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Experimental investigations on the performance characteristic of diesel engine using n- butyl alcohols

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Abstract: The necessary to IC engine is to usage of diesel as a fuel in an economic and environmental benevolent manner. The existing scenario, the very low combustion efficiency of compression ignition engine leads to poor performance of the engine and more emission of incomplete combustion by-products. Hence it was planned to improving the performance efficiency of compression ignition engine and thereby to reducing the exhaust emission by adding n-butanol or n- butyl alcohols at different proportions like 5%, 10% and 15% by fuel volume with diesel fuel. The different performance characteristics observed are while using blending of n-butyl alcohols or n-butanol with diesel were compared and analyzed with engine using without adding any n-butyl alcohols or n-butanol, normal diesel as fuel. The various researcher report that performance analysis at 70% load applied the brake thermal efficiency of engine is increased by 11.789% for 10% n- butyl alcohols or n-butanol blended with diesel fuel. According to various researcher view emission test at 70% load revealed that, the CO, HC and smoke density are increased by 22.222%, 28.571% and 14.757% respectively for 10% blending of n-butanol or n- butyl alcohols with diesel. The NOx emission while using 10% n-butanol blended with diesel is decreased by 19.131% at 80% load.

Keywords: Performance, n-butanol, I.C. Engine, Blended fuel

I. INTRODUCTION

In the present world the economic and environmental aspect do not agree for the usage of diesel, it is not promising to accomplish the living beings without the usage of diesel engine. Therefore it is enforced to IC engine the usage of diesel in an economic and environmental aspect like reduce of pollution. The varies emission like HC,CO, soot NOx etc. from diesel engines is the major pollutants in the present world, seriously affecting the human beings, animals and plants.

This experimental work was aim to study the performance of a four stroke compression ignition diesel engine while using diesel blended with n- butyl alcohols or n-butanol as fuel. The ignition delay period has high influence on ignition of fuel. The various research work have already been done to improve the performances characteristic like brake power of the diesel engine and reduce the exhaust emission of the engine by using adding the additives, different fuel like alcohol, vegetable oil, animal fat oil and etc. with diesel at varying proportions, incorporating by some modifications in the engine by varying or modify the fuel supply system, in the combustion chamber design and adding different additives or fuel like alcohol, vegetable oil, animal fat oil and etc. with the fuels.

n- butyl alcohols or n- Butanols are a primary alcohol with the molecular formula C4H9OH and 4-carbon structures. Its isomers include tert-butanol, isobutanol and tert-butanol. The n-Butanol produced from the fermentation of sugarcane and other carbohydrates products. In the United States it is permitted as a artificial flavorant, used in different cream, rum, candy, cordials, fruit, whiskey, butter, ice cream and baked goodsThe present work reviews the literature concerning the performance of diesel engines operating under transient conditions of alcohol/diesel blends

A comparison of the properties of diesel and n-butanol is given in the table 1 below.

Table 1. Properties of dieseland n-butanol

S.No	Properties	n-butanol	Diesel
1	Molecular formula	C_4H_9OH	$C_{14}H_{22}$
2	Cetanenumber	15	49
3	Kinematic viscosity(cSt)	3.64	2.6
4	Specificgravity	0.81	0.83
5	Lower calorific value(kJ/kg)	33,075	43,200
6	Latent heat ofvaporization(kJ/kg)	585	250

II. EXPERIMENTAL METHODOLOGY

The internal combustion engine load is given by the eddy current dynamometer. A computerized data acquisition system (DAS) is attach with the compression ignition engine to record and measure various engine performance parameters like temperature of incoming and outgoing of cooling water, fuel flow rate to engine, flow rate of cooling water, pressure inside the engine cylinder, speed of the engine, heat release rate of the engine, temperature of incoming air and exhaust gas, etc.

The layout of the engine setup is given in the below figure 1.

