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Estimating the Performance of a 4-Stroke Si Engine Blending Shale Gas with LPG

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Abstract- In today's world due to the depletions of fossil fuels day by day leads us to search for the new fuels which will full fill our needs to run our IC engines. The main focus of this work is to use shale gas as a fuel by blending of shale gas with the LPG gas running vehicles at various proportions to test its performance characteristics.

In North America Natural gas production from the shale gas reserves is now proven to be feasible from numerous operations but many challenges still remain in the full exploitation of these unconventional reservoirs. Production from shale gas reservoirs requires stimulation by hydraulic fracturing due to extremely low permeability of the reservoir rocks.

Keywords- Shale gas, petrol Engines, Engine Performance, BSFC – Brake specific fuel consumption, UHC- Unburned hydro carbons, CO – Carbon monoxide, NOX emissions.

I. INTRODUCTION

Natural gas production from oil and gas bearing organic-rich mudstone formations known as "shale gas," is a rapidly expanding trend in onshore oil and gas exploration and production today, even though so far shale gas production has been started only in the U.S. In some areas, this has included bringing drilling and production to regions of the country that have seen little or no activity in the past. New oil and gas developments bring change to the environmental and socio-economic landscape, particularly in those areas where gas development is a new activity. With these changes have come questions about the nature of shale gas development, the potential environmental impacts, and the ability of the current regulatory structure to deal with this development. Regulators, policy makers, and the public need an objective source of information on which to base answers to these questions and decisions about how to manage the challenges that may accompany shale gas development.

Three factors during the last decade have made shale gas production economically viable.

1) Advances in horizontal drilling,

2) Advances in hydraulic fracturing,

3) Rapid increases in natural gas prices in the last years as a result of significant supply and demand pressures.

- **Shale** is a common form of fine-grained sedimentary rock laid down as mud in relatively calm seas or lakes.
- **Black shale** is shale that was laid down in especially anoxic conditions on the floors of stagnant seas and is rich in organic compounds derived from bacterial, plant and animal matter.
- **Conventional gas** is gas that has migrated, usually from shale, to permeable reservoirs, predominantly sandstone.
- **Shale gas** is gas that remains tightly trapped in shale and consists chiefly of methane, but with ethane, propane, butane and other organic compounds mixed in. It forms when black shale has been subjected to heat and pressure over millions of years, usually at depths of 5,000-15,000 feet.
- **Coal-bed methane** is gas trapped in coal seams that can be tapped by similar methods to those used for shale gas.
- **Tight sand gas** is gas held in sandstone reservoirs that are unusually impermeable; it can be extracted by fracturing the rock.

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A. WHAT IS A SHALE GAS?

- Shale gas is natural gas, no different than what you currently use to heat your home, cook with, or use to generate electricity.
- Shale gas is naturally trapped within very fine grained sedimentary rocks called shale or mudstone. Millions of years ago, the mud and silt that was deposited in ancient oceans and lakes often contained plant and animal debris. Over time these sediments containing this organic material were compacted and solidified through burial, and with increasing temperature and pressure formed shale and mudstone.
- This organic material, through decomposition due to pressure and temperature, generated oil and gas, which in many cases migrated into other rock types such as sandstone and limestone to form conventional oil and gas reservoirs.
- The natural gas that is retained within the shale is referred to as Shale gas. It is this hydrocarbon that we are now able to successfully extract.

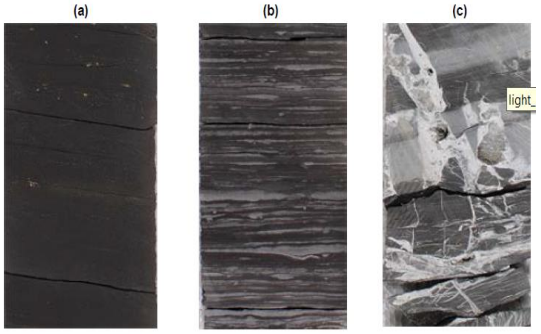

Fig: 1. Shale rocks

B. Shale gas resources and reserves

A surge in oil and gas production from shale rock has transformed energy in the United States, helping reverse declines in oil production and prompting a massive shift from coal to natural gas electricity production that has led to a drop in carbon dioxide emissions (since burning coal releases more carbon dioxide than burning natural gas). A new report (EIA, 10 June 2013) from the U.S. Energy Information Administration lends support to the idea that a similar transformation could take place outside the United States (Bullis, 10 June 2013). Figure is a map from that report, showing global shale gas and oil resources. The map gives a sense of just how wide-spread shale gas and oil resources are. Three countries have more shale gas than the United States: China, Argentina, and Algeria.

