Experimental Investigation on Two Cylinder Diesel Engine Using Biodiesel and Diesel as Fuel with EGR Technique

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Abstract: ***Today a major problem associated with the human being is environmental pollution. It is caused by so many exhaust gases like Nitrogen oxides (Nox), Carbon monoxide (CO), hydro carbon (HC) etc. To reduce the amount of NOx emission engine cylinder has to maintain temperature below 2500°F. Exhaust gas recirculation (EGR) is one of the most effective way for reducing NOx in emission from diesel engine. Two cylinder four stroke direct injection water cooled diesel engine is operates with Karanja Oil and pure diesel and the exhaust gas temperature efficiency, NOx and hydrocarbon, specific fuel consumption were compared for different percentages of hot and cold EGR for diesel and bio diesel as fuel.***

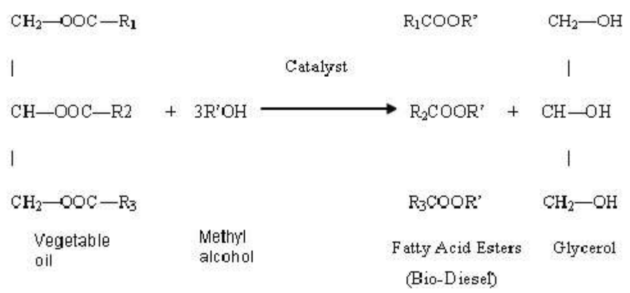
Keywords: Exhaust gas recirculation, NOx emission, Karanja Oil, Diesel engine, Bio-diesel.

1. Introduction

Today most of the problems arise due to environmental pollution. The major gas that affects the human and cause the breathing illness, smog, ozone layer depletion along with that it may cause acid rain also. Basically NOx is formed above 2500°F in the presence of air and nitrogen, compression ignition engine and are proffered prime movers due to excellent drivability and higher thermal efficiency. Biodiesel from vegetable oil are alternative to diesel fuel for diesel engine. The use of biodiesel in diesel engine does not require any engine modification. Biodiesel gives considerable lower emission of particulate matter (PM), Carbon monoxide (CO), and Hydrocarbon (HC) with little penalty on engine performance and fuel consumption. Many researchers have found that biodiesel fueled engine produce higher NOx emission compared to diesel. EGR is an effective technique of reducing NOx emission from the diesel engine, controlling the NOx emission primarily requires reduction of cylinder temperature however. The application of EGR results in higher fuel consumption and emission penalties and also EGR increases HC, CO and PM emission along with slightly higher specific fuel consumption. EGR rate are sufficient for high load. Also as the load increase diesel engine tends to generate more smoke because of reduced oxygen. [2] Md. Nurun Nabi et al conducted experiments in a four stroke naturally aspirated direct injection diesel engine and observed that diesel and bio diesel blends give lower carbon monoxide and smoke emission but higher oxides of nitrogen (NOx) emission as compared with conventional diesel fuel. In 1912, Sir Rudolf diesel used heat peanut oil as fuel in his own designed engine. Deepak Agrawal et al conducted a test on a single cylinder diesel engine and measured the performance and emission characteristics with rice bran methyl ester (RBME) and its blends as fuel with EGR system. They optimized and reported that 20% biodiesel blends with 15% EGR produce the less NOx, CO, HC emission and also improved thermal efficiency and reduced BSFC.

2. Transesterification of Karanja Oil

It is the process by which the heavier molecules of vegetable oil or amide facts which consist of mainly trigly oxide are converted into monogyceride. In this process the oils are reacted with methanol or ethanol in the presence of acid or base catalyst reaction of trensesterification process.



3. Preparation of Bio Diesel

Following ingredients are required in preparation of biodiesel:

- 5 kg Karanja oil, 2 litre methanol, 50gm KOH, water and test rig.
- Five litre of karanja oil was obtained from local market. Oil was filtered by using double layer cotton cloth to remove the solid particle and ether impurities.
- 50 gm of KOH was mixed in 250 ml methanol and stirred until we get homogeneous mixture.
- The Karanja oil was heated upto 60°C and poured in a tank which already contained KOH. Both of the fluids were agitated continuously for two hours and allowed to cool and settled. After about an hour the thick dark brown gel type fluid (glycerol) started setting in the bottom of the tank. The level of glycerol went on

increasing till six hours. It seemed that the reaction and setting was completed in six hours. However to make certain it was allowed to settle for further two hours. The light pale blackish fluid (biodiesel) was formed floating above the gel (glycerol). Both were separated gravitationally in two different vessels.

