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Performance Analysis of Single Cylinder Engine Fueled Using Kerosene-Diesel Blend

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ABSTRACT

The Fast depletion of fossil fuel, swift increase in the price of petroleum products and harmful exhaust emission from the engine collectively created renewed interest among researchers to find out suitable blend. The effects of kerosene-diesel blends on the operation of a diesel engine were investigated in this study when fuelled with neat diesel and Kerosene-Diesel blend in various proportions. Standard experimental procedures were adopted. An Experimental study was conducted to evaluate the characteristics of blending kerosene with diesel fuel on the performance characteristics of a kirloskar made single cylinder 4-stroke diesel engine. Three levels of blend 10%, 20% and 30% of kerosene blending by volume with diesel fuel and they were designated as K10, K20 and K30 respectively, while pure diesel was considered as a baseline and named D. Performance parameters that were studied involve mechanical efficiency, brake thermal efficiency, exhaust temperature and specific fuel consumption.

Key Words: *Brake Thermal Efficiency, Diesel Engine, Diesel-Kerosene Blend, SFC.*

1. INTRODUCTION

The diesel engine's is regarded as a noisy and smoky power plant which has now changed due to advancements in diesel technology which allows one to combine the low fuel consumption with excellent driving performance and low emission characteristics [1, 2, 3]. The term "diesel engine" is used throughout the world to denote compression ignition(CI) engines, two or four stroke, with airless fuel injection. Such engines produce greater power and are adaptive to wide range of fuels [4].

One of the important characteristics of a diesel fuel is its ability to autoignite. A characteristic that is quantified by the fuel's cetane number or index, a greater cetane number or index means that the fuel ignites more quickly [5]. The cetane number of a fuel indicates the self-igniting capability of the fuel and has a direct impact on ignition delay. The higher the cetane number, the shorter the ignition delay and vice versa [5]. High cetane number fuel encourages early and uniform ignition of the fuel. Blends of kerosene and diesel fuel can be used in unmodified diesel engines [6, 7, 8]. The objective of this study was to determine the effect of kerosene blends on diesel engine performance characteristics. Engine performance characteristics are major criteria that govern the suitability of a fuel.

The gelling of the diesel fuel in cold climates is a common phenomenon and diesel fuel suppliers, as well as customers and diesel engine designers, became aware over time to manage the cold flow problems associated with Number 2 diesel fuel in the winter time [9]. Several studies [10, 11, 12, 13] have been done by using different blends with kerosene to enhance the performance of a small high speed diesel engine under high load condition. In Nihon University, Japan, a researcher tested a single cylinder , water cooled diesel engine running with blends of a heavy fuel and low grade kerosene oil for comparison of performance to diesel and the results showed that a mixture of 60% fuel oil and 40% kerosene improved thermal efficiency fairly in case of heavy loading [14]. A researcher in his research, blended kerosene with diesel fuel in various proportions and mentioned that it contributes slight increase in engine emissions [15].

Different studies are done on biodiesels and different types of kerosene based fuels to adapt them for diesel engines and diesel power generators [16, 17, 18, 19]. The studies are generally done with different blends of biodiesel and kerosene with diesel.

2. MATERIALS AND METHODS

2.1 Fuel Used

Many developing countries are producing only a single type of diesel for use. It is used in compression ignition engines. The same fuel is being used in residential heating and industrial furnaces. As an example kerosene is used in domestic application for cooking and space heating [20]. The diesel fuel and kerosene samples used in this study were commercially available in the local market. Pure diesel fuel (named D) was purchased from local fuel station and used as base line fuel. Three blends of diesel – kerosene (with 10%, 20% and 30% kerosene blending by volume) were named K10, K20 and K30 respectively, were used in this experiment.

TABLE 1 : Properties Of The Fuel

Fuel	Diesel(IS 1460:2005)	kerosene (IS:2796- 2008)
Formula	$C_{12}H_{26}$	$C_{10}H_{22}$
Calorific value	44500	45400
Density at 15°C kg/m³	820- 845	791-795
Kinematic viscosity(cst) at 40°C	2-4.5	1.389
Flash point °C min	35	41
Self ignition temperature	725	640

2.2 Test Engine

The experiment was conducted in a single cylinder four stroke diesel engine. The specification of the tested engine is shown in Table 2.

