Performance analysis of single cylinder four strokeSI engine using dual fuel: acetylene and ethanol blend

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Abstract -**The search for an alternative fuel is one of the needs for sustainable development, energy conservation, efficiency, management and environmental preservation. Therefore, any attempt to reduce the consumption of petrol and diesel possible alternative fuels is mostly preferable. Acetylene is one of the tested fuels. It is well known that acetylene is a high flammable and explosive compound. In comparison with commercial liquid fuels, very wide flammability limits and a low Octane Number have relegated the acetylene into the "Iperdetonat" fuels category. The present project includes acetylene and Ethanol blend fuel avoiding knocking for an internal combustion engine. The project investigates working of IC engine on acetylene and Ethanol blend fuel with minor fuel supply system changes. For measuring performance parameter E20 Ethanol blend and Acetylene with 1L/min flow rate were used as a fuel. Results concludes 6% increasing in thermal efficiency. However brake specific fuel consumption increases and volumetric efficiency found to be on decreasing side.**

IndexTerms–**Spark Ignition Engine, DTS-I, Acetylene, Ethanol Blend.**

I. INTRODUCTION

In the present context, the world is facing difficulties with the crisis of fossil fuel depletion and environmental degradation. Conventional hydrocarbon fuels used by internal combustion engines, which continue to dominate many fields like transportation, agriculture, and power generation leads to pollutants like HC (hydrocarbons), So_x (Sulphur oxides), and particulates which are highly harmful to human health. CO2 from Greenhouse gas increases global warming. Promising alternate fuels for internal combustion engines are natural gas, liquefied petroleum gas (LPG), hydrogen, acetylene, producer gas, alcohols, and vegetable oils. Among these fuels, there has been a considerable effort in the world to develop and introduce alternative gaseous fuels to replace conventional fuel by partial replacement or by total replacement. Many of the gaseous fuels can be obtained from renewable sources. They have a high self-ignition temperature; and hence are excellent spark ignition engine fuels.

At the early stage of the Internal Combustion Engines (ICE) development, many fuels were used to feed the engines. Nowadays, two main fuels are normally used for transport systems, gasoline and Diesel, while natural gas is the main fuel in firing power plants. Several research activities were developed in order to study the possibility to feed Internal Combustion Engines with alternative fuels. Acetylene is one of the tested fuels. This fuel has a wide flammability limits and a lower Octane Number in comparison with commercial liquid fuels. Thus, it is necessary to control detonation phenomenon using

P K Sharma andHariharKuinkel, [1]explained the use of acetylene as an alternative fuel in internal combustion engine. They conducted experiments on SI engine using acetylene as the primary and alcohol as the secondary fuel. Results showed that alcohol to be introduced so as to reduce the temperature inside the combustion chamber. It includes the fact that acetylene can be good alternate fuel. Despite of being good fuel for IC engine, there are some of the control measures and safety precautions that are involved in gas phase reactions that can cause serious damages.

Jai VardhanaShrivastava,[2] Explained the method for using Acetylene as alternative fuel in SI engine, this paper shows the mechanism with total setup for running IC engine by acetylene gas produced on board. He shows that IC engine using acetylene as fuel emits less amount of CO2 comparable to fossil fuels thus its use can be very beneficial. Acetylene can also replace L.P. G. with similar minor manipulation in the engine

S. Brusca. [3] Explained that acetylene is highly flammable and explosive compound. Due to its wide flammability limits and very low octane number, acetylene put into "Iperdetonat" fuels category. Thus it is impossible to run an IC engine on acetylene without a detonation phenomenon control system. It is possible to run a conventional IC engine from acetylene, controlling detonation phenomena using alcohol. The IC engine used in this paper is a Briggs & Stratton mono cylinder four strokes Spark ignition engine. Some modifications to the original engine structure were required to use duel fuel: Acetylene & Alcohol. This paper dealt with an experimental study on Internal Combustion engines (ICEs) running on acetylene and alcohol. Inthis paper ethanol was used as secondary fuel with acetylene. The main goal of this paper is reduction of pollutant emissions at very low level maintaining at the same time acceptable engine performance, as well as the engine efficiency.

