



Study The Performance Characteristics Of Acetylene Gas In Dual Fuel Engine With Diethyl Ether Blends

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(Recieved 15 March 2012 Accepted 30 April 2012)

ABSTRACT : Studies reveal that Acetylene gas produced from lime stone (CaCO_3) is renewable in nature and exhibits similar properties to those of hydrogen. An experimental investigation has been carried out on a single cylinder, direct injection (DI), and compression ignition (CI) engine tested with pure diesel and diesel- Acetylene dual fuel mode with diethyl ether (DEE) as oxygenated additive. Experiments were conducted to study the performance characteristics of DI diesel engine in dual fuel mode by aspirating Acetylene gas in the inlet manifold, with diesel- diethyl ether blends (DEE) as an ignition source. Fixed quantity of Acetylene gas was aspirated and Blend of diethyl ether with diesel (DEE10, DEE20 and DEE30) was taken and then readings were taken at various loads. From the detailed study it has been concluded that the blending ratio of DEE20 gives better performance. Dual fuel operation along with addition of diethyl ether resulted in higher thermal efficiency when compared to neat diesel operation. Acetylene aspiration reduces smoke and exhaust temperature.

Keywords: : Renewable, Acetylene Gas, Dual Mode, Performance Characteristics.

I. INTRODUCTION

In the present context, the world is confronted with the twin 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 [1-2]. 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. They cannot be used directly in diesel engines. However, diesel engines can be made to use a considerable amount of gaseous fuels in dual fuel mode without incorporating any major changes in engine construction. The dual fuel mode of operation leads to smoother operation; lower smoke emission and the thermal efficiency are almost comparable to the diesel version at medium and at high loads. however, major drawback with these engines are higher NO_x emissions, poor part load performance, and higher ignition delay with certain gases like biogas and rough engine operation near full load due to high rate of combustion . It is an aid for cold starting

and ignition improver for diesel water emulsion [3]. Diethyl Ether (DEE), an Oxygenated additive can be added to diesel fuels to suppress the NO_x emission. DEE is an excellent ignition enhancer and has a low auto ignition temperature [4]. Iranmanesh et al. found that 5% of DEE with diesel blend was the most effective combination based on performance and emission characteristics [5]. Various researchers tried the blends of DEE with biodiesel to reduce missions. In this research, DEE was added in the ratio of 10%, 20% and 30% with pure diesel to reduce the smoke and exhaust temperature simultaneously and the optimum blending ratio was found out.

Gunea *et al.* [1] conducted experiments on a four-stroke, single cylinder, direct injection diesel engine fuelled with natural gas. Tests were conducted with diesel as the pilot fuel having different cetane numbers in order to find the effects of pilot fuel quality on ignition delay. They concluded that ignition delay of a dual fuel engine mainly depends on pilot fuel quantity and quality. High cetane number pilot fuels can be used to improve performance of engines using low cetane value gaseous fuel.

.Karim [2] has done extensive research to understand the nature of the combustion process in the dual fuel. He has used variety of gases like methane, ethane, propane, butane, hydrogen, ethylene, and Acetylene as primary fuel. It is generally accepted that performance of dual fuel engines, irrespective of the type of gaseous fuel employed,

is better at medium and high loads. However, it has been reported that at low outputs efficiency is slightly inferior to the base line diesel engine. Researchers have stressed the need to control the quantity of both pilot and gaseous fuel depending on load conditions for better performance.

Rao *et al.* [3] Investigated Performance of Diesel Engine In Dual Fuel Mode By Inducting Small Quantity of Hydrogen Diesel. At Higher Loads, The Efficiencies Attained Are Close To Diesel With Notable Reduction In Smoke, Soot Formation, And Exhaust Temperature. NO_x Emissions Are Increased With Increase in Peak Pressure Pugazhvidivu *et al.* [4]. The addition of diethyl ether to the blends reduced the NO_x emission at low and medium loads; however, at high loads the NO_x emission was higher compared to diesel and lower compared to the corresponding biodiesel blend. The addition of diethyl ether to biodiesel blends reduced the both NO_x and smoke emission further All the biodiesel blends produced a higher NO_x emission compared to diesel. With B25 blend, the NO_x emission was reduced by the addition of DEE at all load conditions. With B50, B75 and B100 blends, the NO_x emission was lowered by the addition of DEE at low and medium loads. The addition of 15% to 20% DEE was more beneficial in reducing NO_x compared to 10% DEE.

