REDUCTION OF EMISSIONS USING D-M-C BLENDED BIOFUEL BY Al_2O_3 COATED HEATER IN 24+/-1:1(+1) CR SIE

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ABSTRACT

A single cylinder four-stroke oil cooled Compression Ignition (C.I) engine is modified to use methanol fuel mode to study the performance, emissions, and exhaust gas temperature parameters on aluminium oxide (Al_2O_3) coated heater Surface Ignition Engine (SIE). In order to improve the performance at varying loads, the heating unit is introduced inside the combustion chamber. The brake thermal efficiency is improved by 1.5% in the heater assisted dual fuel +5% of agricultural waste coconut oil mode, and the top of the engine block is grinding to reduce half of the total clearance volume of the engine cylinder and increasing compression ratio (CR) (+1) on the existing CR 24+/-1:1 of the engine. The ratio of tested biofuel blends of Diesel (D) Methanol (M) and, agricultural waste Coconut oil (C) are D85%M10%C05%, D75%M20%C05% and, D70%M25%C05%. The ignition improver n-butanol is added with each fuel blends to uniformly mix the methanol with diesel and agricultural waste coconut oil. The relevant parameters such as brake thermal efficiency, brake specific fuel consumption, exhaust gas temperature, emissions of Carbon Monoxide (CO), Hydro Carbon (HC), Nitrogen Oxide (NOx), and smoke density are evaluated at the speed of 1250rpm. The reduction of brake specific fuel consumption, emissions and increase of break thermal efficiency are given for the D70%M25%C05 fuel blend.

Key words: emissions, coated, compression ratio, ignition, grinding.

1. INTRODUCTION

An air pollution is the toxic to human beings and became the life threat to the human being resulting in diseases such as asthma, lung cancer, and cardiovascular damage. Increase in fossil fuel consumption will end up in depletion of exhaustible resources such as petrol and diesel [1]. The alternative fuel methanol has the ability to be an alternative fuel for internal combustion engine, and methanol can able to produce more power with very less flue gas emission [2]. Emission of CO gradually decreased while increasing the methanol mixing ratio as compared to diesel fuel, and also, the same reduction phenomena happened for NOx. For M5, and M10, HC emission reduction is observed but It is almost similar to that of D100 [3]. Methanol – Diesel blend fuel produced more output power and torque compared to baseline diesel. The exhaust flue gas temperature is observed lower for blended fuel. Addition of M10 to the diesel fuel is beneficial to obtain good engine performance as well as less smoke characteristics [4]. Subsequently the marginal increase in brake thermal efficiency and brake specific fuel consumption is observed, combustion efficiency also higher due to the excess oxygen content in the methanol and increase the effective combustion of fuel with negligible heat loss. The brake specific fuel consumption is increased with methanol addition due to its low calorific value [5]. Additives such as n-butanol also increased the brake specific fuel consumption due to its low calorific value and high oxygen content and the usage of butanol reduced the smoke opacity lower than baseline diesel [6].

Isopropyl alcohol in experiments gives the positive results such as providing chemical homogeneity between diesel and methanol mixture, increasing ignition delay to attain maximum cylinder pressure and reduction in both NOx, HC emission [7]. Increase in Ethanol and Methanol addition with diesel fuel reduce its octane number resulting in a long ignition delay period [8]. Possibly without any modification in engine blended fuel can be used for reduction of NOx and smoke in CI engines [9]. During the usage of fuel blends, the emission of smoke is immensely high when the engine is cold and running at higher speeds, the low emission is observed when the engine is hot and running at lower speeds [10]. The addition of copper oxide nanoparticles to the biodiesel can able to reduce ignition delay associated with methanol to gain effective combustion [11].

2. EXPERIMENTAL SETUP

The stationary four stroke Surface Ignition Engine is shown in Fig.1. The specifications of the SIE are given in Table.1 and the properties of fuels utilized are given in Table.2. The coated heater is fixed in side of the chamber and associated by 12-volt D.C battery to warming ignition chamber. The Fig.2 shown Al_2O_3 Plasma coating on heater and the coated heater is shown in Fig.3. The ratio of tested biofuel blends is shown in Fig.4. The n-butanol additive is added for uniformly mixing of fuels. The engine is running at constant speed of 1250rpm by changing the screw gave the fuel injector siphon. The engine is rushed to increase uniform speed after which it is steadily stacked. The investigations are directed at six force levels. For each heap condition, the engine is run for in any event 10 minutes after which information is gathered. The examination is rehashed multiple times and the normal worth is taken.

