



An International Journal of Advanced Computer Technology

ISSN:2320-0790

LPG as an Alternative fuel in Automobile: A comparative analysis

Ashish Sethiya

enggsethiya@gmail.com

Abstract: Often we use to say fuel prices are hiking, but instead of availability, we always hesitate to make use of alternate fuel cheaper than the conventional fuel. There are many alternate fuels which are having numerous of benefits in addition with cost effectiveness. Using alternate fuel in vehicles is a proven technology and is traditionally in use for past three decades in many developed as well as in developing countries. Internal combustion engines running on liquid petroleum gas (LPG) and natural gas are well-proven technologies and work much similar to gasoline-powered spark-ignition engines [1]. This paper focuses on the use of LPG as a fuel, its pose and con, its comparison with conventional fuel i.e. Petrol, and benefits in adopting LPG as a fuel in vehicles.

Keywords: Alternative fuel, LPG, Environment, Engine performance, Cost economy.

I. Introduction

Internal combustion engine running on Liquefied Petroleum gas are well proven technologies and work much similar to gasoline powered spark-ignition engine. Gasoline is a fuel obtained from fractional distillation of crude oil, the composition of which is paraffins (15% - 60%), naphthenes (30% - 60%), aromatics (3% to 30%), with asphaltics making up the remainder [2]. Conventional gasoline is mostly a blended mixture of more than 200 different hydrocarbon liquids ranging from those containing 4 carbon atoms to those containing 11 or 12 carbon atoms. It has an initial boiling point at atmospheric pressure of about 35 °C (95 °F) and a final boiling point of about 200 °C (395 °F) [3,4]. Presently around 85% of SI engine vehicles are using petrol as a fuel and hence we can see that, the alternative fuel is still not in use. On the other hand LPG like all fossil fuels, it is a non-renewable source of energy. It is extracted from crude oil and natural gas. The main composition of LPG is hydrocarbons containing three or four carbon atoms. The normal components of LPG thus, are propane (C₃H₈) and butane (C₄H₁₀). Small concentrations of other hydrocarbons may also be present. The first LPG cook stove was made in 1912, and the first LPG -fueled car was developed in 1913 [5]. Autogas is the third most popular automotive fuel in the world, with approximately 16

million of 600 million passenger cars powered using the fuel, representing less than 3% of the total market share. Approximately half of all autogas-fueled passenger vehicles are in the five largest markets i.e. Turkey, South Korea, Poland, Italy, and Australia [8].

II. LPG as a fuel

While referring table 2.1, it is noticeable that LPG has a lower calorific value than petrol i.e. it produces less total heat and therefore less peak pressure in the cylinder. LPG is slightly less potent as an internal combustion engine fuel. The driver will instinctively react to this by opening the throttle more to achieve the desired speed or rate of speed increase (often called acceleration). Thus, more LPG will be used than when running on petrol.

The actual increase in liquid volume consumed varies between 10 and 20%. A mean figure of 15% increase in fuel volume consumed is a good figure to rely upon. [6]

The top end of engine performance may be 'clipped' by a small amount, typically 5% (but not with every engine/gas system combination). In reality, no-one drives in the top-end range very often so this reduction is hardly significant. Also consider that

most cars converted to LPG have the largest engines (cc). Reduction of performance at the top end is least noticeable with a larger engine and so it becomes less of an issue. If this does become an issue at some point (**i.e. when towing**) remember that you always have the ability to revert to petrol at the flick of a switch. [6]

less tendency to knock as compared with conventional petrol fuel. Hence this makes the engine more durable and less wear-tear during operation, since knocking affects almost all the parts of engine like piston, spark plug, valves, connecting rod, crankshaft etc.