Iranmanesh *et al.* [5] in this research, the tests were conducted on a single cylinder DI diesel engine fuelled with neat KOMÉ as a base fuel and blends of 5, 10, 15 and 20% DEE on a volume basis. Use of DEE addition to KOMÉ increased BTE in general due to its oxygen content and its effect on lowering the viscosity of the blend, which led to improved spray formation and finally an improvement in the combustion. BTE increased 5.5% with 15% KOMÉ-DEE blend. Smoke opacity slightly reduced with KOMÉ-DEE blends. The effect of DEE on NO_x reduction was more effective than on other emissions. Addition of 15% and 20% DEE reduced NO_x by 40% and 51% respectively.

Vijayabalan *et al.* [6] in this experiment liquefied petroleum gas (LPG), was mixed with air, compressed, and ignited by a small pilot spray of diesel. Dual fuel engine showed a reduction in NO_x and smoke in the entire load range. However, it suffers from the problem of poor brake thermal efficiency and high hydrocarbon and carbon monoxide emissions. In order to improve the performance at lower loads, a glow plug was introduced inside the combustion chamber. The brake thermal efficiency improved by 3% in the glow plug assisted dual fuel mode, especially at low load, and also reduced the hydrocarbon, carbon monoxide, and smoke emissions by 69%, 50% & 9% respectively.

Sivalakshmi *et al.* [7] in this research work, an attempt has been made to analyze the effect of diethyl ether as an

additive at different proportions. The Brake thermal efficiency of B-D15 is found to be higher than that of biodiesel and the brake specific fuel consumption for B-D15 is 9% lower than that of JOME at the maximum load; the use of DEE addition to JOME has showed an increase in CO and HC emissions at maximum load. NO_x emission is reduced by the addition of DEE to JOME. The effect of DEE on NO_x emission is more effective when compared with other emissions.

Kannan *et al.* [8] in this study an oxygenated additive diethyl ether (DEE) was blended with bio diesel in the ratios of 5%, 10%, 15% and 20%. The blending ratio of 20% gives better performance and lesser emissions than other combinations. The highest BTE was obtained for 20% DEE among the blends. The BTE of 20% DEE blend was 29.9% at full load which was 5% higher than biodiesel. Higher values of Cetane number and latent heat of vaporization of DEE led to shorter ignition delay period and reduced combustion temperature respectively. These parameters reduced the emission of NO_x. While compared with biodiesel, reduction of 15% of NO_x emission was observed for 20% DEE blends at full load which was the highest reduction among the blends.

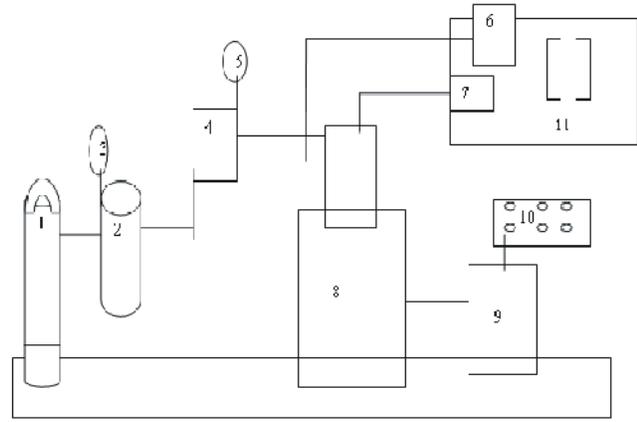
Lakshmanan *et al.* [9] in this work Fixed quantity of Acetylene was aspirated, and readings were taken at various loads. Dual fuel operation resulted in lesser thermal efficiency when compared to neat diesel operation. Acetylene aspiration reduces smoke, soot formation, and exhaust temperature; and increases NO_x emission. The emission of carbon mono oxide and carbon dioxide was lower under all operating conditions when compared to diesel operation. A perceivable reduction in HC, CO and CO₂ emissions was observed with Acetylene operated dual fuel mode. The reduction in HC and CO₂ emissions at maximum load is of 8 % and 3% respectively when compared to diesel operation.