A dynamometer is utilized for estimating the intensity of engine yield 5gas analyzer is utilized for estimating the outflows of CO, HC, NO_x and smoke density of the engine. A fuel utilization meter is utilized for estimating the brake explicit fuel utilization of the engine. The main measurement methods used for the determination of exhaust gas temperatures include resistance temperature sensors and thermocouples. The CR of the base diesel engine is increased by reducing the clearance volume of the engine by removing material by surface grinding, is shown in Fig.5.

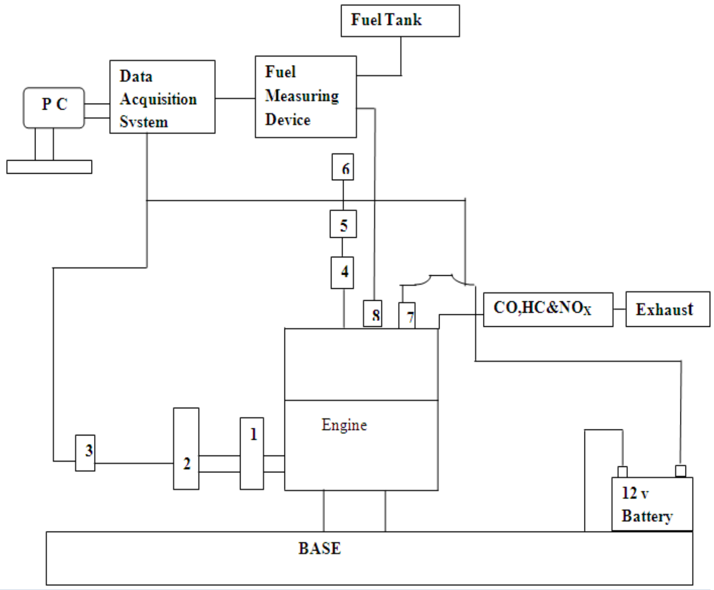

Fig.1 Surface Ignition Engine

1. Flywheel
2. Dynamometer
3. R.P.M. Measuring device
4. Air stabilizing tank
5. Digital air flow meter
6. Air filter
7. Coated heater
8. Injector.

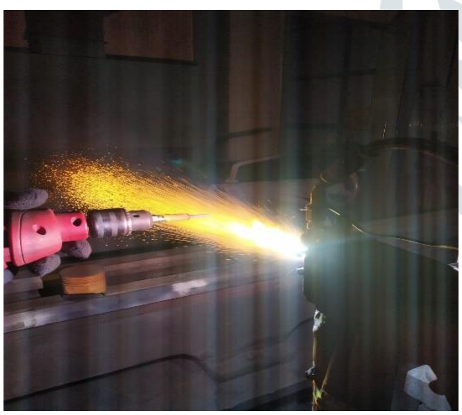

Fig.2 Al_2O_3 Plasma coating on heater

Fig.3 Coated heater

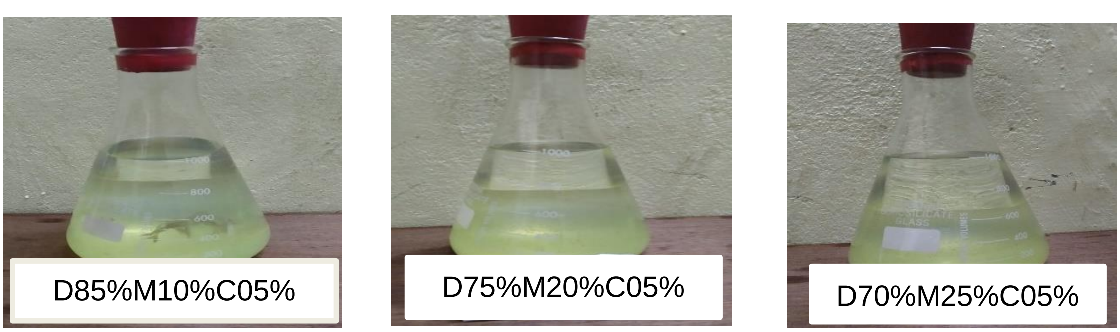

Fig.4 Tested biofuel blends

Fig.5 Surface grinding to increase CR

Table.1 Specifications of the SIE

Engine Type	4 Stroke SIE
No of Cylinder	One
Bore Diameter	86 mm
Stroke Length	77 mm
Engine Displacement	445.3 cc
Compression Ratio	24+/-1:1(+1)
Max. Engine power	6.62 kW at 3400 rpm
Max. Torque	23 Nm at 2000 rpm
Idling Speed	1250 rpm
Method of Cooling	Forced air and oil cooled