Figure shows a map of shale gas plays in the U.S. showing the geographically widespread nature of global shale gas resources. While other countries may have more of these resources than the United States, the impact in some of them may not be as great, or happen as quickly. It could take many years to develop resources in other countries because the geology is somewhat different: the techniques that work in the United States might not work elsewhere. What's more, many countries don't have the needed technological expertise.

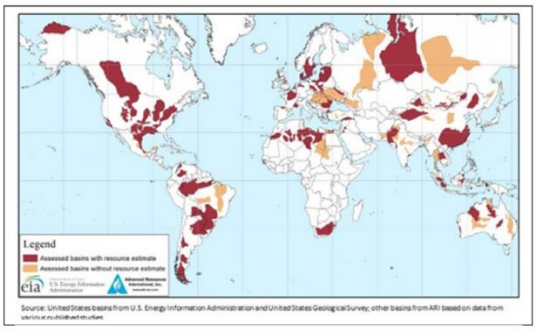

Fig: 2. Assessed shale oil and shale gas formations

C. SHALE GAS COMPOSITION

The gas in the shale formation is likely to be a variable mixture of: methane and other gaseous hydrocarbons; acidic gases (CO2, sulphurous compounds); inert gases (including nitrogen); water vapour; condensed higher hydrocarbons; and entrained particles. Table shows how the gas composition varies between formations as well as between wells in the same formation, in several U.S. shale formations.

Raw shale gas composition as a percentage by volume

	Bar-nett	Marcel-lus	Fayette-ville	New Albany	Antrim	Haynes ville	Mean
Methane (%)	87	85	97	90	62	95	86
Ethane (%)	7	11	1	1	4	0	4
Propane (%)	2	3	0	1	1	0	1
CO_2 (%)	2	0	1	8	4	5	3
N_2 (%)	3	0	1	-	29	0	7

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II. METHODOLOGY

This experimental performance requires auxiliary instruments to support this test. Since there was an implementation of gas injection in the system, additional measures were taken to adhere to those practices. Few of the basic modifications that were done on the SI engine were:

1. Fabrication of frame for performance testing
2. Fitting of nozzle on intake manifold
3. Using of solenoid valve for flow control technique.
4. Implementation of gas kit.

A. Engine specifications

Displacement	92.2cc
Bore*Stroke	50 mm*56.9 mm
Power	7.4bhp (5.4kw)
Torque	7.85Nm
Engine type	Bajaj
Cooling system	Air cooled
Rpm	5800
Stroke	4T
No of cylinder	Single

B. Test Engine and Fuel Properties

The Experiments were taken out on a naturally aspirated, water cooled, single cylinder, direct injection petrol engine. The Engine specifications are shown Table Properties.

Properties	petrol	LPG	Shale gas	B20
Density (Kg/M^3)	716	495	430	425-448
Calorific Value (KJ/Kg)	47100	46100	40455	42100
Octane Number	80-100	135	110	115

C. Engine Equipment

1. Fabrication of frame for performance testing

The frame is made for the performance testing of engine for this angle section bars were welded and engine was mounted inclined angle bars were welded for installing the spring balance and load test arrangement. The nozzle along with the solenoid operated injection setup was casted at the intake manifold. By doing this the fuel will directly open up into the intake manifold and hence will result in superior output.

The nozzle was fitted by drilling on top of the carburetor. The solenoid valve installed basically works in the flow processing. It also regulates the flow control, and it receives signals from the engine where it fluctuates its inlet and outlet valve. A gas kit comprising LPG gas cylinder, vaporizer, regulator, solenoid valve where successfully installed into the experimental process which yielded proper result. Elaboration about vapouriser, solenoid valve and regulator. Vaporiser or Converter name stand for device which convert liquid state of fuel into gas or vapour. Sometime it is called reducer also as it reduce pressure of high pressurized liquid state fuel so it convert into gas or vapour. This product is a kind of stop valve mainly used on vehicle LPG gas pipeline.

