumption can be obtained from $\dot{m}_f = \frac{W_f \times 3600}{t}$

Where

W_f = Fuel weight (Kilogram)

t = Time that the fuel is used (second)

2) Calculation of brake horsepower using the following formula

$$BP = \frac{2\pi TN}{60000}$$

Where

BP = Braking power (Kilowatt)

T = Torsion (Newton-meters)

N = Speed (Round per minute)

3) Calculation of calorific value from fuel (Heating value of fuel)

The heat of the combustion of fuel can be obtained from

$$Q_f = \dot{m}_f LHV$$

Where

Q_f = Calorific value of the combustion of fuel (kilowatt)

m_f = The value of fuel consumption being exhausted (Kilograms per second)

LHV = Low calorific value of fuel (Kilojoules per kilogram)

4) Calculation of thermal brake performance (Brake thermal efficiency)
Can be obtained from

$$\eta_{bt} = \frac{BP}{Q_f}$$

Where

η_{bt} = Thermal brake efficiency

BP = Braking power (kilowatt)

Q_f = Calorific value of the combustion of fuel (kilowatt)

Results

The horsepower prototype with disc brakes uses steel to build the base consisting of different sizes of steel are strong. The structure of the horsepower prototype with brake discs includes a set of devices that can be disassembled to the base of the horsepower prototype using disc brakes, including disc brakes, power transmissions, bearings, couplings, load cells, proxies, Proximity sensor, Microcontroller and caliper brakes (see figure 1). These devices will be mounted to the base structure of the horsepower prototype using a disc brake. Each device will function differently in each section. In the parts separated from the base structure of the horsepower prototype using disc brakes include the control box, fuel weighing set and an additional set to load the engine. All of this can be disassembled in each part of the work.

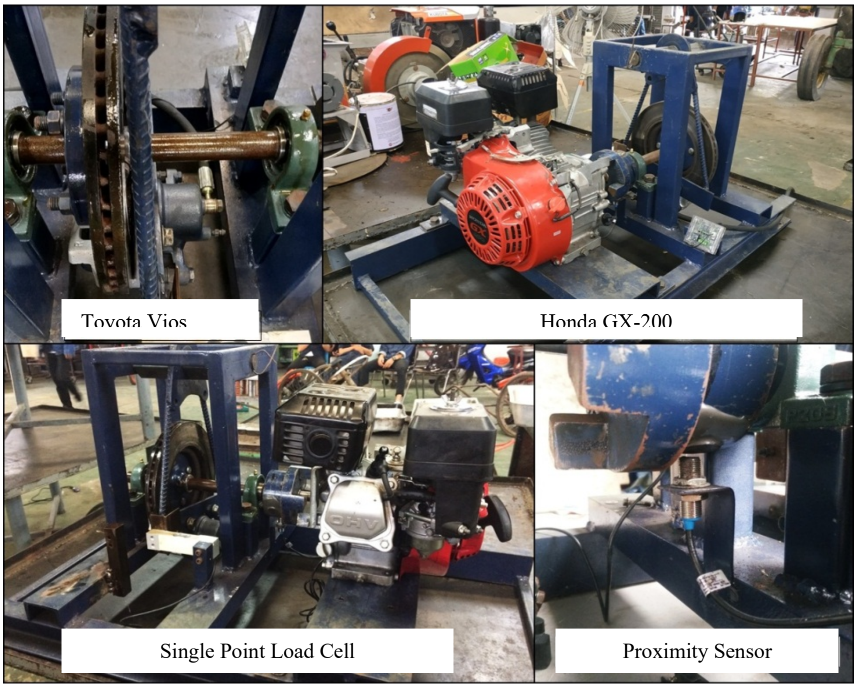

Figure 1 Testing tool kit for horsepower prototype with disc brake

Control box for controlling and receiving signal from the prototype for testing horse power of disc brake prototype including signal from load cells and proximity sensor which will be used for calculating and displaying the results on the screen (see figure 2).