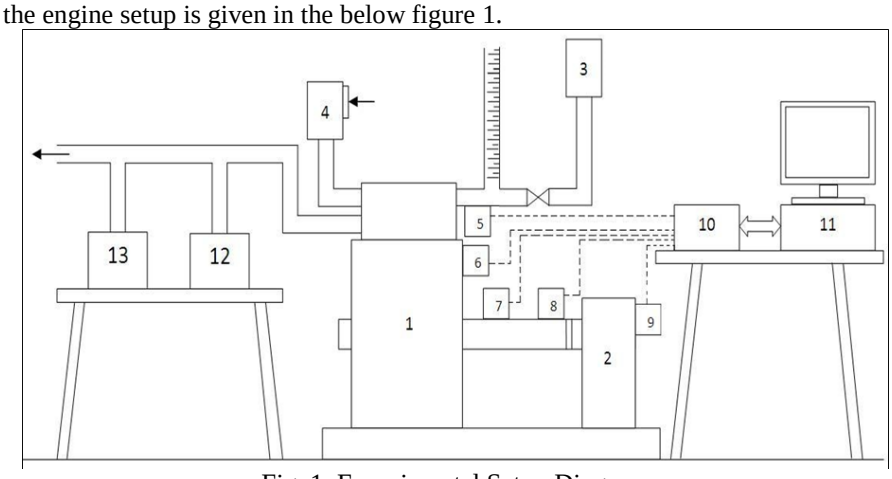

Fig. 1. Experimental Setup Diagram

III. EXPERIMENTAL PROCEDURE

Initially, at no load condition, the engine was started using normal diesel without blended with n-butanol as fuel and allowed to run for five to ten minutes. After five to ten minutes the engine warmed up, the gradually apply the load at the rate of 20% load from the maximum load of engine the load applied through the eddy current dynamometer coupled with the engine and after applying running five to ten minutes. Then the performance character parameters such as heat release rate of the engine, speed of the engine, fuel flow rate, temperature of inlet air entering the cylinder and temperature of exhaust gas are recorded and observed.

Then the applied load gradually increase upto to 40% of the maximum load condition of the engine and the engine was allow to run for five to ten minutes to reach equilibrium conditions of the engine, then the various performance character parameters are recorded as per the standard observation procedure given to the experimental engine.

By following the same procedure the various parameters like speed, brake power, thermal efficiency etc. were recorded and observed for applied higher loads such as 60%, 80% and 100% of the full load of the engine. From the observed and recorded values, the various parameters such brake specific energy consumption

of the engine and engine brake thermal efficiency were evaluated by using standard procedure. The diesel mixed with 5% n-butanol was used as fuel by following the same procedure, the various parameters related to performance characteristics were recorded and observed at different applied loading conditions of engine.

The performance characteristics are evaluated were analysed and compared with the compression ignition engine using ordinary diesel without blending n- butyl alcohols or n- Butanols of as a fuel. From the various performance parameter characteristics of the engine while using diesel and the different blending of diesel with n- butyl alcohols or n-butanol fuels at different applied loading conditions were presented in the form of graphs.

IV. Results and discussion

Comparison of performance characteristics of diesel blends.

Table. 2.Brake thermal efficiency of diesel blended with the n-butanol

LOAD	DIESEL	DIESEL+5%	DIESEL+10%	DIESEL+15%
2	12	12	12.5	13
4	19	20	20.5	21
6	23	23.5	24	24
8	24	26	27	26.5
10	25	27	29	29