When the vehicle consumes LPG, this valve will open automatically in order to ensure that gas flow smoothly and satisfy the LPG combustion need of the vehicle and has a built-in filter to remove impurity from the LPG. A solenoid valve has two main parts: the solenoid and the valve. The solenoid converts electrical energy into mechanical energy which, in turn, opens or closes the valve mechanically .It regulates the pressure of the gas. LPG stored in the cylinder at 200 bar and in liquefied state hence solenoid helps in regulating the pressure and bringing down the at around 1.5 bar

2. Fitting of nozzle on intake manifold

The nozzle along with the solenoid operated injection setup was casted at the intake manifold. By doing this the fuel will directly open up into the intake manifold and hence will result in superior output. The nozzle was fitted by drilling on top of the carburetor.

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3. Using of solenoid valve for flow control technique

The solenoid valve installed basically works in the flow processing. It also regulates the flow control, and it receives signals from the engine where it fluctuates its inlet and outlet valve.

4. Implementation of gas kit

A gas kit comprising LPG gas cylinder, vapouriser, regulator, solenoid valve where successfully installed into the experimental process which yielded proper result. Elaboration about vapouriser, solenoid valve and regulator.

5. Vaporizer

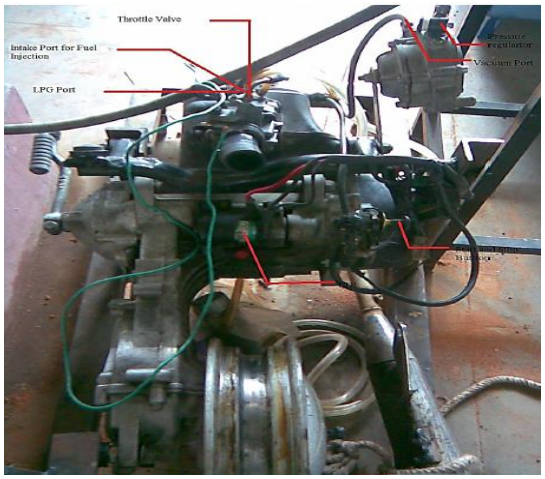
Vaporizers or Converter name stand for device which convert liquid state of fuel into gas or vapour. Sometime it is called reducer also as it reduce pressure of high pressurized liquid state fuel so it convert into gas or vapour. Vaporizer consists of main body of metal by pressure die casting process subsequently followed by vacuum impregnation, shot blasting & hard anodizing process. For pressure drop & maintaining continuous flow requirement generally done either in 3 or 2 stages with the help of diaphragms & lever arrangement set in the main body. Quantity & quality of fuel flow is depending on port diameter of fine precision jet & the volume enclosed by diaphragms. Here jet seat machining, matching rubber pad of high quality long life material & appropriate designed diaphragms control the vaporizers performance.

6. Solenoid Valve

This product is a kind of stop valve mainly used on vehicle LPG gas pipeline. When the vehicle consumes LPG, this valve will open automatically in order to ensure that gas flow smoothly and satisfy the LPG combustion need of the vehicle and has a built-in filter to remove impurity from the LPG.A solenoid valve has two main parts: the solenoid and the valve. The solenoid converts electrical energy into mechanical energy which, in turn, opens or closes the valve mechanically. A direct acting valve has only a small flow circuit. This diaphragm piloted valve multiplies this small flow by using it to control the flow through a much larger orifice.

7. Pressure Regulator

It regulates the pressure of the gas. LPG stored in the cylinder at 200 bar and in liquefied state hence solenoid helps in regulating the pressure and bringing down to around 1.5 bar.



Precautions:

1. Give the necessary electrical connections to the panel and also check the level of lubricating oil in the engine.
2. Check the fuel level in the tank.

Procedure of Experiment

1. Allow the water to flow to the engine and calorimeter and adjust the flow rate to 6lpm & 3lpm.
2. Release the load if any on the dynamometer.
3. Open the three-way cock so that fuel can flow in to the engine.
4. Start the engine by cranking.
5. Allow to attain the study state.
6. Load the engine by switching on the loading switches.
7. Note the following readings for particular condition.