Table.2 Properties of fuels

Properties	**Diesel**	**Methanol**	**Agricultural waste Coconut oil**
Chemical formula	$C_{12}H_{23}$	CH_3OH	$C_4H_8NNAO_2$
Calorific value (kJ/kg)	42500	19700	38100
Viscosity at 20˚C (mPa s)	2.8	0.59	4.1
Flash point (˚C)	78	12	115.5
Boiling point (˚C)	180-330	67.4	95-99

Auto ignition temperature (°C)	230	470	171
Cetane number	45	5.0	56
Density (Kg/m^3) at 20°C	837	790	886.2
Surface tension (N/m) at 20°C	0.023	0.022	0.034

3. RESULTS AND DISCUSSIONS

Alternative fuel evaluation is compared on the basis of engine performance and its environmental effects. The impact of methanol fuel addition to diesel fuel in Surface Ignition Engine is evaluated by the parameters like brake thermal efficiency, brake specific fuel consumption, exhaust gas temperature, emissions of HC, CO, NOx and smoke density.

3.1.Brake Thermal Efficiency

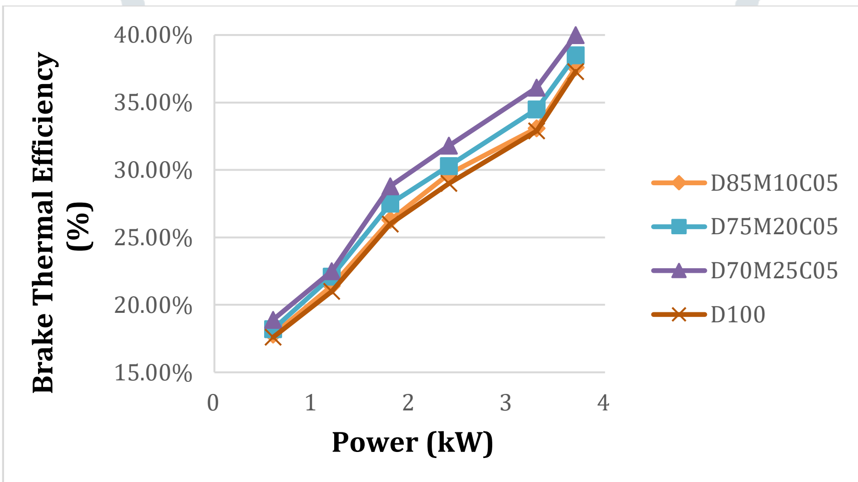

Fig.6 Brake thermal efficiency vs Brake power

Fig.6 shown the variation of brake thermal efficiency of the engine with baseline diesel and blended fuels with respect to brake power. From the graph, it is indicated that with increase of brake power, the brake thermal efficiency also gradually increases for both blended and pure fuel and the maximum brake thermal efficiency is observed at 3.7 kW for D70M25C05.

The graph also shown that with increase in methanol addition, the brake thermal efficiency also increases because methanol contains more oxygen by mass compared to baseline diesel which results in better combustion of fuel and hence increases the efficiency.

