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Emission Characteristics of Totapuri Mango Methyl Ester Biodiesel Fuelled Single Cylinder Four Stroke Diesel Engine

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Abstract-The internal combustion engines are used in many claims to serve the purpose and efficiency improvements have been the hunt of engineers. The present study is to find the performance and emission characteristics of totapuri mango methyl ester biodiesel fueled single cylinder four stroke diesel engine. The engine was operated for 180, 200 and 220 bar injection pressures for D100, B20, B30 and B40 biodiesels. The experiments were carried out on water cooled diesel engine to determine the brake thermal efficiency, specific fuel consumption and emission charecteristics for different injection pressures. The experimental result shows that the brake thermal efficiency of the biodiesel was slightly lower than the brake thermal efficiency of diesel fueled engine. The specific fuel consumption of biodiesel was more compared to diesel. The CO emissions and NOx emissions are lower at the 200 bar injection pressure for all types of biodiesels. The NOx emissions increases and CO2 emissions decreases as totapuri mango methyl ester blend boosts in the pure diesel.

Keywords- Biodiesel, CI engine, Emissions, Nox emission

1. INTRODUCTION

The services of the automotives are superior in the daily life of the human beings. Nowadays, human beings are more depend on the automotives for common purposes like purchasing of food products from the nearest stores and for travelling from on one place to other place which leads to more utilization of petroleum products. The petroleum products are needed to generate thermal energy in the combustion chamber of the automotives for smooth operation. Only 30% of the thermal energy generated by the engine is renewed into useful work and remaining energy is dissipated through cylinder walls, engine head, piston head by direct heat loss and exits through exhaust gasses. The overall efficiency of the internal combustion engine is only about 40% - 42%. This efficiency may be due to a number of issues like; deficient in employing latest methods for design of combustion chamber, meager oxygen furnishing to the combustion chamber, lack of creating turbulence in the combustion chamber, deficient in optimizing the injection pressure of the fuel and compression ratio of the engine. The efficiency of the engine can be improved in one or the other way to save fuel energy and oils. In recent days, there is a maximum demand for fuels and oils leads to higher cost and non availability. This demand can be reduced by improving the efficiency of the internal combustions engines which is the challenge for the engineers [1]. The biodiesels are the alternate fuels can be used in automotives to reduce the use of petroleum products [2]. Many researchers were studied the influence of injection pressure in improving the thermal efficiency of the biodiesel fueled internal combustion engines with declined pollutants and some of the literatures were reviewed [3-4]. N.R.Banapurmath et al., [5] have performed the experiment on a single cylinder, four stroke, direct injection, water cooled CI engine operated using the biodiesels like; Honge, Neem and Rice bran oils. The fuel economy increases and enhances the combustion temperature of the diesel engine compared to the engine operated using the diesel fuel. The emission characteristics are decreased and CO emission is slightly enhanced. Z H Huang et al., [6] have experimented to reduce the exhaust gas emissions in the diesel engine operated by using dimethyl ether. The various parameter like thermal efficiency, specific fuel consumption BSFC and emission characteristics are determined. The fuel economy increases and enhances the combustion temperature of the diesel engine compared to the engine operated using the diesel fuel with decreased emission characteristics. GVNSR Ratnakara Rao et al., [7] have conducted the experiments in a diesel engine using mango oil as a fuel by varying the compression ratio at a steady engine speed of 1500 rpm. The result indicates that the performance is improved by 15.7 is finest compression ratio with the mango oil. The emission characteristics are decreased and CO emission is slightly enhanced. Sukumar Puhan, N et al., [8] in this investigation, mango oil methyl ester was transesterified with methanol via sodium hydroxide as catalyst by reaction duration of 120min. This biodiesel performance in determined in single cylinder 4 stroke DI engine at steady speed. The fuel economy increases and enhances the combustion temperature with moderate performance the diesel engine compared to the engine operated using the diesel fuel. Similar results are indicated by Sharanappa Godiganur et al., [9]. S.K.Haldar yiet et al., [10] they are studied the performance of the diesel engine by using the putranjiva oil blends as the biodiesel fuels. The 30% blend of puntranjiva oil gives the same power out as that of diesel oil fuel power out in the diesel engine. Thus 30% blend of puntranjiva oil can be employed as an substitute fuel for diesel engine with better emission characteristics. Y C Bhatt et al., [11] have conducted the experiments in a diesel engine using mango oil as a fuel by varying the compression ratio at a stable engine speed of 1500 rpm. The calorific value of the mango oil is 96.3 % of the calorific value of the diesel oil. The 20% blend is prepared and used as biodiesel fuel. The result indicates that the performance is improved with enhances in the compression ratio with the mango oil [12]. Some of the investigations were carried out by many researchers on biodiesels [13-16]. A thorough evaluation of the literature survey shows that there are incredibly little investigations have reported on the consequences on the performance of mango methyl ester biodiesel fueled single cylinder 4 stroke diesel engine. Thus, the present investigation is carried out to study the performance and emission characteristics of biodiesel fueled single cylinder 4-stroke diesel engine.

