Exhaust Gas Emission Analysis for Variable Injection Pressure 1-Cylender Engine for 2 Different Feedstock Biodiesel Blended in Diesel

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Abstract- The energy strategy of a country aims at efficiency and security and to provide access which being environment friendly and achievement of an optimum mix of primary resources for energy generation. Fossil fuels will continue to play a dominant role in the energy scenario in our country in the next few decades. However, conventional or fossil fuel resources are limited, non-renewable, polluting and, therefore, need to be used prudently. On the other hand, renewable energy resources are indigenous, non-polluting and virtually inexhaustible. India is endowed with abundant renewable energy resources. Therefore, their use should be encouraged in every possible way. The crude oil price has been fluctuating in the world market and has increased significantly in the recent past, reaching a level of more than $ 140 per barrel. Such unforeseen escalation of crude oil prices is severely straining various economies the world over, particularly those of the developing countries. India's energy security would remain vulnerable until alternative fuels to substitute/supplement petro-based fuels are developed based on indigenously produced renewable feedstocks. In biofuels, the country has a ray of hope in providing energy security. Biofuels are environment friendly fuels and their utilization would address global concerns about containment of carbon emissions. The transportation sector has been identified as a major polluting sector. Use of biofuels have, therefore, becomes compelling in view of the tightening automotive vehicle emission standards to curb air pollution. For the very existence of internal combustion engine in the wide spread as they do now, it is renewable, sustainable and alternative fuel i.e. biodiesel instead of diesel has been increasingly fuelled to study its effects on engine performances and emissions in the recent two decades. In the present work, the performance and emissions of diesel and diesel blended with waste vegetable oil (cooking oil) plus palm staerin is studied, where the fuel, namely, waste vegetable oil biodiesel with palm staerin and diesel were chosen and used as fuel in the form of blends. This work presents the experimental investigation carried on computerized four stroke single cylinder diesel engine with variable compression ratio and variable injection pressure for diesel-(wco + ps)biodiesel blends.

Keywords – Feedstocks, WCOBD, PSBD, emissions, blends, injection pressure etc.

I. INTRODUCTION

Bio-diesel is not your regular vegetable oil and is not safe to swallow. However, biodiesel is considered biodegradable, so it is considered to be much less harmful to the environment if spilled. Biodiesel also has been shown to produce lower tailpipe emissions than regular fuel. The best thing about biodiesel is that it is made from plants and animals, which are renewable resources. The depletion of world petroleum sources and increased environmental concerns has stimulated recent interest in alternative sources for petroleum based fuels. Biodiesel produced from vegetable oil or animal fats by transesterification with alcohol like methanol and ethanol is recommended for use as a substitute for petroleum-based diesel mainly because biodiesel is an oxygenated, renewable, biodegradable and environmentally friendly bio-fuel with similar flow performance and low emission profile. The used cooking oil has been classified as waste, while its potential as a liquid fuel through physical and chemical conversion remains highly interesting. It is increasingly attracting much interest because of its great potential to be used as a diesel substitute known as biodiesel. Direct process via transesterification of cooking oils will give biodiesel. One of the advantages of these fuels is reduced exhaust gas emissions. Experience has shown that vegetable oil based fuels can significantly reduce exhaust gas emissions, including carbon monoxide (CO), carbon dioxide (CO2), and particulate matter (PM). Because of their less concentration of sulfur, the sulfur dioxide greases cannot only reduce the burden of the government in disposing the waste, maintaining public sewers and treating the oily wastewater, but also helps in lowering the production cost of biodiesel significantly. Furthermore, biodiesel fuel has been shown to be successfully produced from waste cooking oils by an alkali-catalyzed transesterification process and can be considered as alternative fuel in diesel engines and other utilities.There is need to convert waste cooking oil from kitchen waste into biodiesel and transesterification is the most suitable process for this conversion.

The present investigation used the emissions of diesel plus diesel blended with waste vegetable oil diesel also called waste cooking oil biodiesel and palm staerin biobiesel is studied and the best emission of oil blends were identified. The blended form of waste vegetable oil plus palm staerin and diesel does not require any engine modification. Hence, this investigation mainly focused on the emissions of diesel and diesel blended with waste vegetable oil plus palm staerin in the proportionate ratios.