II. EXPERIMENTAL SETUP

The experimentation was conducted by incorporating all necessary hardware for measuring engine performance. For safety reasons flame trap is used. Flame Trap is a cylindrical vessel in which water is stored up to 1/3rd volume of the total volume of the vessel. It is used to prevent the backfire to reach the LPG or Acetylene cylinder. The gas which comes from LPG or Acetylene cylinder first goes to the flame trap and then goes to the surge tank through the passage of water. Some time in compression stroke too much energy is produced and that heat energy is sufficient to burn the gas, which is going to the intake of the cylinder of the engine and it catches the backfire, and if we do not use flame trap this fire may go to cylinder of gas and cause the fire and explosive may take place.

Table 1. Fuel Designation.

A12	Acetylene gas (flow Rate of 12 lit/min)
B10	DEE 10%/Diesel 90%
B20	DEE 20%/Diesel 80%
B30	DEE 30%/Diesel 70%



1. Acetylene cylinder, 2. Flame trap 3. Pressure regulator
4. Surge tank 5. Gas flow meter 6. Air flow meter 7. Diesel fuel tank 8. Diesel engine 9. Generator 10. Load cells 11. Control panel

Fig.1. Schematic of the experimental setup.

Table 2. Engine specification.

Make:	Atul Pvt. Ltd. Agra
K.W./H.P.	4.8/6.5
RPM:	1500
Bore (mm)	85
Stroke	110
S.F.C.(gm/kW/hr)	242
Engine weight(kg)	165
Box weight (kg)	255

IV. RESULTS AND DISCUSSIONS

The dual fuel technique is a good method to take the advantage of the fuels, diesel and alternative fuel (ACETYLENE). Experiments were conducted to study the performance characteristics of DI diesel engine in dual fuel mode of operation by aspirating Acetylene gas at constant flow rate in the inlet manifold for various loads, with diesel diethyl ether blends as an ignition source and the results were shown in Fig. 2.

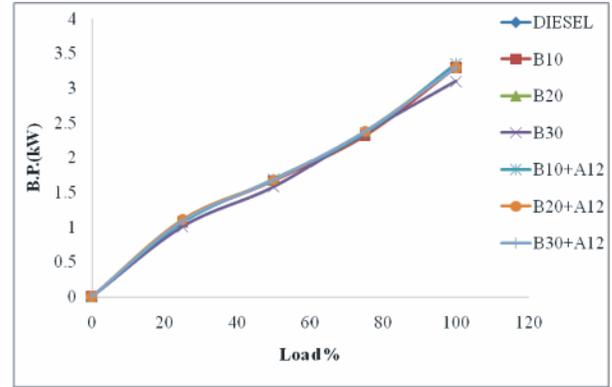


Fig. 2. Brake power vs. load %

Fig. 2., represents brake power developed by engine at different load points. The induction of acetylene using DEE-Diesel blend as pilot fuel exhibits similar power output as compare to diesel fuel. DEE-diesel (B30) blend shows slight lower power output mainly because of lower heating value of fuel.

