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Research Paper

INCREASED MOTORBIKE DRIVING RANGE BY ALTERNATOR CRANKSHAFT COUPLING AND DUAL DRIVE

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As modern culture and technology continue to develop, the growing presence of global warming and irreversible climate change draws increasing amounts of concern from the world's population. Countries around the world are working to drastically optimize the use of fossil fuels, reduce CO2 emissions as well as other harmful environmental pollutants by advancing existing vehicular technology. By incorporating alternative energy drive-trains into vehicles that also use combustion engines, they allow for a slightly cleaner mode of transportation. The paper investigates the effect of externally loading the engine and hence shifting the fuel consumption curve to leanest air fuel ratio to obtain a better driving range. The mechanical design for this test was done in CATIA. The bike is powered by a single cylinder, 4 Stroke air-cooled 125cc conventional petrol engine and a 360W/15A geared DC Motor (Jack Erjavec and Jeff Arias, 2012). The bike's design is chopper in nature with a high front rake angle. Motor gets its power from the batteries and drives the vehicle when the engine's cut off, controlled by an electronic control unit. Our system enables approximately a 40% increase in the bike's overall driving range, lesser air and noise pollution, enhanced comfort in city drive at low speeds and greater co-generative efficiency.

Keywords: Alternator-Flywheel coupling, Battery packs, Chopper, Clutch mechanism, DC Motor, Driving range, Electronic control unit (ECU), Gasoline engine, Multiple drives, Noxious pollution, Rake angle, Variable accelerator

INTRODUCTION

The vehicular population in India is growing at an alarming rate. The streets are congested and thus the trend of buying motorbikes has increased a lot. The gear shifting in this congested city traffic doesn't allow for the optimum fuel consumption. Statistics shows that in India the pollution caused by the motorbike is the highest. According to Indian Auto Industry, domestic motor vehicle sales in the year 2013 shows that motorbike sales was about 80% of the total vehicles sold in the country. Studies also show that by 2050 the fossil fuels will be depleted.

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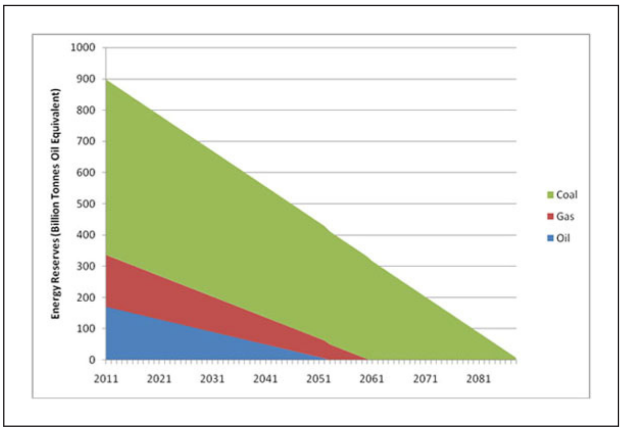
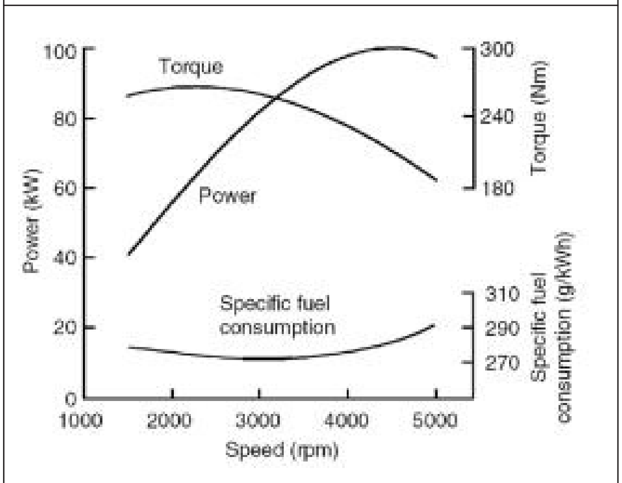


The optimum performance of an internal combustion engine is during the green zone of the vehicle. The green zone indicates the speed range where the emission or fuel consumption is the lowest

Figure 1: Variation of Power at Various Engine Speeds



The optimum performance of an internal combustion engine is during the green zone of the vehicle. The green zone indicates the speed range where the emission or fuel consumption is the lowest. The graph shows that the fuel consumption above and below a specific speed range is high.

By loading the engine when it is not in its green zone we can improve the fuel consumption curve, it may be dead weight or an alternator. Dead weight won't give us regeneration of energy, but with the help of an alternator we can charge the battery also. To disengage the loading of the engine during the green zone a clutch mechanism is implemented.

DESIGN AND FABRICATION

The designing of the motorbike was carried out in CATIA. The rake angle of the bike was increased for better balancing of the front wheel. Designing of the frame had to be done as modification in an already existing bike was not possible due to restriction in space. The vehicle weighs 140Kg.

The energy of the engine is regenerated during different stages, namely:

In idling, the fuel consumption is solely for keeping the engine ON and there is no output at the wheels. Hence by coupling the alternator at the flywheel we are making the engine to do some useful work by charging the batteries (Mark S Duvall, 2005).

At lower gears the torque is maximized to get the vehicle in motion. During this moment, surplus torque is produced. Hence even if we load the engine during this period it won't affect the performance of the engine.

Once the vehicle is moving downhill we normally push the gear to neutral or clutch is engaged. In both cases the engine is working and there is no net output of the engine on the wheels. This system is now similar to what happens during idling of the engine. The vehicle moves due to the gradient. The engine power is thus utilized for charging the battery as mentioned in the idling case (T Markel and A Simpson, 2006).