II. WASTE COOKING OIL

Fried food items are very popular in the coastal regions of India. Generally cooking oil used for frying are sunflower oil, palm oil, coconut oil etc. as they are easily available, and especially so of the coconut oil which is abundantly available in south India. It is well known fact that, when oils such as these are heated for an extended time, they undergo oxidation and give rise to oxides. Many of these such as hydro peroxides, peroxides and polymeric substances have shown adverse health/biological effects such as growth retardation, increase in liver and kidney size as well as cellular damage to different organs when fed to laboratory animals [7]. Thus, used cooking oils constitute a waste generated from activities in the food sectors (industries and large catering or community restaurants), which have greatly increased in recent years. Most of the waste (overused /abused) cooking oil are disposed inappropriately, mostly let into the municipal drainage, leading to water pollution. The primary end use of WCO in existence now is to utilize it as a fuel in residential and industrial heating devices. An alternative to prevent inappropriate disposal of WCO is by recycling it. The main use of recycled WCO is in the production of animal feeds and in a much smaller proportion in the manufacture of soaps and biodegradable lubricants. Some health risks can be traced from the use of recycled cooking oils in animal feeding, such as undesirable levels of contaminants, particularly PAHs (Polycyclic aromatic hydrocarbons), PCBs (Polychlorinated biphenyls), dioxins and dioxin related substances [8]. By consumptions of animal origin foodstuffs like milk, meats, poultry and other products, these undesirable contaminants enter the human body and cause serious long term health hazards. As these contaminants are lip soluble, they accumulate in organic lipids and finally in the body, and thereby their concentration increases gradually over the years. In other words, the body is exposed not only to a single acute action, but also to a chronic action of bioaccumulation of these hazardous compounds over the years [8]. Hence utilizing the recycled WCO in any way is not advisable from health standpoint.

III. MATERIALS AND METHODS

Engine Specifications
The test is carried out in an engineering college using a
kirloskar make,
Type 1cylinder,
4 stroke diesel,
Water cooled,
Model tv1,
Stroke 110 mm,
Bore 87.5 mm.
661 cc,
VCR engine CR range 12 to 18
VIP engine IP range 200bar to 250bar
Dynamometer Type eddy current,
Water cooled,
Loading unit Eddy current

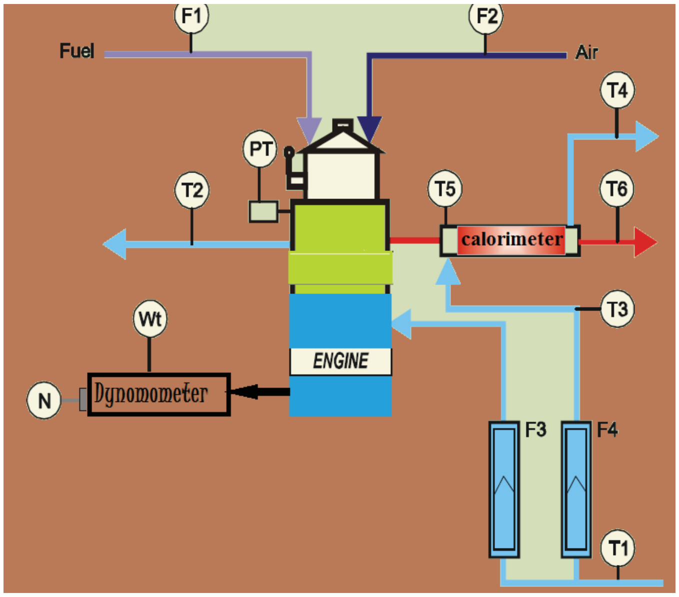

Fig.1. Experimental set up

Where,

F1	Fuel consumption	
F2	Air consumption	
N	Engine speed	rpm
Wt	Loading in	kg
F1	Fuel consumption	kg/hr
F2	Air consumption	kg/hr
F4	Calorimeter water flow	kg/hr
T1	Engine water inlet temperature	^{0}K
T2	Engine water outlet temperature	^{0}K
T3	Calorimeter water inlet temperature	^{0}K
T4	Calorimeter water outlet temperature	^{0}K
T5	Exhaust gas to calorimeter inlet temp.	^{0}K
T6	Exhaust gas from calorimeter outlet temp.	^{0}K

IV. EXPERIMENTATION

A single cylinder, four stroke, air cooled, constant speed direct injection compression ignition with variable injection pressure engine was used in the experimentation. The engine speed was noted using inductive pickup sensor calibrated with digital speed indicator. The mass flow rate of blended fuel is calculated using volumetric basis using a burette and a stop watch. The exhaust gas temperature was measured using a thermocouple attached with digital temperature indicator is employed.