2. PREPARATION OF MANGO METHYL ESTER OIL

The totapuri mango seeds are first collected from the local area, mango juice centers and mango pickle industries. The collected mango seed were dried for two weeks and the outer shell of mango seeds were broken down after drying. Mango seed kernels were dried for a week and then crushed in local oil mill to obtain mango seed oil. The MSO is converted to biodiesel by transesterification process. It is the process of reacting the oil with methanol in the presence of catalyst (KOH). During the process, the molecule of raw mango seed oil is chemically broken to form the ester and glycerol. Mango seed ester is filtered to separate from glycerol. The mango seed oil was mixed with methanol and the mixture is heated at a temperature of 65^{o} C to 75^{o} C. The mixture is stirred occasionally and then kept aside for about 16 hrs. Similar process was adopted for production of biodiesels by M.P.Dorado et al.,[17].

Table 1: The properties of biodiesels

Property	Diesel	MSBD20	MSBD40
Kinematic viscosity at 40° C (m^2/s)	$3.9x10^{-6}$	$8.54x10^{-6}$	$10.69x10^{-6}$
Calorific value (kJ/kg)	43000	40975.9	40193
Density (kg/m^3)	830	824.16	840.16
Flash point (°C)	56	63	71
Fire point (°C)	65	68	80

3. EXPERIMENTAL PROCEDURE

The experiment was conducted to determine the consequence of injection pressure on performance on mango methyl ester biodiesel fuelled CI engine. The experiments were carried out at steady speed of 3000 rpm for comparing the performance of C.I engine by varying its injection pressure for pure diesel and for blend of bio-diesel. The biodiesel blend is prepared by adding 20%, 30% and 40% of mango methyl ester oil to the pure diesel for testing. A single cylinder computerized diesel engine is used for the conduction of experimentations which is an electrically loaded, water cooled engine directly interfaced with computer as shown in figure. This engine having a facility to varying the parameters like; load on the engine, speed and injection pressure of the engine. The piezo-electric pressure transducer is fitted at the crown of the engine head to measure the pressure at each cycle for different constraints. The indicated mean effective pressure values of the cycles are considered based on the repetitiveness in the readings. This is also provided the sensors to gauge the temperature of inlet and exhaust gas, jacket water and calorimeter water temperature. The engine was operated for 180, 200 and 220 bar injection pressures for D100, B20, B30 and B40 biodiesels. The thermal efficiency, specific fuel consumption and emission characteristics were discussed.

Figure 1: Single cylinder 4-stroke diesel engine test rig

4. RESULTS AND DISCUSSIONS

This section presents the experimental results and its discussions on the influence of injection pressure on the specific fuel consumption, brake thermal efficiency, exhaust gas temperature and emission charecteristics of the biodiesel fueled diesel engine.