a. Engine speed
b. Time taken for 20cc of fuel consumption
c. Rotameter reading

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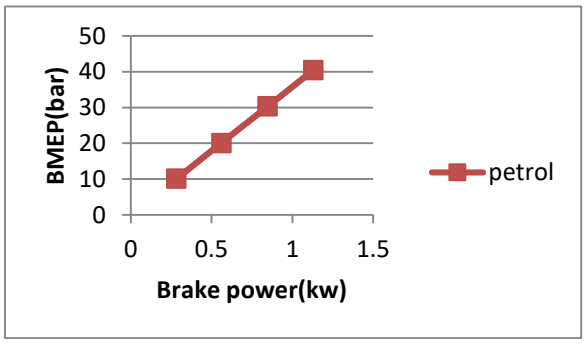
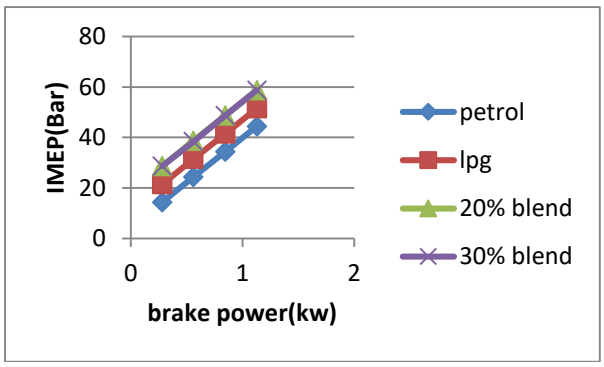
d. Manometer readings, in cm of water
e. Temperatures at different locations
f. Readings of Voltmeter and Ammeter
g. Note pollution values from the pollution setup i.e., multi gas analyzer system
8. After the completion, release the load and then switch of the engine.
9. Allow the water to flow for few minutes and then turn it off.

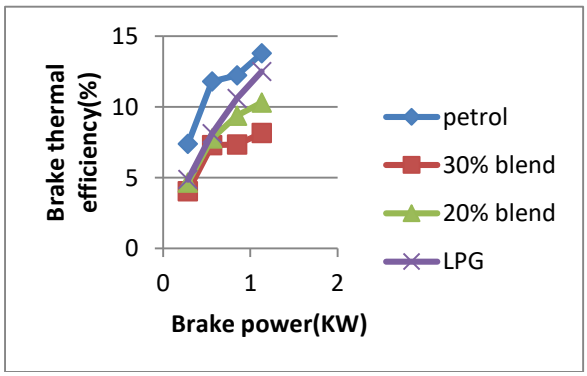
III. RESULTS AND DISCUSSIONS

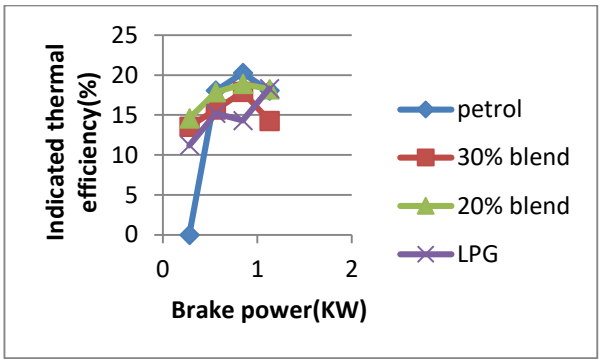
Experimental investigation is performed on diesel engine by varying injection pressure of fuel visually 180,190 and 200 bars. The results are discussed below.