The alternator is coupled to the engine crankshaft by extending the crank shaft with a pulley at the end and a v-belt is used to connect the pulley and the alternator. The alternator crankshaft coupling is made possible by a clutch mechanism fitted on the crankshaft onto which the pulley is fitted. The alternator produces AC current which is converted to DC by using a rectifier. The alternator stops charging the battery when the battery is fully charged. The motor is connected to the battery, potentiometer and the ECU. The potentiometer allows the DC motor to vary the speed and the ECU translates the speed modulation to the motor (Thomas H Bradley and Andrew A Frank, 2007; Benjamin M Geller, 2010).

The engaging and disengaging of the clutch mechanism during the green zone of the vehicle is made possible by implementing a speed sensor. Whenever the speed is above 40 Kmph and below 60 Kmph the clutch mechanism is engaged, unloading the alternator coupling during the optimum performance of the engine. Below 40 Kmph as there is sufficient amount of torque produced by the engine charging of the battery is made possible at ease. Above 60 Kmph the charging is made possible as the vehicle has acquired sufficient momentum.

As the alternator is directly coupled to the crankshaft charging is more efficient. If it had been connected to the chain or the rear wheel there would have been more losses.

The development is a motorbike powered by a single cylinder, 4 Stroke air-cooled 125cc conventional petrol engine and a 270W/15A geared DC Motor (DongsukKum *et al*., 2010; V Ganesan, 2007), giving 40% more driving range than a normal motorcycle.

The rear wheel is driven by the engine itself through a chain drive and the motor is connected to the front wheel by a chain drive making the bike an all-wheel drive. It's designed as a parallel hybrid (DongsukKum *et al*., 2010), so that it can run either on motor or on engine. The bike has a single variable accelerator mechanism for controlling both the engine and the motor (Chan-Chiao Lin, 2003).

The primary power source is the engine itself which is connected to a 24V alternator by a belt drive which charges two 12V/63Ah maintenance free batteries. The battery is charged through the alternator when the engine's running (Noah Vawter, 2008). Motor gets its power from the batteries and drives the vehicle when the engine's cut off. While driven on the DC motor, the use of a controller enables the rider to scale greater speeds. The rider may very well switch to the engine for more power or sudden acceleration, through manual switching (Saurabh Mahapatra, 2008).

Figure 2: Multipart Figures

RESULTS

Vehicle Specification

- 4 Stroke air-cooled 125cc conventional petrol engine (Single Cylinder)
- 15A/120W, 600rpm (at full load)
- Motor to wheel ratio - 2.57:1
- Flywheel to alternator ratio 1:1
- Alternator: 24V/63A.
- Two 12V/63A maintenance free batteries
- Single variable accelerator mechanism
- Manual switching
- All wheel drive- The rear wheel is driven by the engine itself and the motor is connected to the front wheel by a chain drive
- Chopper with high front rake angle and no rear suspension.

Test Results

Test Surface: Toc H ground

Testing Speed of the Vehicle While Driven on Engine: 30Kmph

Mileage Without Hybrid System: Engine only- 30.4 Kmpl

Mileage With Hybrid System

- Engine-30 Kmpl
- Motor-12 Kmpl
- Total mileage-42 Kmpl

As the speed is set at 30Kmph and we get a mileage of 30KmpL on the engine, therefore, the engine is run for 1 hour.

The rate at which the alternator charges the battery is 6 Amps/hour [Checked with an ampere meter connected in series with the alternator and the battery].

Hence, 6 Ampere is now stored in the battery.

Motor consumes 8 Amps/hour

Motor Speed: 15Kmph (when the battery was only partially charged)

Therefore distance covered with motor is 12Km

Increase in driving range (%) = 12/30= 40%.

FUTURE SCOPE

To harness wasted energy due to friction efficiently, the existing DC motor could be used for propulsion as well as braking as this can be achieved by merely changing the polarity whenever braking is required. A stable charging of the battery can be achieved by integrating a super capacitors into the circuit (Donghwa Shin, 2012).

ADVANTAGES

1. This system can run either on engine or on motor, thereby utilising both the power systems to its maximum. Hence, it has a major implication for the reducing petroleum consumption and vehicle air pollution emissions worldwide (Garth Heutel and Erich Muehlegger, 2010).
2. Better utilization of fuel at idling and at low speeds.
3. Reduced wear and tear on the gasoline engine.
4. Reduced noise emissions resulting from substantial use of electric engine at low speeds, leading to roadway noise reduction and beneficial noise health effects.

5. Reduced air pollution emissions due to less fuel consumed per travel mile, leading to improved human health with regard to respiratory and other illness.
6. Increased driving range without refuelling or recharging compared with electric vehicles and perhaps even compared with internal-combustion vehicles. Limitations in range have been a problem for traditional electric vehicles.
7. Auto cut-off of the battery after being fully charged.

DISADVANTAGES

1. It has been observed that the success of the motorbike comes despite the need to carry two complete power systems. In a poorly designed motorbike this might increase the weight and size and therefore greater losses in acceleration and aerodynamic drag.

CONCLUSION

It is clearly seen that by shifting the fuel consumption curve and making the engine work at optimum efficiency most of the time we can increase the driving range combining the electric and conventional IC engine drives.

This system ensures a cleaner and more economical solution to the energy crisis. The system is cost effective and easy to implement as there is a small need to add an alternator, a DC motor and a clutch mechanism to the design. Cost effective as it saves immense amount of money on fuel. In cities driving the vehicle on electric mode increases human comfort as there is no need for constant shifting of gears. The reserve of Fossil fuels is at dwindling level and this paves the way to introduce alternative fuels into the market. The alternate technologies and fuels are not viable and needs further advancement; hence we have to utilize the available technology.

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