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Emission Analysis of Non edible Jatropha Curcus and Madhuca Longifolia B20 Blends with Edible Oil

Environment Enginnering

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***Abstract*—Diminishing of conventional fuels and excessive use of fuels leads to deterioration of the environment, which focuses the research on biofuels. Biofuels from different sources attract the attention of research due to low emission and biodegradability. This paper examines and compares the emission of Jatropha Curcus (JCO) and Madhuca Longifolia (MIO) B20% blends with vegetable oil. Engine emission results indicated that JCO 20 and MIO 20 fuels reduced the average emission of carbon monoxide by 12 and 11% respectively, and hydrocarbons by 15 and 12% respectively. However, the JCO 20 and MIO 20 fuels slightly increased nitrous oxide emission by 7 and 9%, respectively, and carbon dioxide by 7 and 5% respectively compared to conventional diesel. In conclusion, JCO and MIO are potential feedstock for biodiesel production and produce cleaner exhaust emission.**

***Keywords*—Jatropha Curcus, Madhuca Longifolia, Emissions and Biofuels**

I. Introduction

Air pollution is a main cause of health problem in India after water pollution. Beside industrial pollution, vehicle emissions are mainly responsible pollutant content for the deterioration of air quality. Recently exhaust emission have increased many fold due to rapid development of the transport industry and ease availability of vehicles for a large section of society. Due to increases in the numbers of vehicles, emission produced in combustion of petroleum based fuels rises that cause the adverse effect on the environment and health. Moreover, environment assessment authority of India indicates that carbon dioxide (CO_2), nitrogen oxide (NO_X) and carbon monoxide (CO) are the main cause of global warming. The internal combustion (IC) engine of vehicles emits CO_2, NO_X, CO and particulate matter. So to overcome the problem of emission/ environment degradation the Government of India (GOI) in association with Ministry of New and Renewable Energy (MNRE) framed the policy to use B20 fuels in all vehicles up to 2017.

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In addition to that MNRE is also exploiting the potential of non-edible oil for biofuels. Jatropha curcus and Madhuca Longifolia are two prominent non edible plants, to produce biofuels through transesterification in the context of India. But from the last decade many researcher across the countries worked on Jatropha curcus and Madhuca Longifolia for technically and economically viability. So, Biodiesel is one the best biofuels that can reduce the emission as well as import of crude oil.

Various researcher and central laboratories are emphasis on the emission and performance of the engine using different blends of biodiesel. Durbin et al studied and compared diesel fuel with 20% biodiesel blend on four light heavy-duty diesel trucks. The results showed that biodiesel and the biodiesel blends produced lower THC and CO emissions [1]. Nabi.et al., reported combustion and exhaust emissions with neat diesel fuel and diesel–biodiesel blends. From the work, they concluded that biodiesel blends have lower carbon monoxide (CO), and smoke emissions but higher oxides of nitrogen (NO_x) emission [2]. Lapuerta et al the reported that engine emissions from biodiesel and diesel fuels are compared. They concluded that special attention to the most concerning emissions of nitric oxides and particulate matter of biodiesel [3]. Basha et al reviewed biodiesel production, combustion, performance and emissions. They concluded that vegetable oils, either chemically altered or blended with diesel to prevent the engine failure [4]. Q1 et al studied, the biodiesel produced from soybean crude oil was prepared by a method of alkaline-catalyzed transesterification. They proved significant improvement in reduction of carbon monoxide (CO) and Hydrocarbon (HC) had no evident variation for all tested fuels. Moreover Nitrogen oxides (NOx) found slightly higher for biodiesel and its blends [5]. Demirbas and Ayhan predicited the future growth of biodiesel and expected that end of 2010, the United States is expected to become the world's largest single biodiesel market, accounting for roughly 18% of world biodiesel consumption, followed by Germany[6]. Raheman & Ghadge presented the performance and emission of mahua oil and its blend with high speed diesel engine. They concluded that reductions in exhaust emissions and brake specific fuel consumption together with increase brake power, brake thermal efficiency made the blend of biodiesel (B20) a suitable alternative fuel for diesel and thus could help in controlling air pollution [7]. Banapurmath et al concentrate on emissions and performance of higher brake thermal efficiency and lower emissions (HC, CO, NO_X) with sesame oil methyl ester operation and compared to methyl esters of Honge and Jatropha oil [8]. No et al reported that a diesel engine without any modification would run successfully on a blend of 20%