Table1. Composition of fuel mixtures tested

Fuel mixture	Percent diesel (volume)	Percent biodiesel (volume) Feedstock: Waste Cooking Oil	Percent biodiesel (volume) Feedstock: Palm Stearin
1	70	15	15
2	80	10	10
3	90	5	5
4	100	0	0

Note: each fuel mixture is tested for different injection pressure of 200bar, 225bar & 250bar each

Emission analysis was conducted with portable emission analyser DELTA 1600-L. Exhaust gases from the engine was taken directly to the sampling tube. It measures carbon monoxide (CO), carbon dioxide (CO2), hydrocarbons (HC) and nitric oxide (NO). Both heated line and conditioning lines are provide with the instrument. Heated line serves to avoid condensation by ensuring the gas temperature about 200oC and conditioning line maintains the gas temperature bellow 40^0C and the saturation level is correct. The exhaust gas analyzer determines the emissions of CO (carbon monoxides), CO2 (carbon dioxides), HC (hydrocarbons) with means of infrared measurement and O2 (oxygen) and NO (nitrogen oxides) with means of electrochemical sensors. The 5-gas analysis is processed by the integrated microprocessor and described in the display. Table 3 represents specification of emission analyser.

Table2. Specifications of Emission Analyser

Measurement	Measuring Range	Resolution
Oxygen (O2)	0 – 25 % vol	0.01 %
Carbon monoxide (CO)	0 – 15 %	0.01 %
Carbon dioxide (CO2)	0 – 20 %	0.1 %
Carbon hydride (HC)	0 – 20000 ppm n-hexane	1 ppm
Nitrogen monoxide (NO)	0 – 2000 ppm	1 ppm

V. RESULTS AND DISCUSSIONS

A range of fuel mixtures were burned in a systematic study of emission of an IC engine. These mixtures are defined in Table 1 and were tested under three different injection pressures namely 200bar 225bar & 250bar.

The experimental data were collected and worked upon, leading to the results presented in Figures 2-7. In addition to the fuel mixture, petroleum diesel fuel and biodiesel were burned separately so as to establish engine emission during their combustion processes. For simplicity, only a sample of the results obtained from these experiments have been presented and discussed in this section. This enables the main findings of the study to be identified and explained.

Typical results for the variations of the brake power, carbon monoxide and hydrocarbon emissions during the combustion processes for each of the different mixtures are shown in Figures 2-7.

Carbon Monoxide (CO) Emission

The figure 2 to figure 4 shows the CO emission of blends with various BP. From the plot it is observed that is interesting to note that the engine emits more CO for diesel as compared to biodiesel blends under all loading conditions.

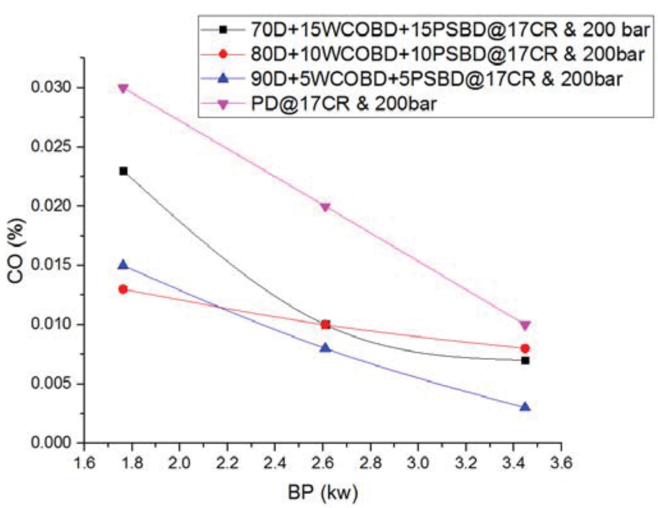

Fig.2. CO % v/s BP(kw) for blends of biodiesel from two different feedstock and diesel @ 200bar injection pressure

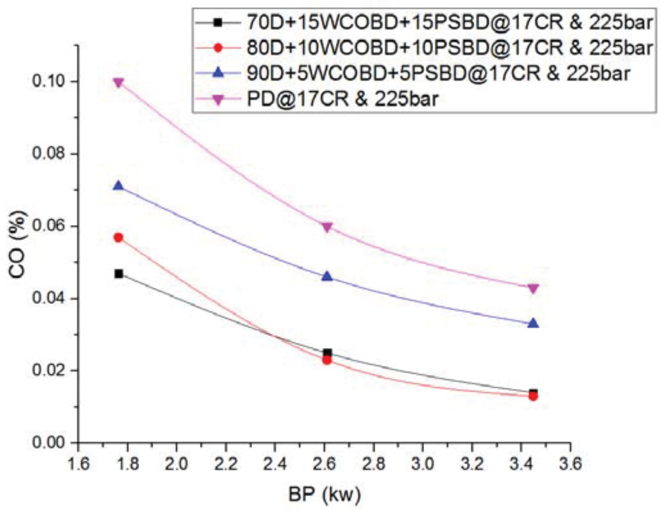

Fig.3. CO% v/s BP(kw) for blends of biodiesel from two different feedstock and diesel @ 225bar injection pressure

