Dual Fuel System Used In Bike

Aman Sharma

Mechanical Engineering Department, Govt. Polytechnic Dehradun, Dehradun (248001), Uttarakhand, India

Abstract: ***The idea of this project comes when we see the only one option available as a fuel in bikes/scooter. So, in this project the design, implementation and fabrication of such a system is done which runs on dual fuel i.e. Petrol and L.P.G. The intension is to explore the possibility of creating a bike which can run smoothly on LPG for longer trips/journey and lower load while still having the capability of switching on petrol for longer as well as shorter trips but at higher loads. In this project an additional LPG cylinder is attached with the bike and all the gas kit and other equipment fitted into bike for integration of LPG fuel into the bike.***

Keywords: Dual fuel bike, Installation of L.P.G cylinder and Gas kit

1. Introduction

In the dual fuel bike the driver is able to switch the fuel system used in vehicle as per the requirements and performance. LPG powered motorcycle is not the new technology it is the established technology and developed few decades ago. But there isn't a readily available kit that someone can retrofit to their existing bike. Similarly, petrol powered bike is also a technology that has already been developed. Because of the size restrictions, future component may need to be custom made to cut down their sizes, therefore this prototype may need to be setup as a bench mount to prove of concept. By this project the actual result difference can be calculated for both the fuels and it also helps to decide which fuel is more suitable for different purpose.

2. Literature Review

L.P.G is the third mostly used fuel in the world with approximately 16 million vehicles runs on this fuel. But it is less than 3% of world usage. It was first produced in 1910 by Dr. Walter Snelling and the first commercially appeared in 1912[5]. In 1928 LPG was first used as vehicle fuel (in the truck) and the first LPG refrigerator was made[8].

The introduction of LPG in most overseas countries was non-mandatory except in the US where federal and state fleets have to comply with the National Energy Policy Act 1992 to have certain percentage of their new vehicles to run on alternative fuels. Overseas governments have used various measures, fiscal and non-fiscal, to create an environment that encourages the use of automotive LPG [2].
In October 1996, the Legislative Council Panel on Transport requested the Research and Library Services Division (RLS) to research on taxis using liquefied petroleum gas (LPG). The objective of this research is to provide information on the use of LPG in vehicles including taxis to familiarize legislators with overseas practices [2].

3. Materials & Methods

The component used in this project are described below:

1. Bike/Motorcycle
Technical specification of bike is given below

Model = Honda CBF
Manufacturer = Honda Auto
Capacity of Engine = 125 cc
Number of stroke = 4
Fuel type = Petrol
Torque developed by engine = 10.2 N-m@6250rpm
Fuel consumption = 35- 40 Km/l
Fuel Tank capacity = 10 liters
Ground clearance =173mm

2. L.P.G. Gas Kit
The following components of LPG Gas kit are-

- **Gas Diffuser**

- **Nozzle**

- **Hosepipe**

- **All other accessories**

3. L.P.G Cylinder

Cylinder capacity = 4 kg

4. Method

The process of developing a Dual fuel bike require a methodical approach to ensure that every element perform its task to the degree required. The following steps are

Recognition of need- Changing emission laws and an overall increasing respect for the environment in which human's lives has ensured that this field of study will always be pursued. When a new technology arrives, it need take its environmental effects.

Conceptualization- A number of different designs elements will be taken into account to ensure that a system can be developed this is suitable with the existing technology.

Feasibility Assessment- A lot of factors must be taken into consideration while designing like economical, ethical and environment friendly.

Preliminary Design- Firstly a design will be finalized which meets all the requirements then available components will be analyzed to determine how best to implement the design.

Detailed Design- when all the components are selected, the layout of system is needs to be designed. Performance of all the component is tested.

Pretesting- A series of tests will be done in this step such as acceleration, deacceleration from braking and freewheeling deacceleration.

Design Implementation- The bike used for testing will be need to be stripped of its motor and other non-critical components. The chosen will then be implemented either on bike frame or as a bench mounted system.

5. Working Principle

L.P.G Engine and Its Working

LPG is made from a mixture of propane, butane, propylene, butylene and other ingredients all of which makes it denser than air, which makes it sink to the ground in the event of leak.

THE system includes a storage tank (can be cylinder), level gauge indicators, mechanical shut-off valve, an evaporator, and an LPG air mixing unit and standard carb urettor. An electro-mechanical solenoid is also present in the petrol line, which shuts during LPG operations and opens while running on petrol. (but in our bike/project we shut on/off supply of fuel i.e. petrol and LPG manually).