vegetable oil and 80% diesel fuel without damage to engine parts. From work they suggested that the biodiesel blends can be use up to 40% blend [9]. Saravanan et al investigated the Mahua oil transesterification using methanol in the presence of alkali catalyst and studied the performance and emission characteristics. They concluded that Emissions such as carbon monoxide, hydrocarbon lesser for Mahua ester compared to diesel by 26% and 20% respectively. Oxides of nitrogen lesser by 4% for the ester compared to diesel [10] . Sohpal et al and Kumar et al synthesized biodiesel from edible, non-edible Jatropha Curcus through transesterification with higher alcohol and reported that Jatropha Curcas oil with butanol in the ratio of 1:25 and sodium hydroxide catalyst with mixing intensity of 250 rpm in isothermal batch reactor provide the optimum production of biodiesel [11 & 12].

II. Material and Method

Jatropha Curcus, Madhuca Longifolia oil and transesterfied edible oil collected from National Biofuels Corporation, New Delhi . The test fuels were blended with diesel using a higher speed of homogenizer operated approximately at 2000 rpm. The experimental investigation was carried out using diesel fuel, B20 edible oil, and non edible Jatropha Curcus (JCO) and Madhuca Longifolia (MIO) blend.

The test engine was a single cylinder compression diesel engine. The engine test rig exhaust connected to 5 gas analyzer probe. Loads applied on the rope-brake dynamo-meter. The temperature measured using thermocouple placed at appropriate place inside the engine. The room temperature measured prior to conduct of experiments. The detailed specifications of the engine are listed in table 1.

TABLE I. ENGINE SPECIFICATION

Parameters	Range
No. of Cylinders	Single Cylinder
Stroke	139.7mm
RPM	810
Power	6 HP (4.4 KW)
Compression ratio	16:1

III. Results & Discussions

A. *Emission Analysis of CO_2*

The variation of CO_2 emissions for all the B-20 blend samples at various loads is shown in Fig. 1. When the engine loading increased, the CO_2 emissions also increased. The biodiesel fuel blends JCO B20 and MIO B20 gave 13 and 18% average increase in CO_2 emissions relative to diesel fuel, respectively. The variation of emission in all other edible oil also increased with engine loading and the result is consistent. The production of carbon dioxide in IC engine from the combustion of pure diesel causes many environmental problems such as the accumulation of carbon dioxide in the atmosphere. Although biofuels combustion produces more carbon dioxide as compare to pure diesel and edible oil, but absorption of CO_2 in plants for photosynthesis helps to maintain CO_2 levels in the atmosphere. The lowest CO_2 (% vol) emission 4.5 observed in B20 soybean oil and highest reported in B20 MIO.