3.2.Brake Specific Fuel Consumption

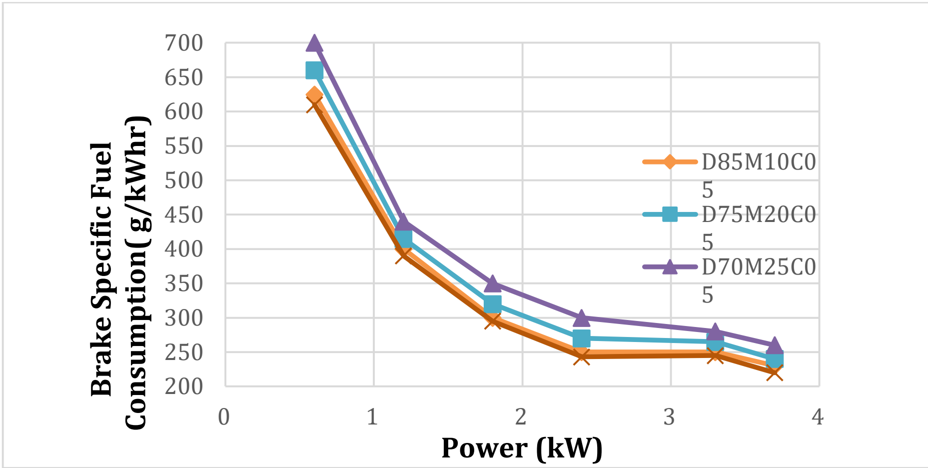

Fig.7 BSFC vs Brake Power

Brake specific fuel consumption (BSFC) is a measure of fuel consumed to produce unit brake power. The Fig.7 represents the variation of brake specific fuel consumption of the engine with baseline diesel and other blended fuels with respect to brake power. The graph clearly shown that the increase in methanol addition to diesel increases the brake specific fuel consumption. It is due to the low calorific value of the methanol than gasoline. The reason behind is that oxygen content in methanol does not contribute to heat generation during combustion.

3.3.Exhaust Gas Temperature

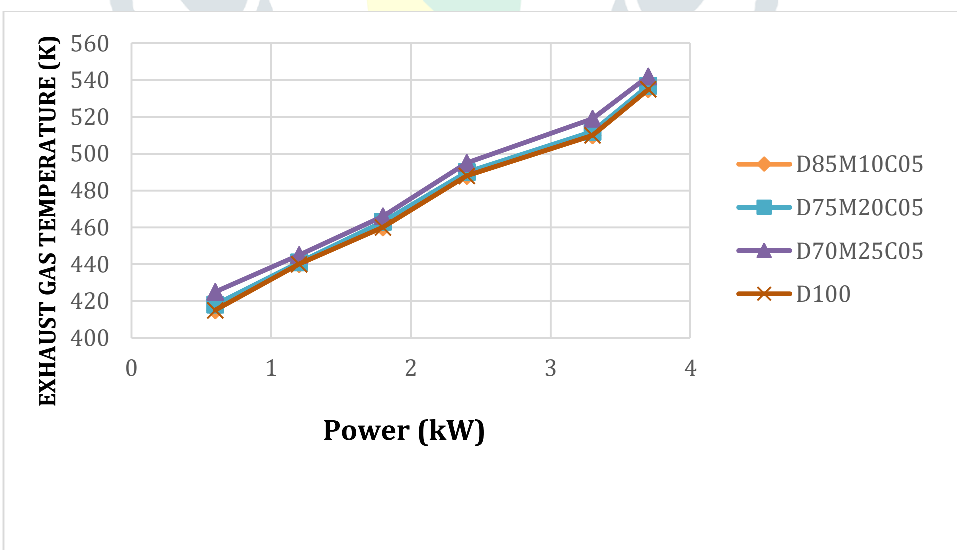

Fig.8 Exhaust Gas Temperature Vs Brake Power

Fig.8 shown the variation of exhaust gas temperature with respect to brake power for the different fuel blends. The maximum exhaust gas temperature is observed for D70M25C05 because the latent heat of vaporization is higher for methanol than pure diesel.