Liquid LPG is pushed into the evaporator through a pipe from the tank. Because of tank pressure the liquid turns to vapors. Engine coolant is responsible for the heating of pressure regulator. Another work of regulator is a safety function as it includes electronic circuit that is used to cut down the supply of LPG if engine stops. When LPG is converted from liquid to vapors state then LPG vapor moves to the mixing unit where it is forwarded into the engine as a dry fuel mixture. The amount of LPG being consumed is controlled by a combination of converter and mixer adjustments.

The chemical reaction which take place in the engine during the burning of LPG is given below-

In case where sufficient oxygen is supplied or we can say that properly maintained engine

Propane $C_3H_3 + 5O_2 \longrightarrow 3O_2 + 4H_2O + Heat$

Butane $2C_4H_{10} + 13O_2 \longrightarrow 8CO_2 + 10H_2O + Heat$

In case where insufficient oxygen is supplied or we can say that improperly maintained engine

$2CH_3H_8 + 7O_2 \longrightarrow 2CO_2 + 2CO + 2C + 8H_2O + Heat$

$C_4H_4 + 4O_2 \longrightarrow CO_2 + CO + 2C + 2H_2O + Heat$

The energy emitted by burning of propane and butane are 50.34 MJ/Kg and 49.6 MJ/Kg.

6. Fabrication

The fabrication process takes the following steps:

Step 1
First of all we have installed the gas kit at the side of the bike. We have mounted it with the help of nut and bolt.

Step 2
The hosepipes are allowed to pass under the petrol tank chamber to the carburetor of the engine.

Step 3
We installed the gas kit nozzle on the top of the inlet manifold of the engine. This nozzle has two delivery valves, one of which is directly connected to the gas kit by which the gas is being supplied to the engine for burning the fuel and other hose pipes are connected to the gas kit as a returning valve, this will maintain the circulation of the gas inside the engine. Here the gas nozzle is fitted below the carburetor, because the gas has no connection with petrol.

Step 4
Now the most important step and vital job is to place the cylinder of LPG, due to high ignition temperature of LPG it become very risky to put the chamber near the engine. So, the cylinder was put away from the engine compartment.

Step 5
The cylinder was fitted on the iron angle at the side bike with the help of nuts and bolts.

Step 6
Dual fuel bike is ready. As shown in fig.

7. Result & Discussion

- **Calculation of Power and Mechanical Efficiency**

Diameter of piston (d) = 50 mm = 0.050 m
Length of piston (l) = 54 mm = 0.054 m
Area of piston(A) = $\pi * r^2 = 3.14*(0.050/2)^2 = 0.0019634\ m^2$
Torque for specific bike (T) = 10.2 N-m
Speed (N) = 6250 rpm
Number of cylinder (K) = 1
Indicated mean effective pressure (*imep*) = 13 bar = $13*10^5$ N/m^2
Break power (BP) = (2 *π*N*T)/(60*1000) KW
BP = (2*3.14*6250*10.2)/(60*1000)
Break power (BP) = 6.67 KW

Indicated power (IP) =(*imep**L*A*N*K)/(60*1000) KW
IP = $(13*10^5*0.054*0.0019634*6250*1)/\ (60*1000)$
Indicated power (IP) = 7.20 KW

Frictional Power Loss = Indicated power - Break power
Frictional Power Loss = 7.20 – 6.67
Frictional Power Loss = 0.53 KW

Mechanical efficiency = Break power/Indicated power
Mechanical efficiency = (6.67/7.20)*100
Mechanical efficiency = 92.63%

- **Calculation of Air Fuel Ratio (A/F Ratio)**

By chemical formula of petrol the required air fuel ratio for petrol engine is considered as 14:1, Similarly the air fuel ratio for LPG engine will be as –

LPG is mainly composed of propane (C_3H_8)

$$C_3H_8 + 5O_2 \longrightarrow 3O_2 + 4H_2O$$

Since,
(36+8) Kg of C_3H_8 needs 5*32 Kg of O_2
1 Kg of C_3H_8 needs 160/40 Kg of O_2 = 3.63 Kg of O_2
23% of O_2 is present in air by mass
3.63*(100/23) = 15:8

So,
Air Fuel Ratio = 15:8

- **Calculation of Mass Flow Rate and Thermal Efficiency**

In case of LPG
We have,
$m_f = C_d * A_f \sqrt{(2*\rho*\Delta p)}$
where,
C_d = coefficient of discharge
A_f = area of flow
(ρ) = density of fluid