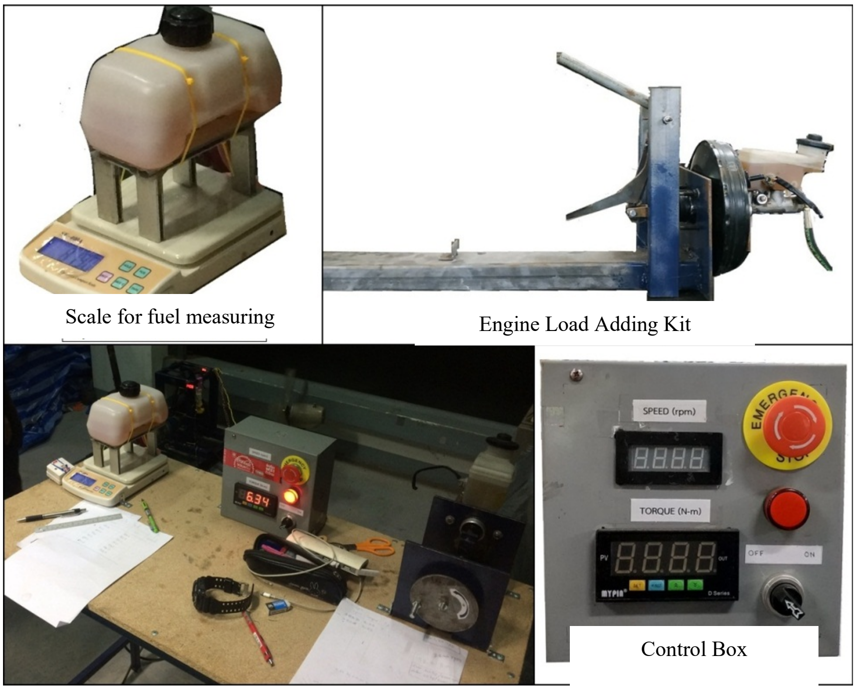

Figure 2 Control box

From the performance test of the engine, it can be seen that the prototype engine tests of horsepower using disc brakes with 1900 - 3400 rpm in the duration of the 1900 rpm, the torque and power of the engine increased together until reaching the speed of rpm 2500 rpm, which is the highest torque of the engine. When the speed increases, the engine torque decreases steadily but the engine power will increase steadily to the speed of 3000 rpm which has the highest power of the engine. The minimum torque for testing of the engine was 8.69 newton-meters at 3400 rpm, the maximum torque of the engine was 11.58 newton-meters at 2500 rpm and the engine power was 2.02 kW at 1900 rpm and the maximum power of the engine is 3.29 kW at 3000 rpm.

The result of measuring the torque and power of the water brake horsepower test showed that the performance test set of a single cylinder engine meets the standards. The type of horsepower brake test has a speed cycle of 1900 - 3400 rpm. For the 1800 rpm, the torque and engine power increased until reaching the speed of 2500 rpm in which torque and power of reach the maximum point. And when the rpm increased, the engine torque and power decreased. In this experiment, the minimum torque of the engine is 2.99 newton-meters at 3400 rpm, the maximum engine torque of 12.24 newton-meters at 2500 rpm and the engine power of 1.07 kW at 3400 rpm and maximum power of engine 3.21 kW at 2500 rpm.

According to the performance test of the engine, it can be seen that at a speed of 1900 rpm, the prototype horsepower using disc brakes had a fuel consumption rate of 0.22 grams per second. A set of performance tests for single cylinder engines then meet the standards. The type of brake horsepower type test machine had a fuel consumption rate of 0.19 grams per second and at the speed is 2500 rpm. The prototype engine was then tested for the disc type horsepower and the standardized single-cylinder type engine performance. The fuel consumption rate for horsepower engine with water brake was at 0.30 grams per second. When the engine speed increased to 3000 rpm, the prototype horsepower type brake disc type engine would reach the highest fuel consumption of the engine at 0.33 grams per second.