Table 2.1: Density & Calorific value of different fuels

| S. No. | Particulars | Density | Calorific Value |
|--------|-------------|--------------|-----------------|
| 1. | LPG | 0.54 Kg/lit | 49.6 MJ/Kg |
| 2. | Petrol | 0.741 Kg/lit | 44.15 MJ/Kg |
| 3. | Diesel | 0.837 Kg/Lit | 42.91 MJ/Kg |
| 4. | Kerosene | 0.807 Kg/Lit | 43.69 MJ/Kg |

Source: <http://www.claverton-energy.com>

Unlike petrol, LPG is in a pure gaseous state at normal atmospheric pressures and temperatures. It needs very little encouragement to vaporize and lends itself more readily to mixing with air (to get the Oxygen required for a combustible mixture). It needs no fuel pump to get it out of the tank and up to the engine, as the large pressure differential between the tank's interior and the atmosphere.

1. Combustion characteristics of LPG as a fuel & some parameters to check combustion quality.

Table 2.2: CO₂ emission from the source fuel

| S. No. | Source fuel | CO ₂ emission Kg per Litre |
|--------|-------------|---------------------------------------|
| 1. | Diesel | 2.640 |
| 2. | Petrol | 2.392 |
| 3. | LPG | 1.665 |

Table 2.3 : Octane number of fuels

| S. No. | Fuel | Octane number |
|--------|--------|---------------|
| 1. | LPG | 104-112 |
| 2. | Petrol | 87-92 |

Source: US department of energy, http://www.eere.energy.gov/basics/vehicles/propane_vehicles.html

Table 2.3 shows that the octane number of LPG is comparable with the gasoline. That means LPG has



Figure 2.1: Piston & Spark Plug damage due to knocking in Engine

III. An Overview of Indian Automotive LPG Market

Globally, LPG is used as a fuel in More than 13 million vehicles, supported by around 52,000 LPG filling station. Global Auto LPG consumption exceeds 20 Million Tonnes, in comparison to India still at about 0.3 Million Tonnes level.

Use of LPG as an auto fuel in India was permitted in year 2000 through an amendment in the motor vehicles act, by Ministry of Road Transport and Highways. Now, Auto LPG is available in more than 350 Cities with a network of around 900 Stations across the country, which makes it the most widely available alternate fuel. This has encouraged an increasing number of vehicle owners to convert to Auto LPG, an economical & environment friendly fuel, paving way for India to become one of the leading Auto LPG markets of the world in the next few years [9].

Most of the leading vehicle manufacturers of the country now offer Factory Fitted LPG Variants. Maruti, Hyundai Motors, Tata Motors, General Motors etc. have launched their best selling models in LPG Variants. Some of the popular OE offered LPG vehicles are Maruti Wagon R, Hyundai Accent LPG, Santro, General Motors Spark, Tata Motors Xeta and Maruti Omni and 800 cc [9].

IV. Comparison of LPG with other fuels

LPG has several advantages and limitations when compared to fuels like petrol and diesel. This paper gives an overview of comparison of LPG with petrol and diesel in following aspects:

- environmental impact;
- efficiency and performance;
- safety; and
- cost.

1. Environmental Impact

LPG is cleaner than petrol and diesel because it is composed of predominantly simple hydrocarbon compounds. LPG is free of lead and most additives and contains very little sulphur as the octane rating of LPG is higher than petrol hence no need to add additives. Compared with emissions from vehicles on petrol and diesel, emissions from LPG-driven vehicles contain lower levels of hydrocarbon compounds (HC), nitrogen oxides (NOx), sulphur oxides, air toxics, and particulates [10]:

| S. No. | Exhaust Components | LPG | Petrol | Diesel |
|--------|--------------------|-----|--------|--------|
|--------|--------------------|-----|--------|--------|

| | | | | |
|-----|-----------------|------|---|---|
| 1. | CO | Base | - | 0 |
| 2. | HC | Base | - | 0 |
| 3. | NO _x | Base | - | - |
| 4. | Particulates | Base | 0 | - |
| 5. | NO ₂ | Base | - | - |
| 6. | SO ₂ | Base | - | - |
| 7. | Benzene | Base | - | 0 |
| 8. | 1,3 Butadiene | Base | - | - |
| 9. | Formaldehyde | Base | - | - |
| 10. | Summer Smog | Base | - | - |
| 11. | Winter Smog | Base | 0 | - |
| 12. | Acidification | Base | - | - |

Sources

- Netherlands Agency for Energy and the Environment
- TNO Road Research Institute
- United States Environmental Protection Agency
- A Study On LPG As a Fuel For Vehicles Research and Library Services Division Legislative Council Secretariat, Hong Kong by: Miss Eva LIU et. al.