The US Patent on "Internal combustion System Using Acetylene Fuel" filed by Joseph W. Wulff[4] in 1999 Invents that an environmentally clean dual fuel for an internal combustion engine comprises acetylene as a primary fuel and a combustible fuel, such as one or more fluids selected from alcohol such as ethanol, methyl Alcohol Etc. The present invention relates to a system using fuel comprising at least two combustible ingredients and more particularly, without limitation, to an internal combustion engine using fuels comprising acetylene and another combustible fuel. He explained that acetylene as a single fuel cannot be burned in an IC engine without severe knock and early ignition in the intake port, and in the cylinder, causing engine stopping and damage. So it is necessary to introduce a secondary combustible fuel which reduce knocking and early ignition in intake port. In this patent explained that Start-up and operation of an internal combustion engine utilizing the dual fuel generally comprises two stages. The first stage involves starting the engine with the Secondary fuel and, after a relatively short Warm-up period; the second stage involves generating power output by the engine, largely arising from combustion of the primary fuel. Injection of the secondary fuel is continued, however, to realize the early ignition and knock prevention provided thereby. In this invention the engine operated on dual fuel (acetylene as primary fuel and methyl alcohol as the secondary fuel) provided the test result that emission level from acetylene operated internal combustion system, even without emission control devices, were well below the governmentally establish regulatory limits, showing such a system to be environmentally superior to prior art internal combustion system.

II. EXPERIMENTAL SETUP AND TEST PROCEDURE

The four-stroke digital twins spark ignition engine used in this study has a displacement of 125cc and a compression ratio of 10.8:1. It is a single cylinder, naturally aspirated, forced air cooled with a bowl in piston combustion chamber and equipped with a single overhead camshaft (SOHC). The detail specifications of the engine are listed in Table 1.

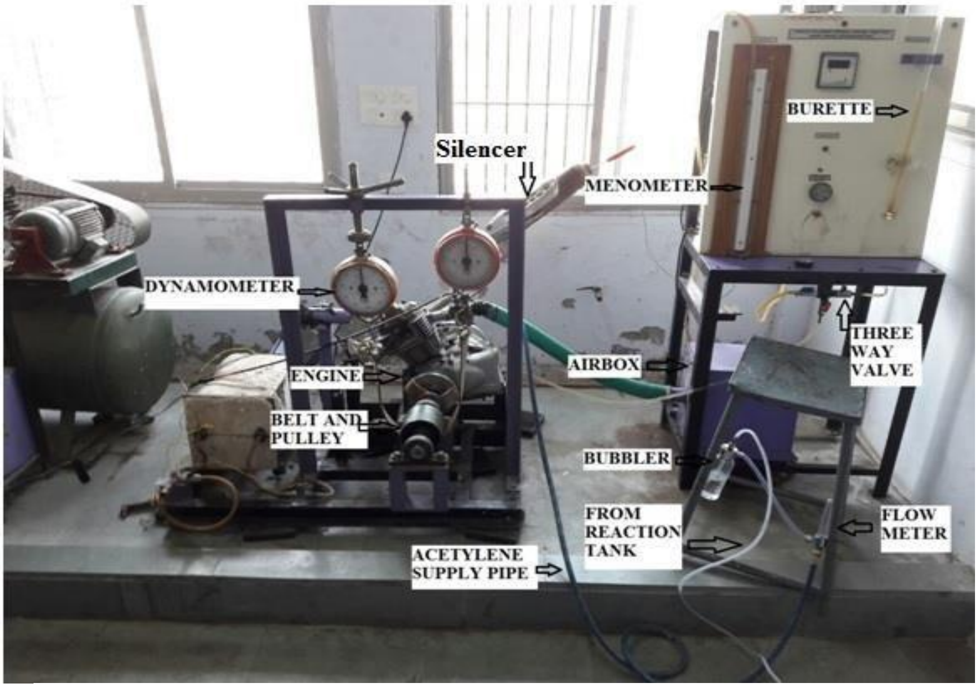

Figure 1Engine Test Rig

Table 1Specification of DTS-i Engine

Engine Type	4-Stroke Single Cylinder Air-Cooled
Engine Displacement(cc)	124.6 cc
Compression Ratio	10.8:1
Maximum Power	11ps @ 8000 rpm
Maximum Torque	10.8 nm @ 5500 rpm
Cylinder Bore	57 mm
Stoke	48.8 mm
Ignition	Microprocessor Controlled Digital CDI