4.1 *Influence of injection pressure on specific fuel consumption*

Figure 2 depicts the influence of injection pressure on specific fuel consumption by the diesel engine when the engine was operated for 180 bar, 200 bar and 220 bar injection pressures for D100, B20, B30 and B40 biodiesels. The specific fuel consumption is lower at the 200 bar injection pressure for all types of biodiesels. The specific fuel consumption increases as mango methyl ester blend augments in the pure diesel. The specific fuel consumption of B20 biodiesel enhances by 6.67% and the specific fuel consumption of B40 biodiesel enhances by 16.67% when compared to the specific fuel consumption of D100 diesel at 200 bar injection pressure [18].

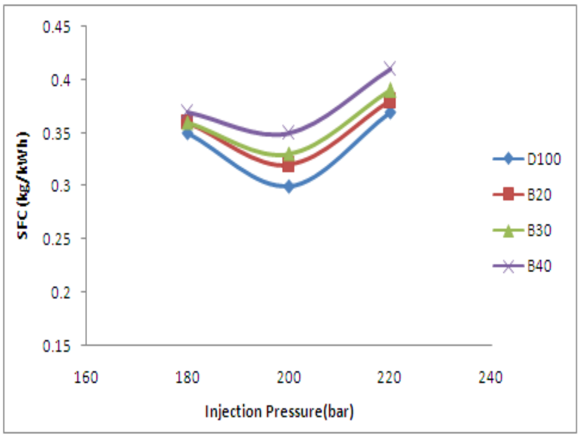

Figure 2: Influence of injection pressure on specific fuel consumption

4.2 *Influence of injection pressure on brake thermal efficiency*

Figure 3 illustrates the influence of injection pressure on brake thermal efficiency of the diesel engine when the engine was operated for 180 bar, 200 bar and 220 bar injection pressures for D100, B20, B30 and B40 biodiesels. The brake thermal efficiency is superior at the 200 bar injection pressure for all types of biodiesels. The brake thermal efficiency decreases as mango methyl ester blend boosts in the pure diesel. The brake thermal efficiency of B20 biodiesel declines by 5.87% and the brake thermal efficiency of biodiesel B30 diminish by 14.78% when compared to the brake thermal efficiency of D100 diesel at 200 bar injection pressure [19].

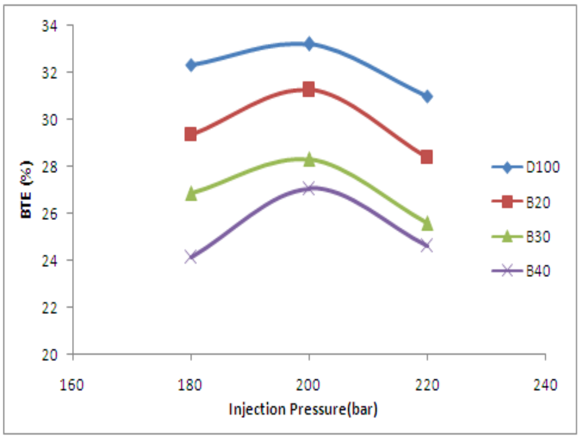

Figure 3: Influence of injection pressure on Brake thermal efficiency

4.3 *Influence of injection pressure on exhaust gas temperature*

Figure 4 illustrates the influence of injection pressure on exhaust gas temperature of the diesel engine when the engine was operated for 180 bar, 200 bar and 220 bar injection pressures for D100, B20, B30 and B40 biodiesels. The exhaust gas temperature is lower at the 200 bar injection pressure for all types of biodiesels. The exhaust gas temperature decreases as mango methyl ester blend boosts in the pure diesel. The exhaust gas temperature of B20 biodiesel declines by 3.2% and the exhaust gas temperature of biodiesel B40 diminish by 6.73% when compared to the exhaust gas temperature of D100 diesel at 200 bar injection pressure [20].

