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Performance and Emission Characteristics of Multi Cylinder Petrol Engine using LPG With Methanol

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Abstract: **-- The most promising alternative fuel will have the greatest impact on future society. The rapid growth of environmental pollution, energy security and future fuel supply, the non petroleum based alternative fuels are used to increase the efficiency of the fuel and impact on green house gases. LPG is a mixture of petroleum and natural gases that exist in a liquid state at ambient temperatures under moderate pressure (less than 200 psi). LPG has a high Octane rating, which indicates that the engine operated by LPG would be more efficient than that of equivalent petrol engine. LPG has been used as an alternative fuel in the existing S.I. engine with slight modification in the fuel supply system. The vaporizer is required to convert the liquid fuel into vapour supplied to the carburettor. The working of the experimental setup is four cylinders, four stroke petrol engine with the solenoid actuator. The actuator allows LPG to the carburetor through the vaporizer kit. LPG is metered by hanging type weighing scale. Methanol is added with LPG by volume under gravity before vaporizer kit. Engine hot water heats up the vaporizer kit for raise in temperature of LPG and to evaporate the methanol easily. The petrol engine is started with LPG and then it is run by a mixture of LPG and methanol by adjusting the LPG flow. The performance and emission characteristics of engine are investigated by varying the quantity of methanol and LPG. The thermal and mechanical efficiencies are increased with addition of methanol and the specific fuel consumption is decreased. The emission characteristics like CO, CO2, HC and NOx are also reduced**

Keywords**: LPG, methanol, vaporizer kit, S.I. Engine, performance, emission.**

1. INTRODUCTION

Since the fossil fuel reserves are going to be exhausted in the nearby future, and the warning of global warming results due to the increasing concentration of carbon dioxide and NOx in the atmosphere. Fossil fuels are consumed in increased trend due to increased transportation. Methanol is considered to be an alternate fuel. It is made from syngas and destructive distillation of wood wastes. Fuel properties of methanol are density at 20°C is 0.792 kg/l with boiling point of 64.5°C. Its self-ignition temperature is 464°C and research/motor octane numbers are 112/92 which is higher than petrol.

A brief survey of the statistics of LPG usage in a worldwide is conducted up to 1979. They present a reasonable picture but estimated projections up to the mid-1980s and forecasted the world economic situation at that time [1].We can identify some alternatives which might under certain conditions and assumptions be more attractive than base line engines. We should have R&D programs to define the attributes of those promising alternatives more precisely [9]. If alcohol is available on a sustainable basis at the right price, likely that engines would quickly available to use them [16] .Unburned methanol emissions have low photo chemical reactivity. CNG and LPG seem to have little advantage of cleaner

exhaust than gasoline; both should be encouraged since they can reduce our dependence on OPEC to some extent [3].The emissions of CO, CO2 and NOx are considerably lower than gasoline at increasing speeds.

Significant reductions in CO, CO2 and NOx emissions were obtained when methanol was used instead of gasoline in SI engines. In addition, substantial increase in engine power and brake thermal efficiency also could be acquired if engines with low compression ratios could be run at higher compression ratios [13]. Alternative fuels, almost all have properties which are similar to those of existing types of fuels, and therefore the technology required to handle them is already well known. With the use of LPG, specific fuel consumption and CO emissions were much lower without noticeable power loss while HC emissions are shown to be little affected by fuel substitution. In contrast, NOx emissions were higher, but

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could be kept below current and future emission limits [14]. LPG is at least as clean burning as gasoline [11]. Ethanol, methanol, DEE, DME, and their blends have highly attractive clean-burning characteristics, and are considered potential transportation fuel alternatives for both gasoline and diesel fuel-powered motor vehicles [4]. The addition of methanol to gasoline increases the octane number, thus engines fuelled with methanol-gasoline blend can operate at higher compression ratios [10, 11].Engine performance parameters such as effective power and efficiency increase with increasing ethanol amount also in the blended fuel as a result of improved combustion. Ethanol addition to gasoline leads to leaner operation and improves combustion. Consequently, cylinder pressure and temperature increases and combustion duration decreases [6]. The brake specific fuel consumption has registered variations from a reduction of about 6% to an increase of about 3% at low speed and from a reduction of about 6% to an increase of about 8% at high speed relative to the original engine design and for all stroke lengths and engine speeds studied on LPG powered four stroke SI engine under variable stroke length and compression ratio [8]. Simultaneous use of different additives is less efficient as compared to their individual introduction and additives demonstrate high antiknock efficiency, providing higher octane number [2].