TABLE 2 : Engine Specification

Item	Specification
Engine Manufacture	Kirloskar
Fuel Type	Diesel
No. of Cylinders	1
Max. Power	5.HP @ 1500 rpm
Bore	80 mm
Stroke	110 mm

2.3 Test Procedure

The system is drained initially and refilling with pure diesel fuel (D) before commencing test requires, for warming up, the engine run without load for 20 minutes. The speed of the engine was increased at the same load until the engine becomes stable, which is being determined from the exhaust temperature. Engine speed was fixed at 1500 rpm and the engine is run for 2 minutes at that fixed speed and load. The data required in the analysis was obtained with the help of Electronic Data Acquisition System connected to the test engine at varying load values by loading using an Electrical Dynamometer Loading. Then, the pure diesel specimen (D) was replaced with the specimen K10, K20 and K30 and the performance data are gathered at varying load conditions and the graphs are plotted for each parameters analysed against Brake Power.

3. RESULTS AND DISCUSSIONS

a) Fig. 1 shows the effect of fuel type on Brake Thermal Efficiency (ηBTE) at different Brake Powers with engine run at 1500 rpm. It has been seen from the figure that the BTE first increases as brake power increase and then falls with increase in brakepower(Load) after some time for all concentration of fuel tested. Brake thermal efficiency is always found to be higher with increasing the kerosene concentration as compared with baseline diesel fuel.

b) Fig. 2 shows the effect of Mechanical Efficiency (ηmech) at different Brake Powers with engine run at 1500 rpm. It has been seen from the figure that the mechanical efficiency first increases as brake power increase and then falls with increase in brakepower (Load) after some time for all concentration of fuel tested. Mechanical efficiency is always found to be higher with increasing the kerosene concentration as compared with baseline diesel fuel.

c) Fig. 3 shows the exhaust gas temperature variations for the test fuels with varying brake power. It was observed that the temperature of the exhaust gas increases with the brake power (load) because more fuel is burnt at higher loads to meet the power requirement. It was also observed that the exhaust gas temperature increased with percentage of kerosene in the test fuel for all load conditions.

d) Fig. 4 shows the variations of specific fuel consumption (SFC) of various kerosene-diesel blends as a function of brake power. Specific fuel consumption decreased with increase in engine brake power (load). This reduction in the SFC can be attributed to the higher calorific value of kerosene as compared to diesel fuel. In order words, only less quantity of fuel is needed to produce the same amount of energy.