According to the relationship between engine torque and engine speed, it can be seen that at a speed of 1900 rpm, the prototype brake disc horsepower test engine had 10.19 newton-meters. The water brake horsepower had engine torque of 11.46 newton-meters. When the speed was around 2500 rpm, the prototype of the brake disc type horsepower test system had the maximum torque of the engine 11.58 newton-meters and the test kit for the performance of the single cylinder type engine meets the standards. As the speed increased, the

torque decreased continuously until the engine speed reached 3400 rpm. The prototype of the brake disc type horsepower test engine could have a minimum torque of 8.69 newton-meters and a single-cylinder engine performance test set that meets the standards the type of brake horsepower type water test engine had the lowest torque of the engine 2.99 newton-meters.

The relationship between engine power and engine speed showed that at 1900 rpm, the brake horsepower prototype engine could receive the lowest power of the 2.03 kW engine and a single-cylinder engine performance test set that meets the standards, the horsepower type brakes with water tests could obtain the engine power of 2.16 kilowatts. When the speed was around 2500 rpm, the prototype brake horsepower engine had approximately 2.98 kilowatts of engine power and a set of performance tests for a single cylinder type engine that meets the standards, the water brake horsepower engine test will get the maximum power of the engine 3.21 kW. And when the speed rises to 3000 rpm, the brake horsepower prototype will have the maximum power of 3.29 kilowatts of engine and a set of performance tests of a single cylinder type engine that meets the standards of the water brake horsepower tests obtained 2.94 kilowatts of engine power. When the speed increases, the power will gradually decrease until the speed is at 3400 rpm. The prototype of disc brake horsepower will have 3.09 kilowatts and a set of performance tests for a single cylinder engine that meets the standards water brake horsepower tests will obtain the engine power of 1.07 kilowatts.

In addition, the relationship between the thermal efficiency of brakes and engine speed showed that at a speed of 1900 rpm, the prototype of disc brake horsepower test system will have the lowest thermal efficiency of the brakes of the engine, 21.27 percent, and the performance test kit of a single cylinder type engine that meets the standards as for the water brake horsepower, the maximum thermal efficiency of the engine is 25.98%. And when the speed is around 2500 rpm, the brake horsepower prototype will have the maximum thermal efficiency of the engine at 25.36 percent and the single-cylinder engine that meets the standards has thermal efficiency of 24.28 percent of the brakes. When the rpm speed increases, the thermal efficiency of the brakes will gradually decrease until the engine speed is 3400 rpm. The prototype horsepower engine using disc brakes has thermal efficiency of the brakes at 23.44% whereas the single cylinder engines that meet the standards as for the water brake horsepower engine performed the minimum brake heat efficiency of the engine at 10.90%.

Conclusion

This paper presents the comparison of the performance of a small multi-purpose petrol engine Honda GX-200 1-cylinder 4-stroke 196 cc 6.5 horsepower, gasohol 95 fuel using a horsepower disc brake prototype and performance tests for single cylinder engines that meet the standards as for water brake horsepower engine.

It was found that the Prototype of Disk brake Dynamometer maximum engine torque was 11.58 Nm at 2500 rpm. The maximum power of engine was 3.29 kW at 3000 rpm and maximum thermal efficiency of engine brake was 25.36 % at 2500 rpm. When being compared the performance of a standard single-cylinder engine performance test with the all-purpose gasoline engine Honda GX-200 1-stroke 4-stroke 196 cm^3 gasohol 95, it was found that Maximum engine torque was less than 5.39 %, the maximum engine power was higher than 2.49 %, the maximum fuel consumption of the engine was higher than 10 % and the maximum thermal efficiency of the engine was higher than 2.39 %.

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References

[1] Department of Alternative Energy Development and Efficiency. (2015). Alterative Energy Development Plan : AEDP 2013-2036. Ministry of Energy. Thailand.

[2] Teerapat Kuwannarat and Jitti Pantawanit. (2007). Four-stroke engine performance test using Benzyl and Gasohol . Bachelor of Engineering Thesis. Burapha University.

[3] Witoon Huansoong. (2007).A study of Benzyl engine using ethanol as main energy source. Master of Education Thesis. Srinakharinwirot University .

[4] Tahir, M. M. (2015). New design of a low cost small engine dynamometer Engine Testing. Mechanics and Materials Vol. 699 pp 642-647.