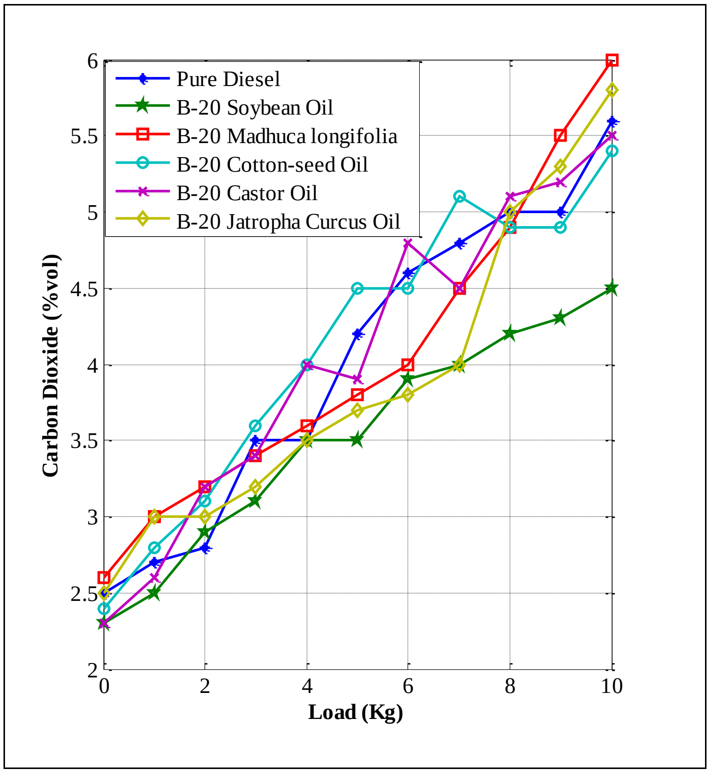

Figure1. Variation of CO_2 emissions with respect to engine loading

B. *Emission Analysis of CO*

Clean emissions of H-C require excess of oxygen for complete combustion in IC engine. In general absence/lower volume of molecular oxygen in the fuel, combustion was incomplete, and CO was emitted. In addition to that, various parameters like the air to fuel ratio, the engine loading, the injection timing and the fuel type influence CO emissions. The variation of CO emissions with pure diesel and biodiesel blends is shown in Fig. 2. Over the entire range of engine loading, the JCO B20 and MIO B20 reduced the CO emissions by 20% and 18% relative to pure diesel, respectively. But the emission of CO (% vol) from B20 of soybean blend is approximately equal pure diesel at lowest loading. The reduction of CO emissions is attributed to the higher oxygen content and cetane number of biodiesel fuel. JCO and MIO contain 15% more oxygen that diesel. The higher percentage of oxygen content of biodiesel allows more carbon molecules to burn, and fuel combustion is complete. Thus, CO emissions are lower in biodiesel fuel as compared to diesel.

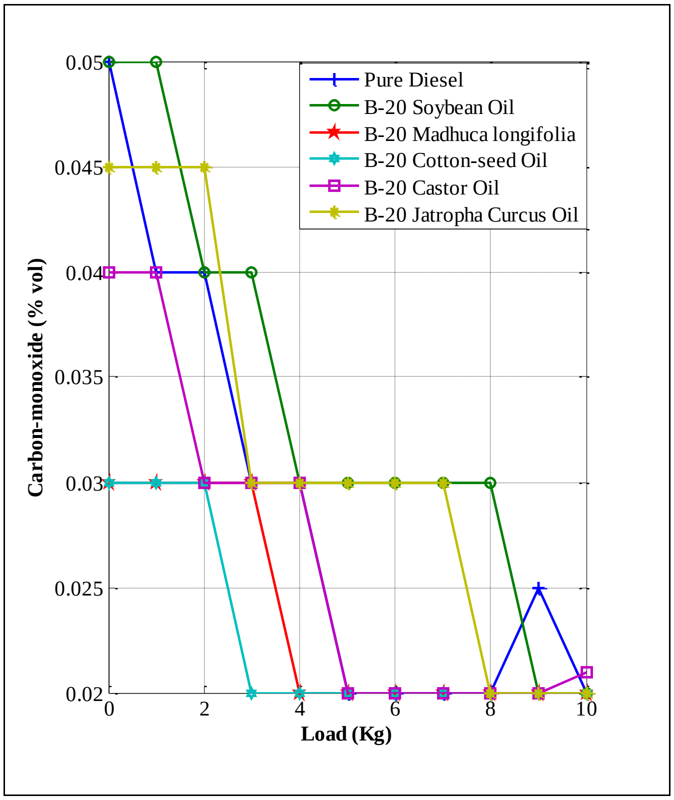

Figure2. Variation of CO emissions with respect to engine loading

C. *Emission Analysis of NO_x*

Biofuels are mostly contained higher percentage of unsaturated fatty acids (Oleic, linoleic and palmatic) that rise adiabatic flame temperatures, which cause higher NO emissions. The variation of the NO emissions for pure diesel and biodiesel blend fuels is shown in Fig. 3. The NO values are higher for JCO B20 and MIO B20 biodiesel blends than diesel fuel. On average, the JCO B20 and MIO B20 produce 6% and 3% higher NO emissions, respectively, than diesel fuel over the entire range of loading. This result can be attributed to the leaner air/fuel ratio as biodiesel is an oxygenated fuel and contains 12-18% excess molecular oxygen than pure diesel that raises combustion chamber temperatures and improves combustion. Thus, NO emissions are higher for biodiesel blends than for diesel fuel.

D. *Emission Analysis of H-C*

Biodiesel fuels have molecular oxygen 15-20 % higher than conventional diesel. H-C emission is the product of unburned H-C of fuel due incomplete combustion of fuels and flame quenching. The variation of H-C emissions for diesel and biodiesel blend fuels is shown in Fig. 4.