3.4.HC Emission

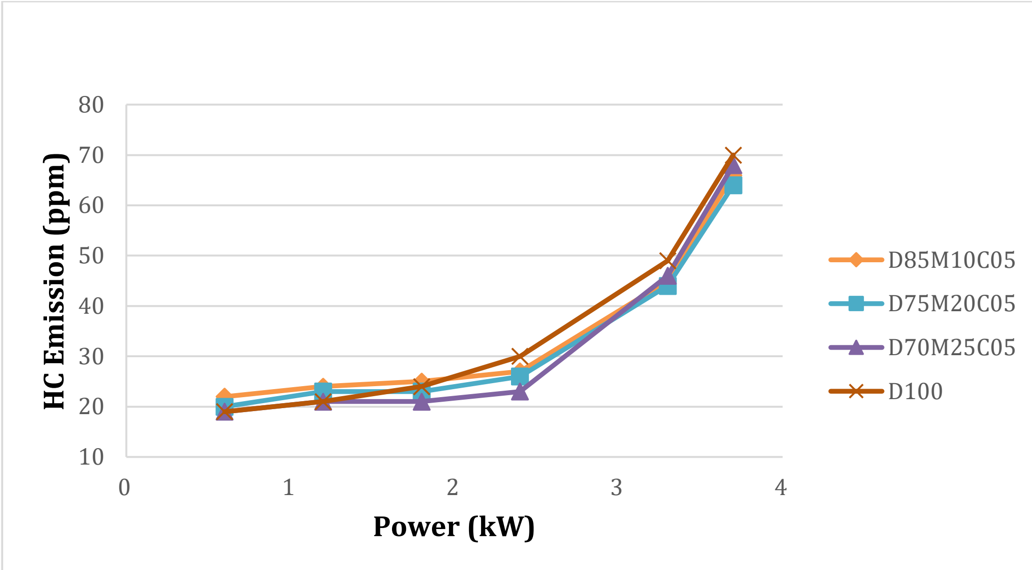

Fig.9 HC Emission Vs Brake Power

Fig.9 shown the variation of HC emission for different fuel blends with respect to brake power. Generally, unburnt hydrocarbons caused by the ineffective combustion of air fuel mixture. When the methanol is added to diesel, it provides enough oxygen to produce efficient combustion of fuel so that the addition of methanol as a supplementary fuel to diesel reduces the HC emission. The graph indicates the blends of D75M20C05 and D70M25C05 produce less amount of HC emission compared to baseline pure diesel. It also shown the steep increase in HC emission for D70M25C05 when power is increased, it may have happened due to non-uniform combustion at full load condition.

3.5.CO Emission

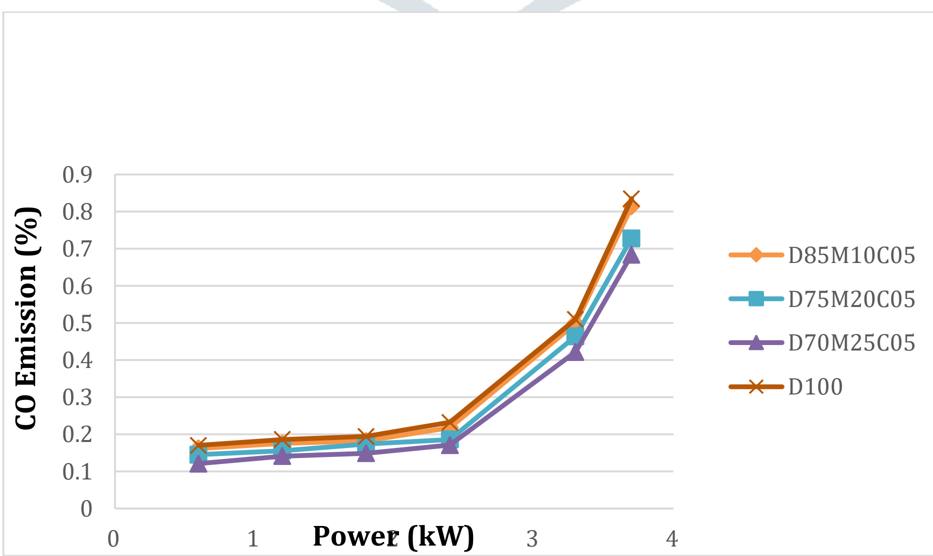

Fig.10 CO Emission Vs Brake Power

Fig.10 shown the variation of CO emission for different fuel blends with respect to brake power. Insufficient oxygen in fuel causes the formation of CO. when the CO has no oxygen to oxidize, then it will remain as CO instead of oxidizing into CO_2. Due to the large amount of oxygen content in methanol, the CO emission is reduced as the methanol addition is increased. The figure shown that the D70M25C05 produces less CO emission compared to other fuel blends.