Using LPG in SI engines, the burning rate of fuel is increased, and thus, the combustion duration is decreased. As a consequence of this, the cylinder pressures and temperatures predicted for LPG are higher than those obtained for gasoline [7].LPG will become available in increasing quantities and the extra volumes will be used primarily for automotive fuels and chemical plant feedstock. The automotive sector should be able to secure priority by bidding higher prices [5]. LPG decreases the cyclic variations and emissions, and it is a more suitable fuel for lean combustion engine when compared with gasoline. It can be deduced that the increase in the relative air–fuel ratio increases the coefficient of variations in IMEP [12]. It is concluded that methanol addition of 0.5 ml/min. with LPG shows optimum characteristics [15]. Hence a challenging solution to the problems of oil depletion and increased atmospheric pollution is to switch over to alternative fuels with additives. Here the use of LPG as fuel mixed with methanol additive in multi cylinder gasoline engine and the influence on performance and pollution parameters are analysed.

II. EXPERIMENTAL SET UP

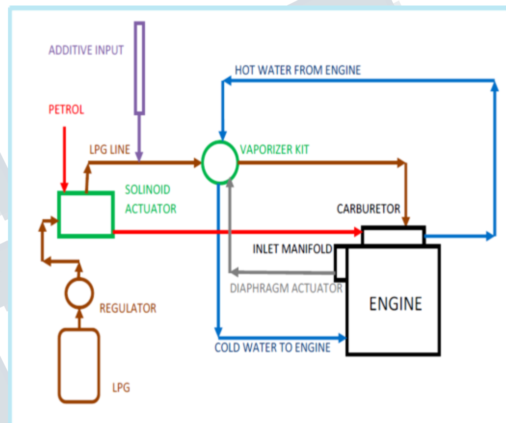

Fig.1 Layout of Experimental Setup

Fig.2 Photo of Experimental Setup

Table.1 Engine Specifications

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S. No	Description	Details
1	Cylinder configuration	Inline
2	Engine type/Model	4 stroke cycle water cooled
3	Engine displacement	1489 cc
4	Bore & stroke	73.2x 88.9 mm
5	Fuel type	Petrol
6	No of cylinders	4
7	Valves per cylinder	2
8	Max Power	37 Kw@4200 rpm

2.1 Experimental procedure:

Methanol is taken along with LPG due to density difference and by gravity before the vaporizer kit and metered by volume. The solenoid actuator switch allows either LPG to vaporizer kit and then to carburetor or petrol directly to the carburetor. LPG is metered by hanging type weighing scale, because of temperature difference between LPG and atmosphere is avoiding water droplet stagnation on LPG cylinder. Vaporizer kit have the connections of engine hot water as inlet and cold water as outlet to the engine, and LPG in and out and vacuum from inlet manifold to control LPG flow by diaphragm. [Fig. 1]. Engine started with LPG and adjusted the LPG flow to add methanol. The objective is to analyze performance and emission parameters and to investigate the optimum performance with methanol quantity varied with LPG.

III. RESULTS AND DISCUSSIONS:

The operational characteristics of the petrol engine run with LPG and additives were analyzed . The experimental results obtained were discussed in this paper.

3.1 Brake thermal efficiency:

The variation in brake thermal efficiency with Brake Power [fig.3]. The brake thermal efficiency is high for the methanol addition at 0.8 ml/min. and low at 0.667 ml/min. The other 2.0 ml/min and 1.0 ml/min addition also increases brake thermal efficiency but less when comparing with 0.8 ml/min and 0.667 ml/min additions. The brake thermal efficiency increases with LPG alone (Meth.0ml/min) as fuel which is less than other methonal additions .The brake thermal efficiency increases with methonal addition due to increase in evoporation rate which results in better combustion of fuel mixture.