Remarks :

- + represents better than LPG
- 0 represents more or less equal to LPG
- represents worse than LPG

With the above analysis, it is clear that LPG emission as compared with the petrol and diesel reduces to a great extent. Hence use of LPG as a fuel for automobile helps in reducing emissions.

Measures Taken

Auto emissions account for over 60% of the city’s air pollution and close to 50% of the city’s residents suffer from major respiratory disorders. In Kolkata, Carcinogenic benzene levels in 2006-07, were found to be as high as 36 ug/cum, much higher than Delhi, which has a larger vehicle population. This is against an average limit of 5 ug/cum, specified by the National Draft Ambient Air Standard. Due to this, Kolkata High Court order mandates all 15 year old public vehicles to be replaced. Out of 32,000 auto rickshaws plying on the streets of Kolkata and its suburbs, 4000 have converted to LPG.

2. Efficiency and Performance

Efficiency of LPG is similar to that of petrol engine, however, both the LPG & Petrol engines are not as efficient as diesel engine as the CR is at much higher side.

Million dollar question, wheather LPG hurt my engine?

In fact being on the light end of the hydrocarbon scale, there is almost no carbon in LPG. Due to this, oil will stay cleaner saving time, money, oil and oil filters.

- LPG enter into engine directly in a vapor form, & there is no "raw" fuel entering the cylinders which washes the lubricating oil off the cylinder walls so the piston rings stay better lubricated resulting in many LPG and LNG fueled engines lasting up to Two times longer than the same engine on gasoline.
- LPG and CNG cause no problems with valves in any engine designed to run on unleaded fuel.

3. Safety

LPG tends to be more flammable than both petrol and diesel because it has a wider flammability limit. Flammability limit of a fuel is a range of percentages within which the fuel would burn in air while outside the range, the fuel would not burn. The percentage is the ratio between the volumes of the fuel (in gaseous state) to the volume of air in a given area. A fuel with a wide flammability limit burns more readily than a fuel with narrow limit.

There is no conclusive evidence to show that LPG is more dangerous or less dangerous than petrol or diesel. Human factor plays an important role in affecting the safety in using LPG. For example, Japan have not experienced any explosion or serious accidents in the past 30 years since it introduced various safety measures regulating the use of LPG. A study in Canada showed that human error was the major cause of accidents involving LPG vehicles [10].

Following points to be considered for the safe driving with LPG

- Don't allow any work on an LPG vehicle, which could affect the fuel system, before

you have identified the risks and precautions to be taken.

- Don't attempt roadside repairs unless you are trained and approved equipment is available.

V. Reference:

- [1] Dipl.-Ing (FH) Horst Bauer, ed. (1996). Automotive Handbook (4th ed.). Stuttgart: Robert Bosch GmbH. ISBN 0837603331
- [2] <http://www.petroleum.co.uk/composition>
- [3] Gasoline FAQ - Part2 of 4, Bruce Hamilton, Industrial Research Ltd. (IRL), a Crown Research Institute of New Zealand.
- [4] Gary, J.H. and Handwerk, G.E. (2001). Petroleum Refining Technology and Economics, 4th Edition. Marcel Dekker, Inc.. ISBN 0-8247-0482-7.
- [5] http://edugreen.teri.res.in/explore/n_renew/lpg.htm
- [6] <http://www.go-lpg.co.uk/diffperf.html>
- [7] <http://www.claverton-energy.com>
- [8] Kakar, Sunil. "A Global Way Forward: Creating a Sustainable Growing Autogas Market". World LP Gas Association. Retrieved 27 September 2011.
- [9] Indian Auto LPG Coalition, <http://www.iac.org.in/auto-lpg-in-india>
- [10] A Study On LPG As a Fuel For Vehicles Research and Library Services Division Legislative Council Secretariat, Hong Kong by: Miss Eva LIU et. al.