3.6.NO_x Emission

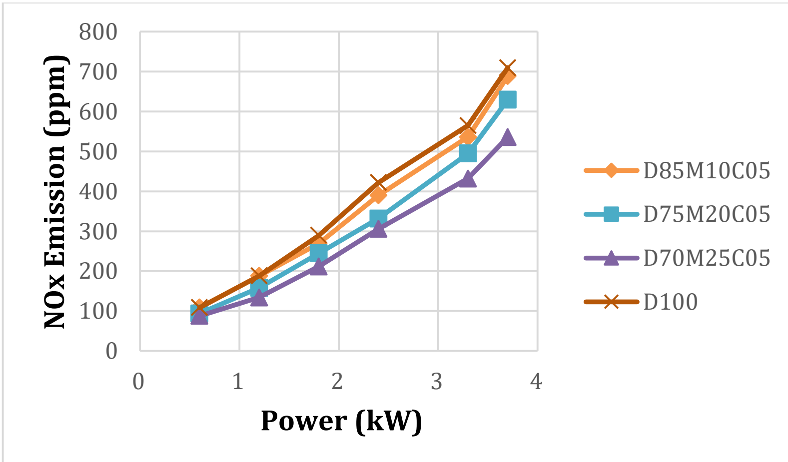

Fig.11 NO_x Emission Vs Brake Power

Fig.11 shown the variation of NO_x emission for the different fuel blends with respect to brake power. The oxides of nitrogen (NO, NO_2) coming out from the muffler after the combustion of fuel is popularly known as NO_x. Also, the graph indicates the NO_X emission is lower for D70M25C05 compared to other fuel blends. High combustion efficiency and high latent heat of vaporization of methanol assisted the low emission of NO_x at M25 blend.

3.7.Smoke Emission

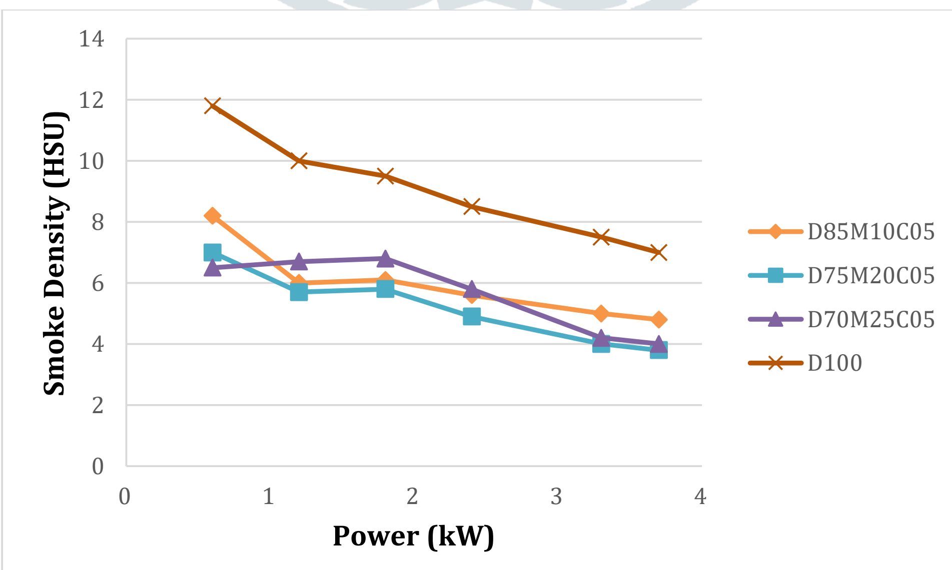

Fig.12 Smoke Density Vs Brake Power

Fig.12 shown the variation of smoke density for different fuel blends with respect to brake power. Smoke emission is possible if there is a fuel rich zone at high temperature and pressure. The figure shown the steep decrease in smoke emission because of the methanol addition. The presence of oxygen in methanol promotes the oxidation soot nuclei and reduces the fuel rich zone formation during combustion which results in reduction of smoke.

4. CONCLUSION:

This experimental study investigated that the methanol fuel can be a suitable alternative fuel of SIE. A crucial improvement observed in terms of brake thermal efficiency, combustion efficiency and brake specific fuel consumption. It identified that n-butanol is a suitable additive to uniformly mix the methanol with diesel. Unfortunately, the brake specific fuel consumption increased as the methanol added to diesel due to lower calorific value of methanol. The reduction in emission observed with blended fuels. Harmful emissions of NO_x, HC, CO and smoke reduction observed at D70M25C05 by 24.5%, 10%, 18% and 42% respectively. This study was concluded that the modification done in the engine has been a key to got good results at D70M25C05 blended fuel ratio.

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