1. Test was carried out with first with gasoline fuel for with dual spark after steady state is achieved on an engine. Torque is measure with the help of Rope Brake dynamometer. The engine crank-shaft is coupled with pulley by universal joint in the shaft for reducing shocks, vibration and prevents failure of shaft. Pulley is attached with the spring balance with the help of rope.
2. At first engine was operated with dual spark with gasoline as a fuel. Desired load was set and speed is measured and set by using tachometer. Observations were taken after steady state condition of engine is achieved.
3. 10cc fuel consumption is measured with stop watch. To avoid cyclic variation average data is considered.
4. Exhaust gas temperature is measured by J Type Thermocouple which is indicated in J Type Temperature Indicator
5. After that Acetylene was produced by reacting calcium carbide with water. And stored in a storage tank.
6. Then the engine starts with ethanol blend E20, after steady state is achieved. The produced Acetylene is supplied as a secondary fuel to the intake of carburettor with constant 1L/min flow.
7. Flow rate was insured to be constant by regularly checking flow meter.
8. After steady state is achieved observation were taken for dual spark with Dual Fuel: - Acetylene and Ethanol blend.

III. RESULT AND DISCUSSION

Results obtained from the experiments conducted with dual spark plugs at different loading conditions with constant rpm using pure gasoline under lean mixture and Dual Fuel (Acetylene and Ethanol Blend) are presented in Figures 2 to 7. All the results have been taken as per IS Standard and corrected to the atmospheric condition by multiplying with the correction factor.

1. Brake Specific Fuel Consumption v/s Load

Fig. 2 and Fig. 3 shows variation of Brake specific fuel consumption for constant rpm at 1500 and 2500rpm.Brake Specific Fuel Consumption (Bsfc) is explained as the quantity of equivalent gasoline consumed per kilowatt of power (produced by the engine). Equivalent gasoline amount of Acetylene and Ethanol blend was calculated by considering the lower heat value. By the sum of equivalent gasoline amount of Acetylene and Ethanol blend consumption, the total fuel consumption was determined." Figure 2 and 3 shows variation in brake specific fuel consumption with load at 1500 and 2500 rpm respectively for gasoline fuel and Dual fuel (Acetylene + Ethanol blend). Result shows Dual fuel consumption is more as compared to petrol fuel. BSFC for petrol is less than Acetylene and ethanol blend. We can see that when engine runs at 1500 and 2500 rpm on Dual fuel have 4-6% high BSFC compare to Acetylene and Ethanol blend.