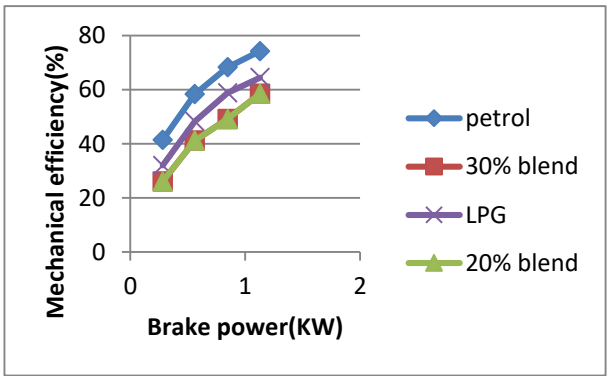
A. Effect on engine performance

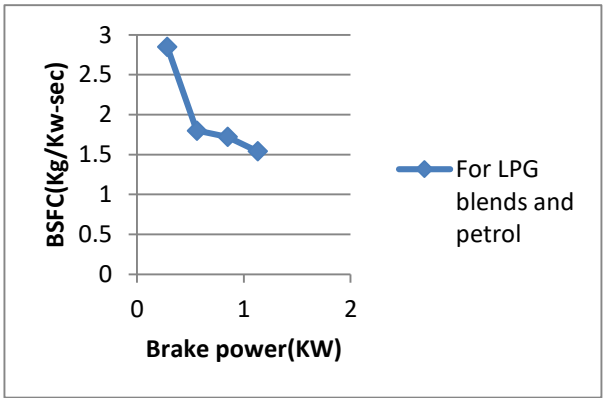




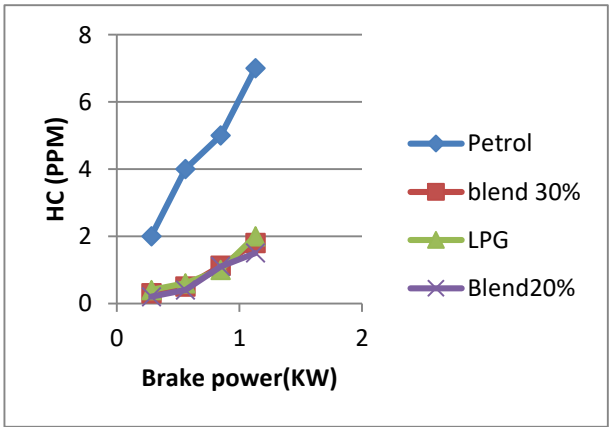








Emission Results



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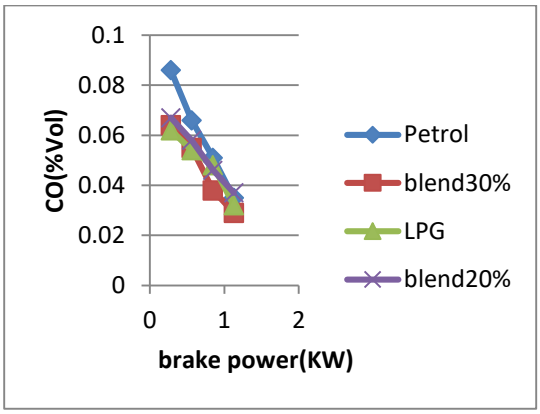

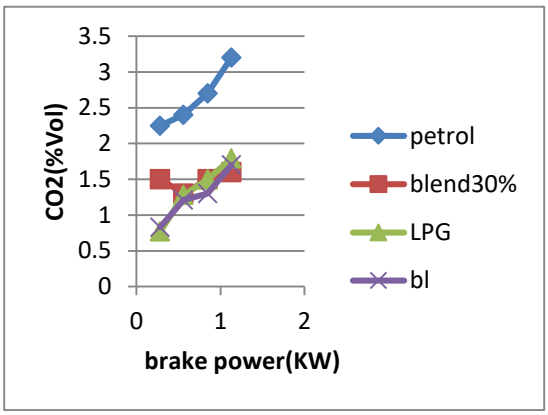

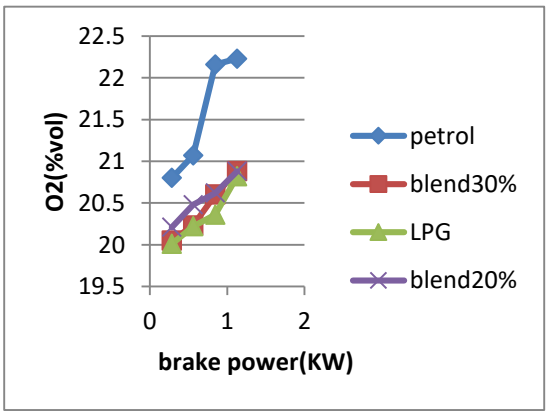

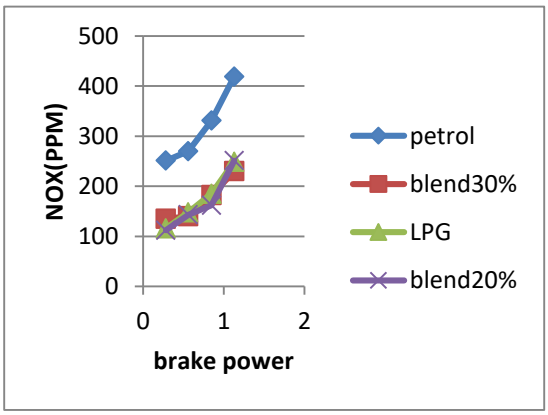

IV. CONCLUSION

Although there are some difficulties in its production but its properties makes it as an excellent alternate fuel in now a day's automobiles

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