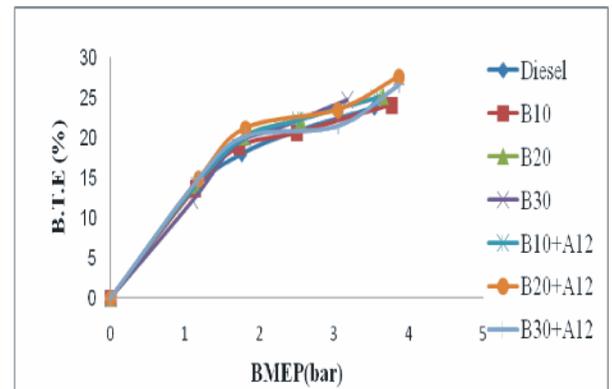


Fig 3. Brake Thermal Efficiency vs. Brake Mean Effective Pressure

Fig. 3., represents brake thermal efficiency at different load points. Dual fuel operation with acetylene gas shows similar b.t.e. comparable to baseline diesel fuel. This may be due to improved combustion takes place by using DEE-diesel blend as pilot fuel. This proves that oxygenated blend such as DEE and acetylene gas in dual fuel mode is a potential fuel for diesel engine.

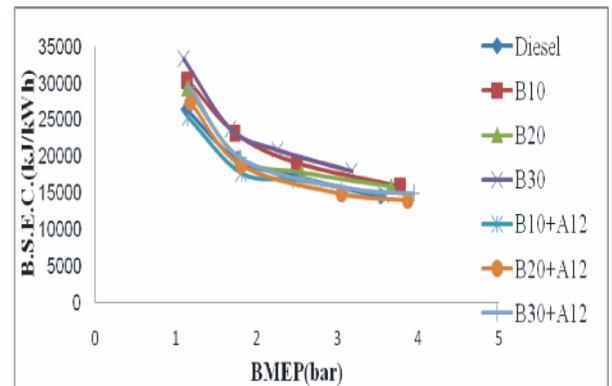


Fig. 4: Brake Specific Energy Consumption vs. Brake Mean Effective Pressure

Fig 4., represents brake specific energy consumption at different load points. The B.S.E.C. is more reliable parameter when using different fuels in the same engine. The B.S.E.C. decreases with increase in engine load. This may due to improved utilization of fuels with increase in engine load. The dual fuel operation along with DEE-diesel blend as pilot shows better fuel utilization as compare to diesel. This may results in slightly higher brake thermal efficiency as shown in Fig. 3. The DEE-diesel blend (B30) represents higher BSEC this may mainly due to lower heating value of the fuel.

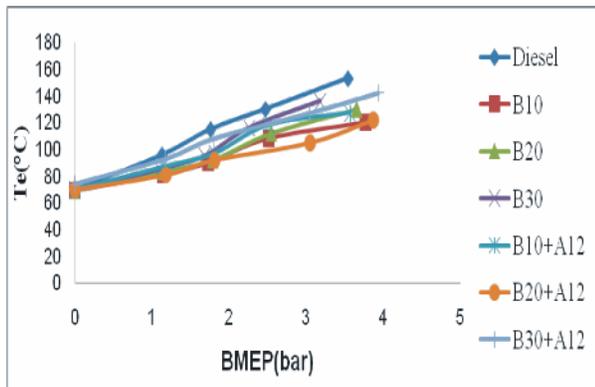


Fig. 5. Exhaust Temperature vs. Brake Mean Effective Pressure

Fig. 5.. represents exhaust gas temperature at different engine load points. Dual fuel operation and DEE-diesel blends exhibits low gas temperature as compare to diesel at all engine loading. This may due to the lean air fuel mixture inside the combustion which absorbs heat due to higher specific capacity of the cylinder charge results in this behaviour.

V. CONCLUSIONS

The following conclusions have been achieved based on the experimental results :

1. Dual fuel operation along with DEE-diesel blend as pilot fuel exhibits good engine performance as compare to diesel fuel.
2. There was an increment in Brake Power and Brake Thermal Efficiency without sacrificing brake specific fuel consumption for all loads with addition of only Diethyl ether up to 20% but soon after it decreases

and engine start knocking.

3. Brake power and Brake thermal efficiency increase with Acetylene addition into blend of Diesel +DEE. It was also found that for all blends Acetylene gas addition will reduce brake specific energy consumption.
4. Brake power and Brake thermal efficiency was found maximum with Acetylene addition into blend of Diesel + DEE20 for all loads, however resulting into lower brake specific fuel consumption.
5. Exhaust temperature in dual mode is lower than diesel operation.

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