Since the transesterification is a reversible reaction therefore the excess methanol was used to ensure the completion of reaction. This was recovered by distillation method for further use.

4. Washing and Neutralization

Due to unreached KOH, PH value of the biodiesel was found to be 905 the biodiesel was washed with distilled water repeatedly to remove the KOH. The amount of soupy form went on decreasing with every wash. After four wash the soupy foam was completely absent and crystal clear water was formed. At that time the PH value of biodiesel was found to be 6.9 which is very close to that of diesel properties of fuel.

5. Exhaust Gas Recirculation

Part of the exhaust gas is to be re-circulated and put back to the combustion chamber along with the intake air. The quantity of this EGR is to be measured and controlled accurately; hence a by-pass for the exhaust gas is provided along with the manually controlled EGR valve. The exhaust gas comes out of the engine during the exhaust stroke at high pressure. It is pulsating in nature. It is desirable to remove these pulses in order to make the volumetric flow rate measurement of the re-circulated gas possible. For this purpose, another smaller air box is installed in the EGR route. An orifice meter is designed and installed to measure the volumetric flow rate of the EGR. A U-tube manometer is mounted across the orifice in order to measure the EGR flow rate.

EGR (%) is defined as the mass percentage of the re-circulated exhaust (MEGR) in total intake mixture (Mi)

$$\% \, EGR = \frac{\text{MEGR}}{\text{Mi}} \text{ X } 100$$

Where,
MEGR = Mass of re-circulated gas
Mi = Mass of total intake air of the cylinder.

6. Experimental Set-Up

A two cylinder diesel engine generator set is used in present investigation. It is a water cooled vertical direct injection, four stroke compression ignition engine. A variable venturi in which EGR- injector was allowed to move axially. At the rated speed (750 rpm) the engine develops approximately 7.5 KW power output. The inlet valve opens at 4.5 BTDC and closeness at 35.5^{o} ABDC. The exhaust valve opens at 35.5^{o}BBDC and closes at 4.5 ATDC. The engine is coupled with a single phase 220 volt A.C. generator. A load bank of 5.5 KW is used for loading the engine system.

Table 1: Engine Specification

Type	*Four Stroke*
Injection	Direct
Engine Manufacture	Dynamic Engineering Equipment
Cylinder	2
Bore x Stroke (mm)	200 X 300
Power/ Engine Speed (rpm)	7.5/ 15 00
Orifice Diameter (mm)	32
Injected Fuel mass (g)	1.02
Compression Ratio	16:5:1

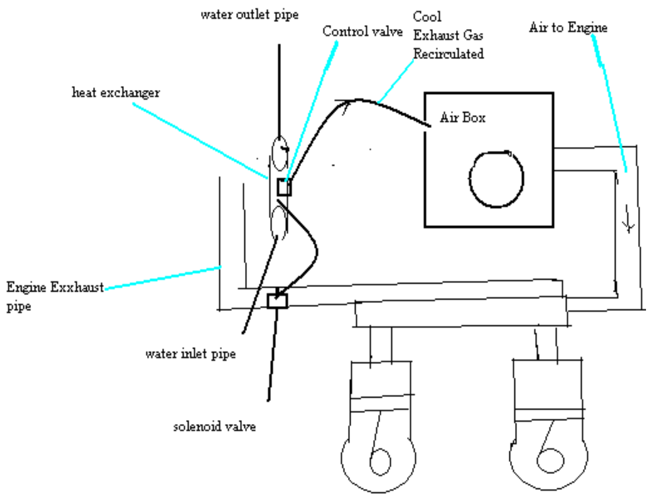


Figure 1: EGR system

Table 2: Fuel properties of karanja oil, diesel, biodiesel and its blends

Sr. No	*Fuel*	*Relative density*	*Kinematic viscosity (cSt)*	*Calorific value (MJ/kg)*
1	Karanja oil	0.913	27.81	34.01
2	B100	0.856	9.50	36.11
3	B20	0.845	3.34	38.21
4	B50	0.862	5.41	37.23
5	Diesel	0.844	2.60	42.21

7. Result and Discussion

In this experiment the engine test was carried out at 750 rpm. Here the performance and emission characteristics of engine are compared using different blends of biodiesel and diesel at fixed 15% EGR rate.

8. Exhaust Temperature

Figure 2 shows the variation of exhaust gas temperature with diesel and B20, B50, B100 with EGR. It can be observed that with 15% EGR rate diesel have lowest exhaust gas temperature as compared to blends of biodiesel .This is possible due to lower availability of oxygen for combustion and higher specific heat of intake air mixture.