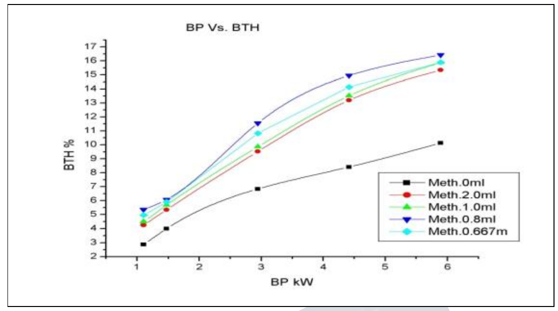

Fig.3 Variation of Brake Thermal efficiency with BP

3.2Specific fuel consumption:

The specific fuel consumption is high at minimum Brake Power for all blends of methanol and LPG alone. Specific fuel consumption is more for LPG alone without methonol addition and reduces with further increase in Brake Power and observed low values for both 0.8 ml/min. and. 0.667 ml/min compared with other rate of 2.0 ml/min and 1.0 ml/min methonal additions. The specific fuel consumption is found to be comparatively high for LPG without methanol (Meth.0ml) and reduces with addition of methonal quantity, being the reason that methonal addition slightly improves diffusion of fuel air mixture to have improved combustion efficiency . Further decreasing the rate of methonol addition further reduces specific fuel consumption . The specific fuel consumption is comparitively low for 0.8ml/min methanol addition than other quantity addition. The variation in specific fuel consumption with Brake Power is shown in [fig.4]

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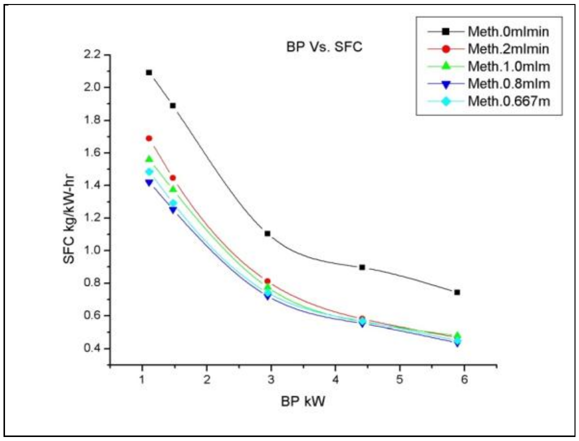

Fig.4 Variation of Specific fuel consumption with BP

3.2 CO Emission:

The variation in carbon monoxide emission with Brake Power [fig.5] indicates that the carbon monoxide emission with various brake power for LPG with different rate of methanol additions is found to be low for 0.667 ml/min and 0.8 ml/min. and high for 1 ml/min and intermediate value for 2.00 ml/min. For all ml/min additions of methanol except 0.667 ml/min and 0.8 ml/min, carbon monoxide emission increases with brake power. Carbon monoxide emission for LPG alone is observed as intermediate with 2.00 ml/min and 0.8 ml/min. methanol additions.

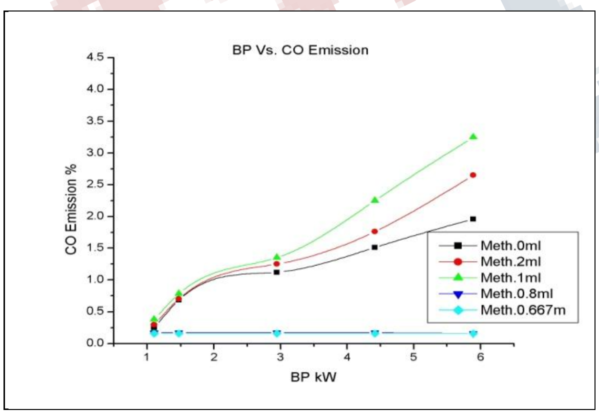

Fig.5 Variation of Carbon Monoxide levels with BP

3.4 CO_2 Emissions:

The variation in carbon dioxide emission with Brake Power is shown in [fig.6]. Carbon dioxide emissions are found to be less for addition of methanol 0.667ml/min and 0.8 ml/min and high for LPG fuel alone (Meth.0ml) and show intermediate results for 2.0 ml/min and 1.0 ml/min. addition of methanol. For all ml/min additions methanol indicates carbon dioxide level increases with load. Evaporative losses are comparatively low at lower additions of methanol can improve the combustion.