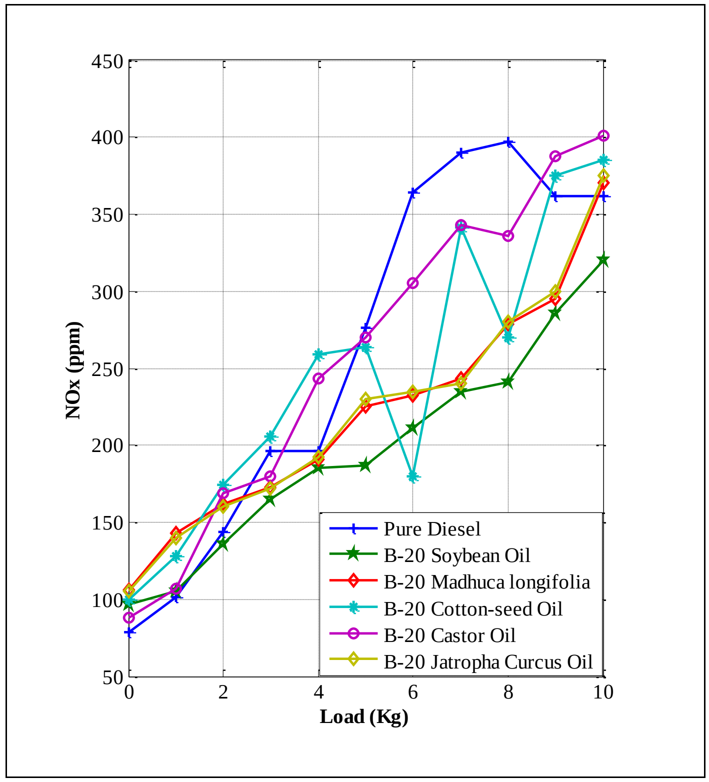

Figure3. Variation of NOx emissions with respect to engine loading

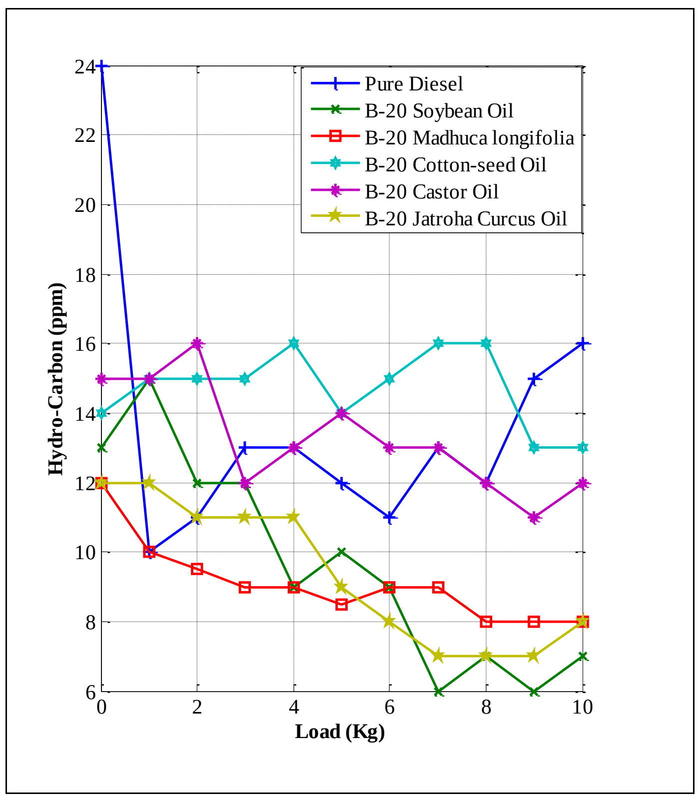

Figure4. Variation of H-C emissions with respect to engine loading

For the JCO B20 and MIO B20, the unburned HC emissions are lower than for diesel fuel. Over the entire range of engine loading, the normal reductions in H-C emission for the JCO B20 and MIO B20 are 46% and 52% relative to pure diesel, respectively. These reductions are attributed to the high oxygen contents of these biodiesel fuels. Biodiesel contains more oxygen and less carbon and hydrogen than diesel fuel, which guarantees more complete combustion.

iv. Conclusions

JCO and MIO have excel to potential to reduce dependency on fossil-based diesel fuel and environmental pollution, In this paper, over the entire range of engine loading, the JCO20 and MIO20 reduced the average CO emissions by 20 and 18%, respectively; and HC emissions by 46 and 52%, respectively. However, the JCO20 and MIO 20 slightly increased NO emissions by 6 and 3%, respectively, and CO_2 emissions by 13 and 18% relative to diesel fuel. In conclusion, the Jatropha curcus and Madhuca Longifolia oils are potential feedstock for biodiesel production, and the JB10 and MB10 biodiesels can replace diesel fuel in unmodified engines to reduce exhaust emissions into the environment.

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