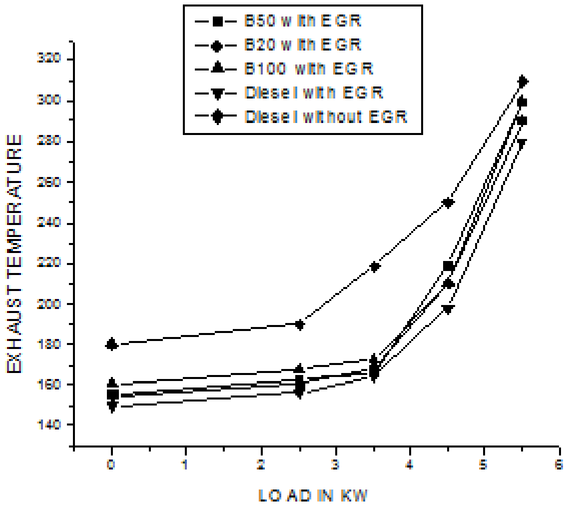


Figure 2: Load vs Exhaust Temperature

Brake Thermal Efficiency: Figure 3 shows the variation of brake thermal efficiency of biodiesel blends and biodiesel with EGR. It is observed that thermal efficiency are improved with increasing concentration of biodiesel and it's blends due to the higher oxygen present in the biodiesel. The higher thermal efficiency is obtained from B20 with 15% EGR.

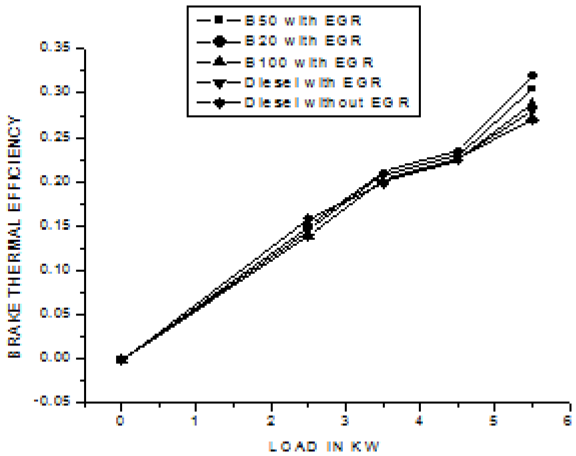


Figure 3: Load vs Thermal efficiency

Specific fuel consumption: Figure 4 shows the variation in specific fuel consumption at different load with and without EGR. It is observed that specific fuel consumption is lower for diesel at low loads operated with EGR. Specific fuel consumption is increased with increasing concentration of biodiesel blends due to lower calorific value and higher viscosity of biodiesel. The specific fuel consumption is higher in biodiesel blends as compared to diesel at full load operation with EGR.

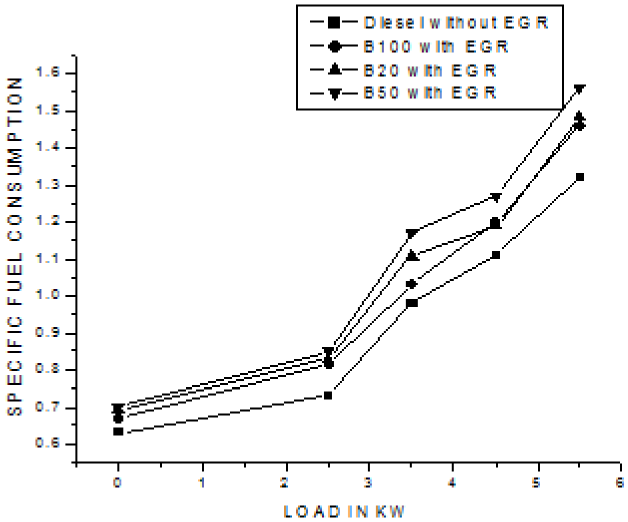


Figure 4: Load vs specific fuel consumption

9. Conclusion

The effect of EGR rates along with diesel and biodiesel fuel on performance parameters was investigated. The main conclusions are summarized as follow:

1) The exhaust gas temperature of engine with diesel as fuel was found to be lower than biodiesel and it's blends with constant EGR rate
2) The brake thermal efficiency of diesel engine under investigation with biodiesel and its blends fuel was to be higher than diesel as fuel with 15% EGR rate.
3) The specific fuel consumption of biodiesel and its blends was found to be higher than diesel as fuel with 15% EGR rate.

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