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KIDLAT: A DIESEL HYBRID VEHICLE

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ABSTRACT

This study came up with a solution to the rising fuel prices by designing and building the Philippines' first diesel-hybrid car. A hybrid vehicle combines a conventional internal combustion engine propulsion system with an electric propulsion system. The output aims to achieve better fuel efficiency compared with conventional automotive vehicles. The study used a series hybrid power train where only the electric motor drives the drivetrain, while the internal combustion engine acts as generator to power the electric motor. With the diesel engine running at its most efficient state, fuel efficiency increased exponentially while maintaining the speed required of a typical vehicle.

The study also designed and fabricated an aerodynamic body, reducing air drag and further improving fuel efficiency.

The whole project lasted around six months. The researchers designed the automotive chassis and body during the first two months. The remaining time was used to construct the vehicle itself.

When the automobile was tested in Sepang, Malaysia, the results showed that it can run up to 59.9 km/l. Compared to typical cars running an average of 10km/l, the diesel-hybrid car designed by the researchers registered almost six times more.

The results of the study opened possibilities for consumers saving at least Php 4.00 per kilometer. These are big savings especially now that fuel prices are always increasing.

1. RATIONALE AND SIGNIFICANCE

The researchers tested the diesel engine performance to identify its brake specific fuel consumption at different speeds and loads, and to determine the best state to run the engine. By coupling the diesel engine (running at its most efficient state) with an electric motor, the study aims to produce a fuel-efficient hybrid vehicle. This project hopes to provide a solution to the ever-increasing fuel prices in the country for the benefit of the consumers.

Knowing an engine's brake specific fuel consumption tells researchers the most efficient state at which it runs. In addition, knowledge of aerodynamics will help them design a car body with reduced air drag. Stress and strain analysis will also show whether or not the car chassis design can withstand the stresses produced while the vehicle is running. Furthermore, to successfully create a "controller" for the electric engine, extensive knowledge on electric circuits is required.

Using theories on thermodynamics, fluid dynamics, stress analysis, electrical circuits and mechanical/electrical design, the researchers aim to produce the Philippines' first aerodynamic diesel-hybrid car.

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This project aims to determine whether hybrids meet the expectations for environmental benefits. It also hopes to promote awareness on conscientious design of commercial vehicles to lessen the impacts of increasing fuel prices on consumers and carbon emission on the environment.

1. OBJECTIVES

The project aims to develop an aerodynamic hybrid vehicle to increase fuel efficiency while maintaining the speed required of normal vehicles.

It will fabricate all necessary parts of the automobile except the engine. And to further improve fuel efficiency, the researchers will determine the most efficient state for the diesel engine which will be the basis for its desired rpm.

2. PROBLEM STATEMENT AND DESCRIPTION

Increased fuel efficiency through a hybrid vehicle presents a solution for consumers who continue to bear the brunt of increasing fuel prices. It also addresses looming energy and environmental crises by reducing carbon emission through a vehicle that consumes less fuel while still running at a very efficient state.

For example, a typical diesel car will run for 10km/l which translates to 4.865 pesos/km. The research's output, on the other hand, can attain 59.9km/l, translating to only 0.812 pesos/km. This gives consumers savings of up to 4.053pesos/km which can go a long way especially today when fuel prices are always on the rise.

Currently, there are hybrid cars available in the market like the Toyota Prius which is around Php 1.4 million. These cars are very expensive so consumers normally choose the cheaper, inefficient cars.

This project aims to show that efficient cars need not be expensive, and that the Philippines has the capability to produce its own brand of efficient cars. This research will also highlight the Filipino engineer's skills while raising awareness on the environmental impact of inefficient vehicles.

3. METHODOLOGY

The project was divided into four parts: (1) the design and fabrication of the chassis along with the vehicle parts (e.g. shaft, pillow block, steering mechanism, etc.), (2) the design and fabrication of the car body using carbon fiber to develop a lighter but structurally sound aerodynamic design, (3) the design and fabrication of the electrical components and the electrical controller for the electric engine, (4) testing the performance of the diesel engine to determine its most efficient running state.

To design an aerodynamic car body, the researchers used the ANSYS software and the principles of fluid dynamics. The software calculated the coefficient of drag. Furthermore, to fabricate a body for the vehicle using carbon fiber, an initial mold was first produced which was then used as pattern for the carbon body.