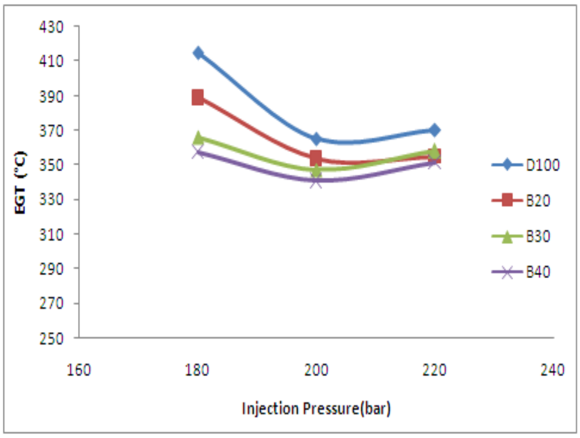

Figure 4: Influence of injection pressure on exhaust gas temperature

4.4 *Influence of injection pressure on CO emissions*

Figure 5 illustrates the influence of injection pressure on CO emissions of the diesel engine when the engine was operated for 180 bar, 200 bar and 220 bar injection pressures for D100, B20, B30 and B40 biodiesels. The CO emissions are lower at the 200 bar injection pressure for all types of biodiesels. The CO emissions increases as mango methyl ester blend boosts in the pure diesel. The CO emissions of B20 biodiesel amplifies and the CO emissions of biodiesel B30 boosts when compared to the CO emissions of D100 diesel at 200 bar injection pressure [21].

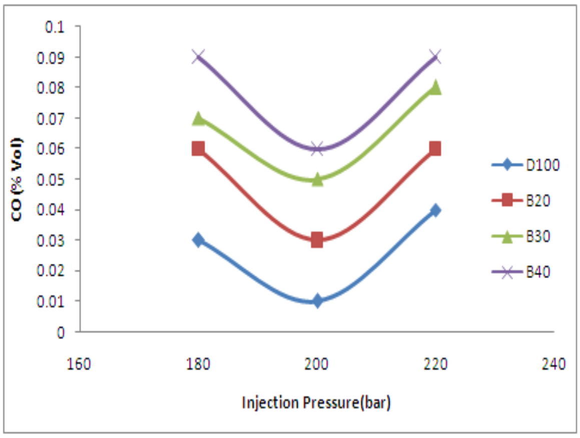

Figure 5: Influence of injection pressure on CO emissions

4.5 *Influence of injection pressure on HC emissions*

Figure 6 illustrates the influence of injection pressure on HC emissions of the diesel engine when the engine was operated for 180 bar, 200 bar and 220 bar injection pressures for D100, B20, B30 and B40 biodiesels. The HC emissions are higher at the 200 bar injection pressure for all types of biodiesels. The HC emissions decreases as mango methyl ester blend boosts in the pure diesel. The HC emissions of B20 biodiesel declines by 8.33% and the HC emissions of biodiesel B30 diminish by 20.83% when compared to the HC emissions of D100 diesel at 200 bar injection pressure [22].

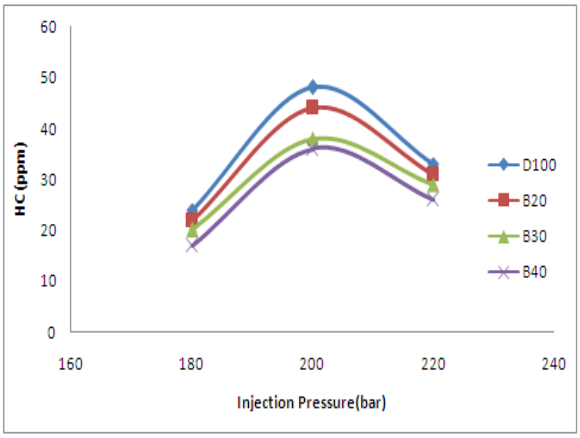

Figure 6: Influence of injection pressure on HC emissions

4.6 *Influence of injection pressure on NOx emissions*

Figure 7 illustrates the influence of injection pressure on NOx emissions of the diesel engine when the engine was operated for 180 bar, 200 bar and 220 bar injection pressures for D100, B20, B30 and B40 biodiesels. The NOx emissions are lower at the 200 bar injection pressure for all types of biodiesels. The NOx emissions increases as mango methyl ester blend boosts in the pure diesel. The NOx emissions of B20 biodiesel boosts by 8.86% and the NOx emissions of biodiesel B30 amplifies by 15.18% when compared to the NOx emissions of D100 diesel at 200 bar injection pressure [22].