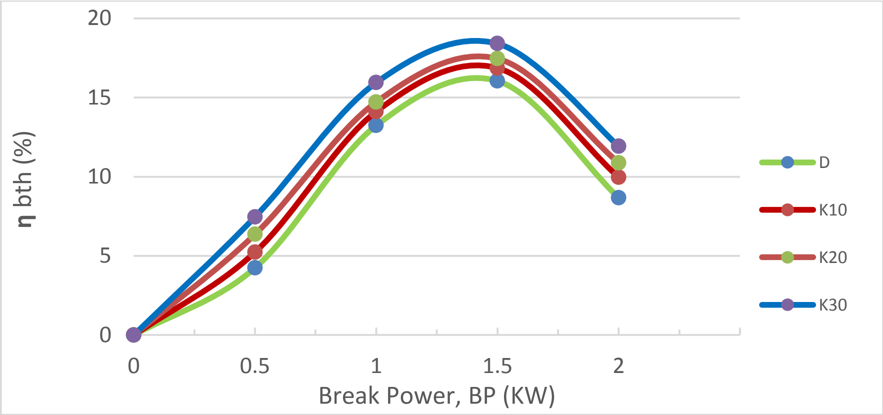

Fig 1- Plot of Brakethermal Efficiency (η_{bth}) vs Break power, BP

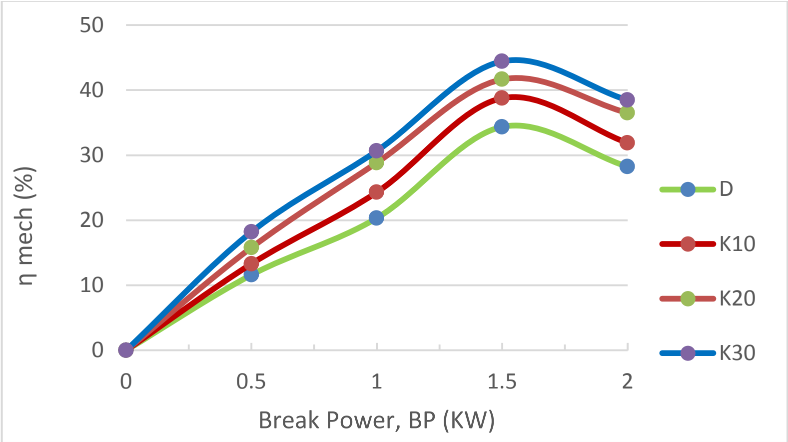

Fig 2- Plot of Mechanical Efficiency (η_{mech}) vs Break power, BP

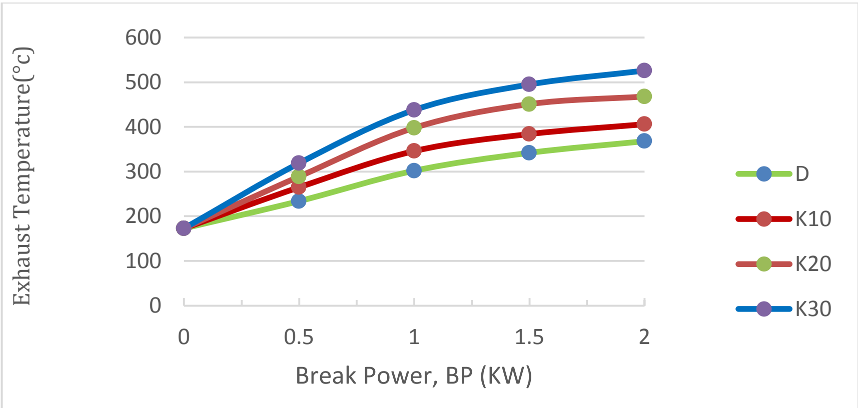

Fig 3- Plot of Exhaust Temperature vs Break power, BP

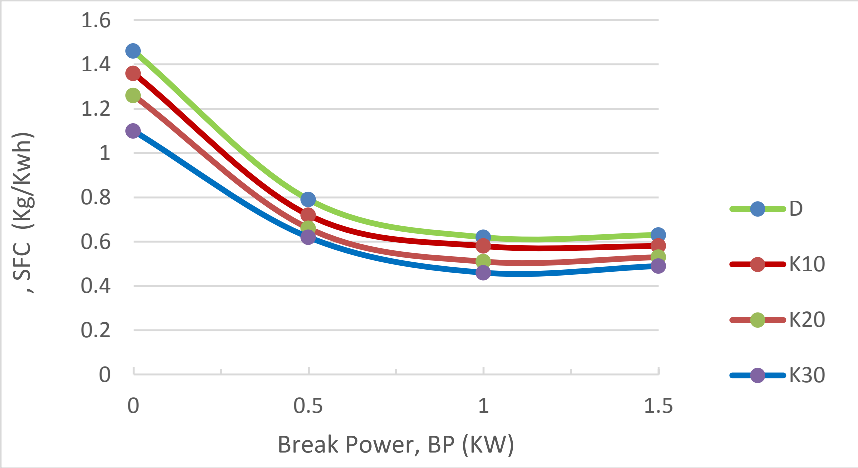

Fig 4- Plot of Specific Fuel consumption, SFC vs Break power, BP

4.CONCLUSIONS

The performances of four stroke single cylinder diesel engine, when operating with different fuel blends at rated rpm and rated load conditions have been experimentally investigated in the present study and the following results were obtained.

a) Brake thermal efficiency (ηBTE) and Mechanical efficiency (ηmech) slightly increases with increase in the concentration of kerosene in kerosene-diesel blends as compared with pure diesel fuel . This is because of the fuel properties such lower viscosity, density, and higher calorific value of blends K10, K20 and K30.

b) The exhaust gas temperature increased with increase in percentage concentration of kerosene in the kerosene-diesel blends as compared with pure diesel fuel for all brake power conditions. This may be due to the oxygen content of kerosene, which improves combustion and thus may increase the exhaust gas temperature

c) The Specific fuel consumption (SFC) decreased with increase in percentage concentration of kerosene in the kerosene-diesel blends as compared with pure diesel fuel. Decrease in SFC of the blended fuels was due to faster combustion and evaporation of the blend particles as compared with diesel fuel.

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