For the computer design of the car chassis and components, the researchers used Pro-Engineering. The same software was used to test the stresses generated on the parts. In fabricating and producing these parts, they used the CNC, the lathe machine, wielding machines and the other machines in the Mechanical Engineering Department.

During the engine performance testing, the researchers used the VRTL Lab with its chassis dynamometer which measured the engine's power, torque, speed and efficiency.

Finally, in constructing the electric controller used in adjusting the voltage and current output of the electric engine, knowledge of electric circuitry was essential.

After the construction phase, the researchers conducted a test run under actual road conditions to determine the vehicle's fuel efficiency.

4. RESULTS AND RECOMMENDATION

After extensive testing on the aerodynamics of the body design, the results showed that the automobile has a coefficient of drag of 0.2. This is better compared with typical commercial vehicles that have an average of 0.3-0.35 coefficient of drag.

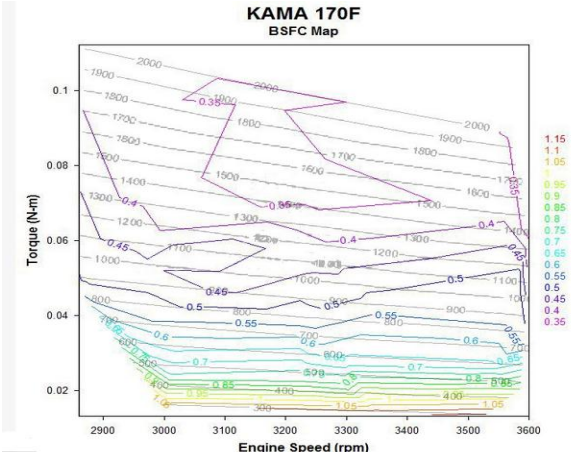
In addition, after testing the performance of the diesel engine and determining its torque and speed, the researchers found it advantageous to keep the diesel engine running at 45kph.

The use of a series hybrid configuration kept the diesel engine running at the desired rpm. This translated to a 40-volt (800 Watts) power output for the electric motor to turn the wheels of the car. This configuration allowed the vehicle to reach up to 60kph.

During the testing for fuel efficiency, the automobile was filled with 1L of diesel. The test run showed that it can run up to 59.9km/L.

To improve on fuel efficiency, the researchers recommend making the body lighter by either taking away material or making the body thinner. In addition, a super capacitor may be considered as a rechargeable battery. Once the super capacitor is fully charged, the engine may be turned off and the super capacitor will, then, act as the sole power source, further improving the car's fuel efficiency. It will also be advantageous to lessen the friction created by the rotation of the shafts.

Figures



DIESEL ENGINE (KAMA) PERFORMANCE

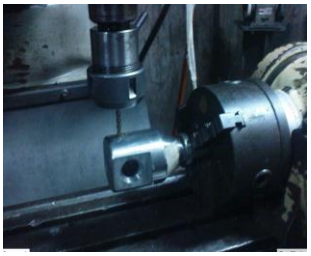
Tables

Shell Eco-marathon ASIA 2011

Diesel Fuel Award

Rank	Country	School Name	Team Name	Race Number	Fuel Type	Best Result km/l
1	Philippines	University of the Philippines, Diliman	Team UP	561	Diesel	59.9

Photos

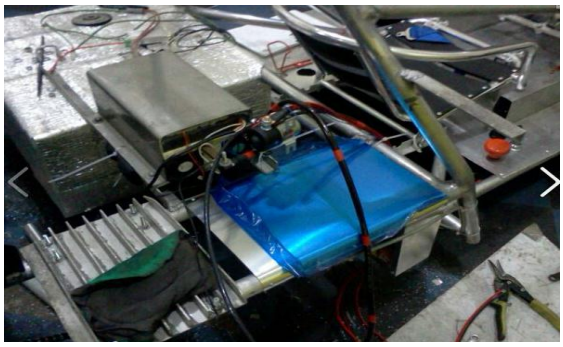



CAR PARTS (MANUFACTURED USING THE MACHINES IN THE MECHANICAL ENGINEERING DEPARTMENT)

REAR ASSEMBLY

ENGINE CONFIGURATION


FINAL CHASSIS ASSEMBLY WITH PARTS



ELECTRIC ENGINE CONTROLLER(FABRICATED IN UP PEL)

BODY FABRICATION

Visit to Malacañang Palace

SEPANG MALAYSIA "SHELL ECOMARATHON ASIA 2011"

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