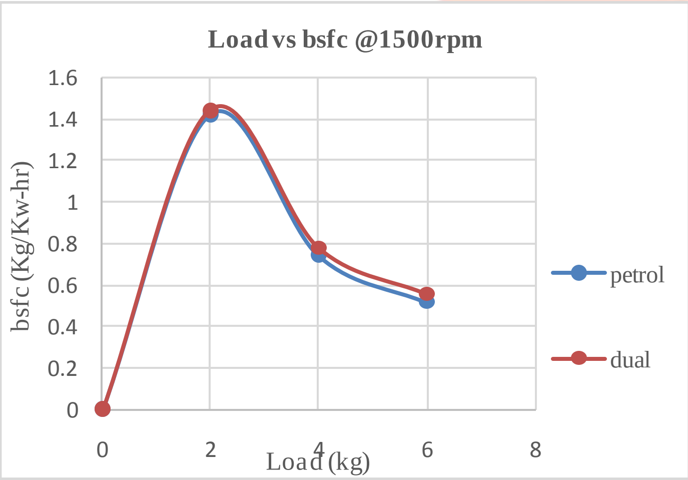

Figure 1Brake specific Fuel Consumption vs load at 1500rpm

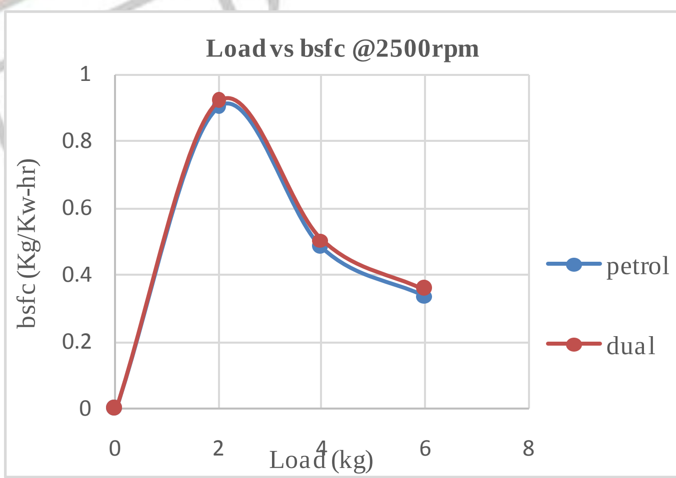

Figure 3 Brake specific Fuel consumption vs load at 2500rpm

2. Thermal Efficiency vs Load

Fig. 4 and Fig. 5 shows variation of Thermal efficiency vs load at 1500rpm and 2500rpm Thermal efficiency is the conversion of mechanical energy into chemical energy. The work done from the given fuel power is measured by the thermal efficiency. Figure 4 and 5, shows variation in brake thermal efficiency with load at 1500 and 2500 rpm respectively for gasoline fuel and dual fuel. It indicates that as brake power increases the thermal efficiency increases. When engine running on 1500 rpm and 6kg load the thermal efficiency increases 4%. When engine is running on 2500 rpm with 6kg loading the thermal efficiency increases 6%.