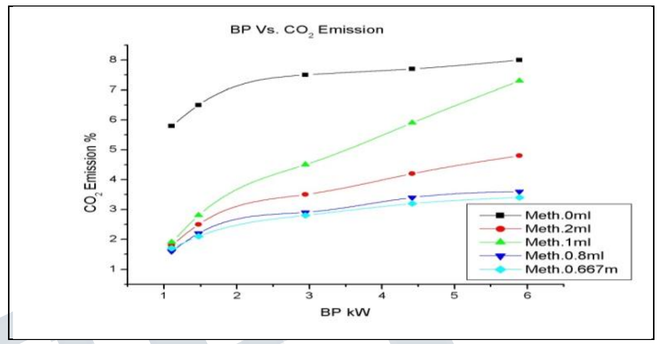

Fig.6. Variation of Carbon Dioxide levels with BP

3.5 HC Emission:

The variation in Hydro carbon emission with Brake Power is shown in [fig.7]. Hydro carbon emission is at base line values for LPG alone (Meth.0ml/min addition). Hydro carbon emissions were found reduced with increase in brake power for all rate of methanol addition. For 0.667 ml/min and for 0.8 ml/min additions gives optimum values compare with other rate of additions. For decrease in methanol ml/min additions, the hydro carbon emission decreases with brake power. The dilution of air fuel mixture due to increase in methanol addition be the cause for hydro carbon emission.

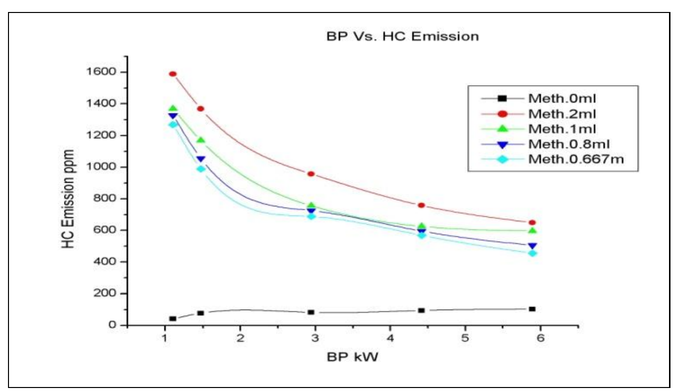

Fig.7 Variation of Hydro Carbon levels with BP

3.6 NO_X emission:

The variation in nitrous oxide emission with brake power is shown in [fig.8]. The nitrous oxide emission is very low for methanol addition of 1 ml/min.,0.8 ml/min. and 0.667 ml/min. This may be due to the engine running at lower peak temperatures even with increase in brake power. The level is increasing for LPG alone (Meth.0ml) without methonal addition with increase in brake power. For 2 ml/min methanol addition the nitrous oxide emission is decreasing with increase in brake power.

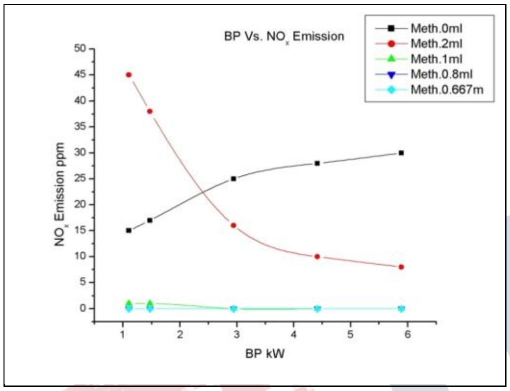

Fig.8 Variation of Nitrous Oxide levels with BP

IV. CONCLUSIONS

It is concluded that the performance characteristics of petrol engine operated with LPG and methonal, the brake thermal efficiency is high for methanol addition of 0.8 ml/min and 0.667ml/min. The specific fuel consumption is decreased with increase in brake power for all rate of methonal addition and is low for 0.8 and 0.667 ml/min. In the overall investigation the performance and emission parameters for addition of methanol flow rate with respect to increase in brake power are increases brake thermal efficiency and decreases the specific fuel consumption. For LPG with methanol addition of 0.667 ml/min and 0.8 ml/min emissions is low comparing with other flow rate of methanol and LPG without methanol. The methanol addition of 0.8 ml/min. with LPG gives optimum characteristics both in performance and emission parameters. The methanol in liquid phase at atmospheric pressure with LPG in gaseous state is difficult and complex process. Hence methanol is added by decreasing the LPG intake pressure by adjusting the flow rate of intake manifold higher than the intake suction pressure of LPG. From the investigation, it is confirmed that the LPG could be used as an alternative fuel in a petrol engine with methonal additive at constant flow rate.

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