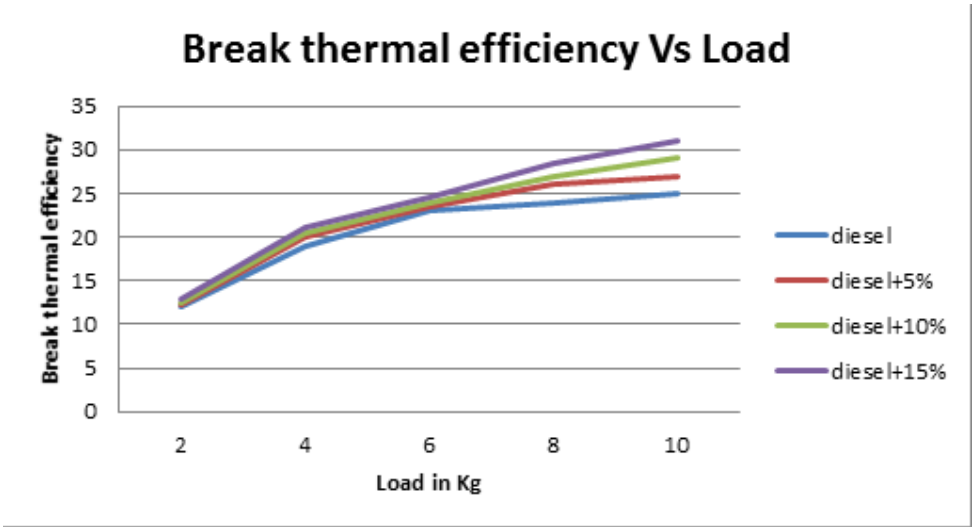

Fig. 2. Brake Thermal Efficiency VS Load

Above graph show the comparison between brake thermal efficiency of engine and applied load condition. From this graphs shows the brake thermal efficiency is increase with increasing n-butanol percentage in the fuel. At 80% load applied to the engine, the engine brake thermal efficiency is increased by 6.518%, 8.917%, 10.437%, 10.518% and 11.789% for the addition of 5%, 10% and 15% n-butanol or n- butyl alcohols blended with diesel fuel respectively. Already reported by many researchers increase in engine brake thermal efficiency by adding or blending alcohols with diesel as a fuel. The increase in engine brake thermal efficiency by the improving the injection fuel spray characteristics by the addition of alcohols. The increase in the engine brake thermal efficiency may also due to the higher premixed combustion of n-butanol or n- butyl alcohol

blended fuels because of low cetane number compare to the diesel which leads the increase in percentage of combustion at the constant volume.

Table. 3. Brake specific energy consumption

LOAD	DIESEL	DIESEL+5%	DIESEL+10%	DIESEL+15%
2	28200	28000	28200	28200
4	18000	17800+	17800	17800
6	15000	14800	14800	14800
8	14000	13600	13400	13400
10	13000	12000	11800	11800

Below graphs shows between engine brake specific energy or fuel consumption VS load revealed that the brake specific energy or fuel consumption decreases at all applied loading conditions for all the n-butanol or n- butyl alcohols blend fuels. The high volatility of n-butanol fuel which has been blended with normal diesel improves the fuel spray characteristics so fuel fast atomisation and vaporization so efficient or complete combustion take place. At 80% applied load, the brake specific energy consumption decreases by 6.120%, 8.190%, 9.454%, 9.520% and 10.548% for the addition of 5%, 10% and 15% n-butanol or n- butyl alcohols with diesel fuel respectively. The decrease in brake specific energy or fuel consumption may also due to the low calorific fuel value of n-butanol compare to diesel.

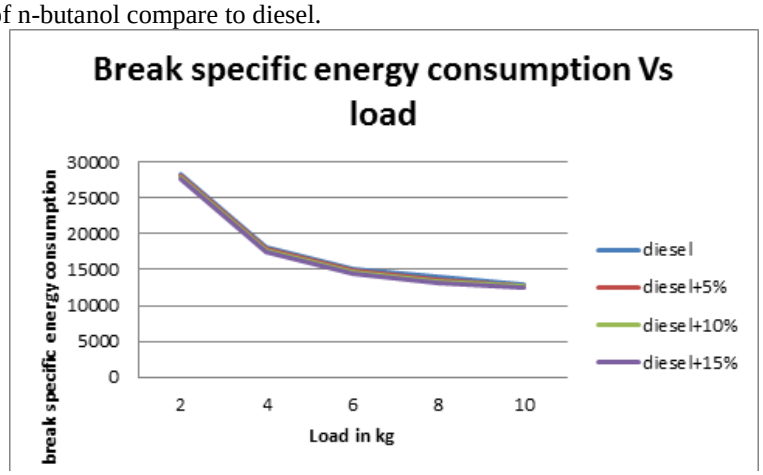

Fig. 3. Brake specific energy consumption VS Load

V. Conclusion

In this experimental investigation aimed at to enhance the performance of the compression ignition diesel engine while using diesel fuel as blend with n- butyl alcohols or n-butanol at different volume proportions like 5%, 10% and 15% is attainable. In addition to this fuel spay character of diesel fuel increase the combustion characteristic of the engine increase. From this experimentation investigation of addition of n-butanol or n- butyl alcohols with diesel resulted in increase the compressed ignition engine brake thermal energy efficiency at all applied load ranges for all the n-butanol or n- butyl alcohols with diesel blended fuels. The addition of n- butyl alcohols or n-butanol with diesel reduces the brake specific energy consumption at medium and high loads of engine.

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