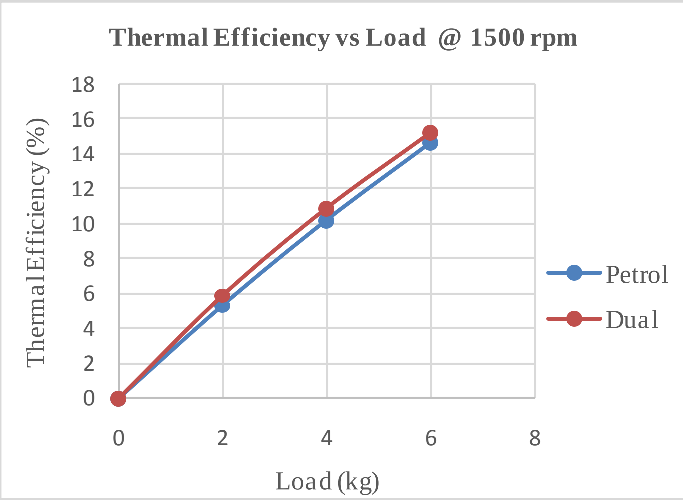

Figure 4 Thermal efficiency vs load at 1500rpm

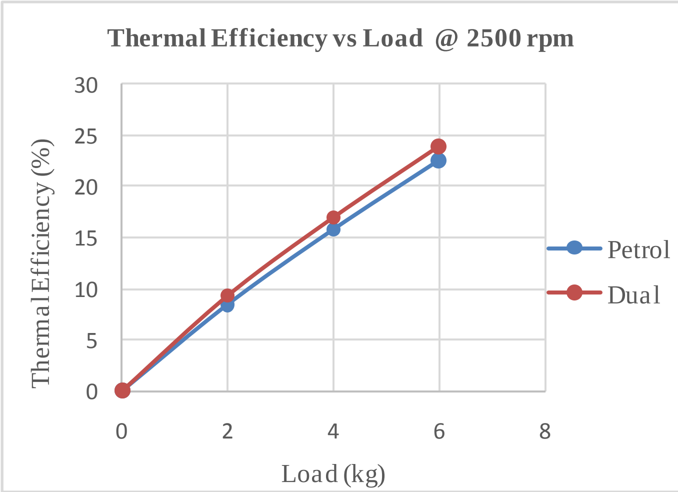

Figure 5 Thermal efficiency vs load at 2500rpm

3. Volumetric Efficiencyvs Load

Fig. 6 and Fig. 7 shows variation of volumetric efficiency vs load at 1500rpm and 2500rpm. Volumetric efficiency The volumetric efficiency is ratio of actual volume of charge drawn in the cylinder to the swept volume Graph 6.5 and 6.6 shows variation in volumetric efficiency with load at 1500 and 2500 rpm respectively for gasoline fuel and dual fuel. When compared with Ethanol blend and Acetylene gas mixed gasoline fuel there is slight decrease in volumetric efficiency as some portion of the volume is compensated by the Acetylene and ethanol blend.

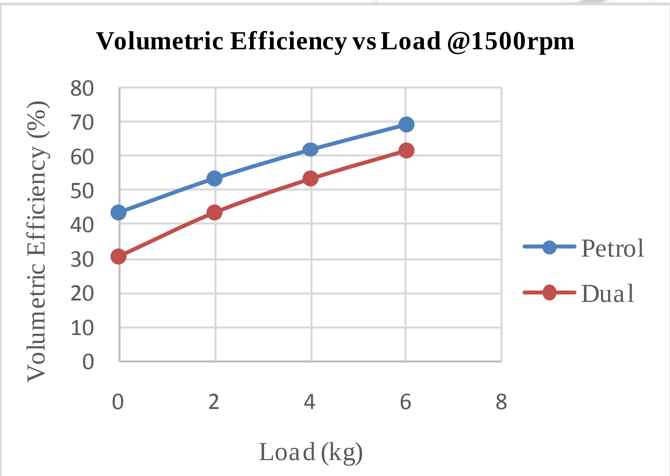

Figure 6 Volumetric Efficiency vs Load at 1500rpm

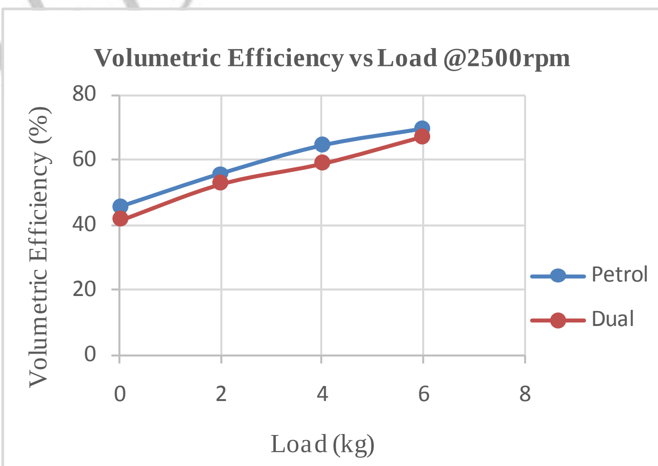

Figure 7 Volumetric Efficiency vs loadat 2500rpm

IV CONCLUSION

The dual fuel technique is a good method to take the advantage of the fuels, alcohol and alternative fuel (ACETYLENE).The study highlights the use of acetylene as a fuel for S.I engine; this fuel can be used with conventional S.I engine with minor fabrication and manipulations. As acetylene has wide range of merits on economic as well as environmental grounds. It is less costly than conventional fuel as acetylene is produced from calcium carbonate which is in large quantity.

Results shows below were observed when petrol fuel is compared with 1 Liter/min acetylene was mixed 20 % Ethanol and 80% petrol fuel.

1. Thermal Efficiency shows slight increase about 2-6% which shows a possibility that it could be more increased if flow of acetylene increased.
2. Volumetric efficiency is continuously decreasing along with the flow rates as some amount of intake air is replaced by acetylene gas.
3. Brake specific fuel consumption also slightly increases as ethanol blend has lower calorific value as compared to petrol fuel.

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