Figures

Figure 1

Testing tool kit for horsepower prototype with disc brake

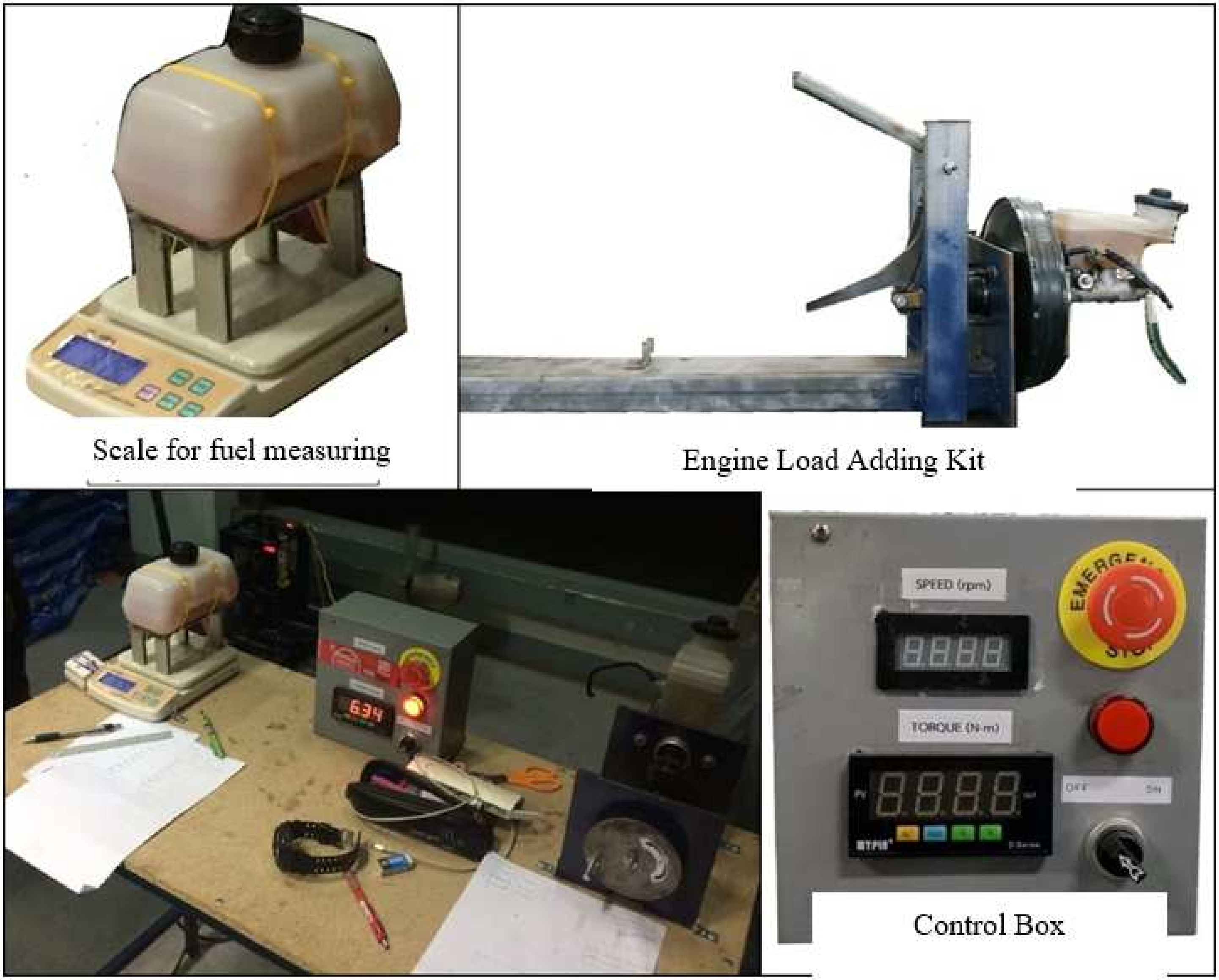

Figure 2

Control box