The pressure inside the cylinder is generally calculated by the vapor pressure of the mixture so the vapor pressure of propane and butane are 1550 and 520 KPa. Therefore, the total vapor of the mixture will be equal as –

Total vapor pressure of a mixture = partial pressure of butane + partial pressure of propane
LPG contain 70% propane and 30% butane

So,
The pressure of LPG mixture = (0.7*1550) + (0.3*520)
=1241KPa

The pressure of LPG mixture = 12.41 bar
Assuming pressure of gas inside the throttle or the combustion chamber = 6 bar
$m_f = Cd*A_f\sqrt{(2*\rho*\Delta p)}$
$m_f = 0.09*7*10^{-6}\sqrt{2*2(12.41-6)}$
$m_f = 3.190*10^{-6}$ Kg/sec

Thermal efficiency = Break power / (Mass flow rate of LPG * calorific value of LPG)
Thermal efficiency = $6.67/(3.190*10^{-6}*46000)$
Thermal efficiency = 45.45 %

In case of petrol
Similarly, mass of petrol injected inside the throttle valve or inside the combustion chamber is taken as 1.436 Kg/hr or $4*10^{-4}$ kg/sec, when throttle is fully open.

Therefore,
Thermal efficiency = BP/(m_f * calorific value of petrol)
Thermal efficiency = $6.67/(4*10^{-6}*44500)$
Thermal efficiency = 37%

8. Conclusion

The original purpose of this project is to develop a duel fuel powered bike. This project is rejected due to its complexities which would make it very expensive to retrofit and in the end cause rejection of this system. The decision was made to develop a straight a straight LPG powered bike during the investigation, there were number of different elements identified which were needed to complete the conversion. These elements were the gas cylinder, the cylinder mount, the gas regulator, gas shut off valves, the gas line etc. After fabrication the gas cylinder mounts it was established that it would be very feasible to mount a gas cylinder away from the storage compartment. The gas cylinders are large enough to hold a combine volume of 3.4 liter s with 85% of their capacity. This would provide the operator of the vehicle with enough fuel to travel fairly conservatively around 80 km at a cost of 95 INR. In comparison to original bike setup which would travel a little more than 50 Km for the same price so it proves an excellent experiment for its cost saving and its lower impact on environment. When its compare to a small size medium 4-cylinder car which approximately 300INR for every 100 Km it makes the LPG bike a very cheap transportation in countries like India where there are a large number of registered bikes.

From the initial test, which was run without load on the motor, it looks promising for these gas cylinder to be quite capable of suppling a constant flow of vaporized gas. If this prove to be accurate the cost involved with producing a conversion kit would be lowered quite considerably because the cost of regulator is about half of a vaporizer. This saving may be neglected however if the addition of a decided gas/air mixer or carburetor solve the acceleration problems. A recommendation of this reports would be for a mixer to be tested in conjunction with the current regulator to see whether reliable acceleration of the bike could be achieved or if a different type of regulator is needed. If sustainable operation is achieved the bike should be put on a dynamometer and run under load whit the small barbecue bottle again to see whether it can last long for at least 20 minutes without showing signs of running out of vapor.

This would need to be done prior to the gas cylinder being made as it would be beneficial to have the bike running correctly before spending money setting up a test rig and making dies for passing the tori spherical ends. If it proves plausible that the bike can be successfully converted into LPG there is very high potential for a cross over to compressed natural gas once the infrastructure is in place to provide a convenient supply to the public. The other possibilities is for the operator to use a gas compressor to refuel a LPG cylinder in their garage at home making use of the gas pipe line running past their houses. Even if the cost of conversion exceeds half the cost of original bike, the benefits to the environment would easily make the extra price worthwhile, especially with a carbon tax likely to be incurred on all fossils fuel burning engines.

9. Future Aspect

- This concept can be used in cars and heavy lift vehicles like buses and trucks.
- Other fuel can also be used like CNG in place of LPG.

10. Acknowledgments

The authors thanks to the management and faculties of mechanical engineering department of Govt. polytechnic Dehradun, for their support for completion of this project.

References

[1] "Advance Internal Combustion Engine"- by Dr. S.Senthil.
[2] http://www.legco.gov.hk/yr97-98/english/sec/library/967rp05.pdf
[3] "Design of Machine Element"- by V.B. Bhandari.
[4] A textbook of Automobile Engineering- by R.K. Rajput
[5] www.wikipedia.com
[6] "Machine design"- by R.S. Khurmi
[7] A textbook of "I.C. Engine"- by V. Ganesan.
[8] www.google.com