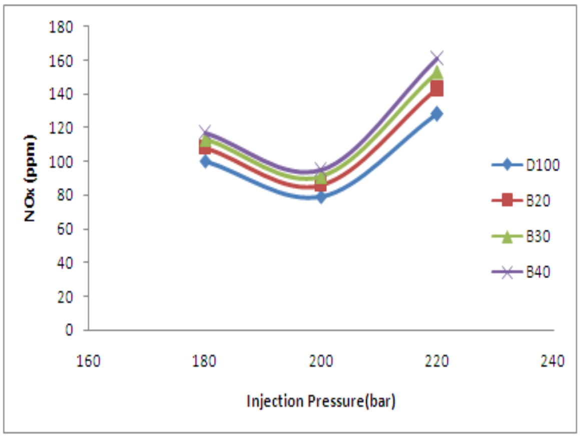

Figure 7: Influence of injection pressure on NOx emissions

4.7 *Influence of injection pressure on CO_2 emissions*

Figure 8 illustrates the influence of injection pressure on CO_2 emissions of the diesel engine when the engine was operated for 180 bar, 200 bar and 220 bar injection pressures for D100, B20, B30 and B40 biodiesels. The CO_2 emissions are higher at the 200 bar injection pressure for all types of biodiesels. The CO_2 emissions decreases as mango methyl ester blend boosts in the pure diesel. The CO_2 emissions of B20 biodiesel declines by 13.15% and the CO_2 emissions of biodiesel B40 diminish by 21.05% when compared to the CO_2 emissions of D100 diesel at 200 bar injection pressure.

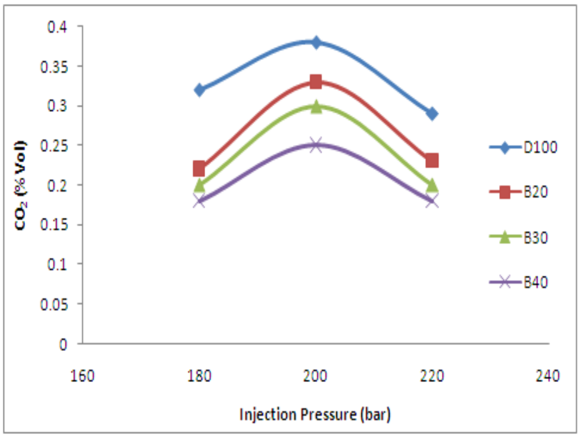

Figure 8: Influence of injection pressure on CO_2 emissions

5. CONCLUSIONS

The performance and emission characteristics of mango methyl ester biodiesel fuelled CI engine were determined. The totapuri mango oil was extracted from the mango seeds collected from the local area, mango juice centers and mango pickle industries. The specific fuel consumption is lower at the 200 bar injection pressure for all types of biodiesels. The specific fuel consumption increases as mango methyl ester blend augments in the pure diesel. The brake thermal efficiency is superior at the 200 bar injection pressure for all types of biodiesels. The brake thermal efficiency of B20 biodiesel declines by 5.87% and the brake thermal efficiency of biodiesel B30 diminish by 14.78% when compared to the brake thermal efficiency of D100 diesel at 200 bar injection pressure. The CO emissions are lower at the 200 bar injection pressure for all types of biodiesels. The NOx emissions are lower at the 200 bar injection pressure for all types of biodiesels. The NOx emissions increases and CO_2 emissions decreases as mango methyl ester blend boosts in the pure diesel.

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