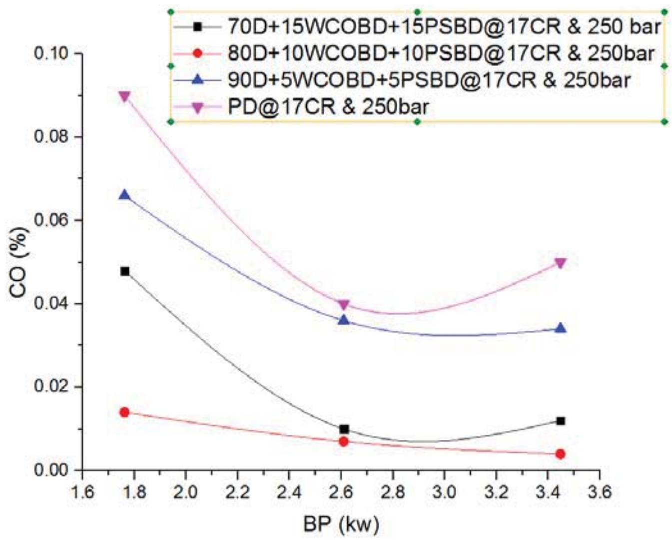

Fig.4. CO % v/s BP(kw) for blends of biodiesel from two different feedstock and diesel @ 250bar injection pressure

As the injection pressure increase the effect on emission is that its component CO decreases further both for the blended and standard diesel.

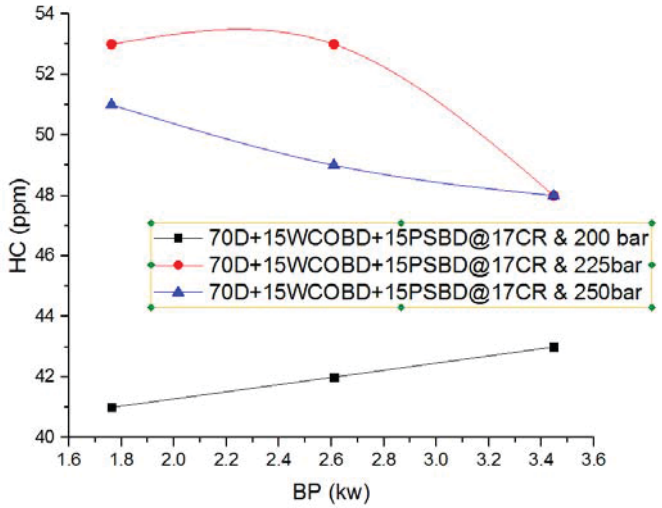

Fig.5. HC (ppm) v/s BP(kw) for a 30%blended diesel from two different feedstock @ different injection pressure

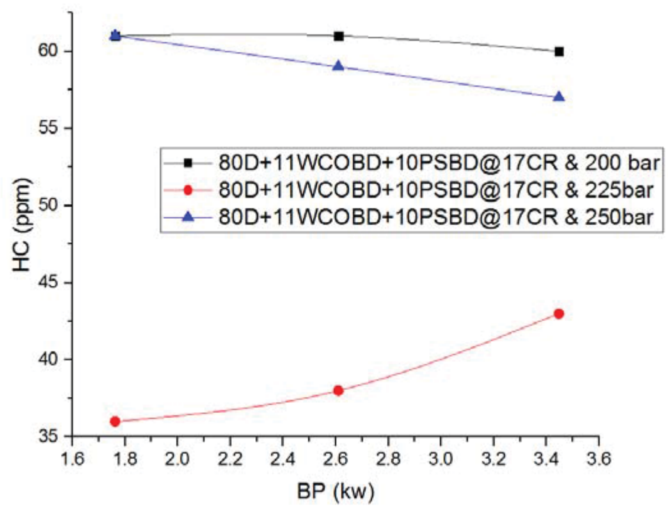

Fig.6. HC(ppm) v/s BP(kw) for a 20%blended diesel from two different feedstock @ different injection pressure

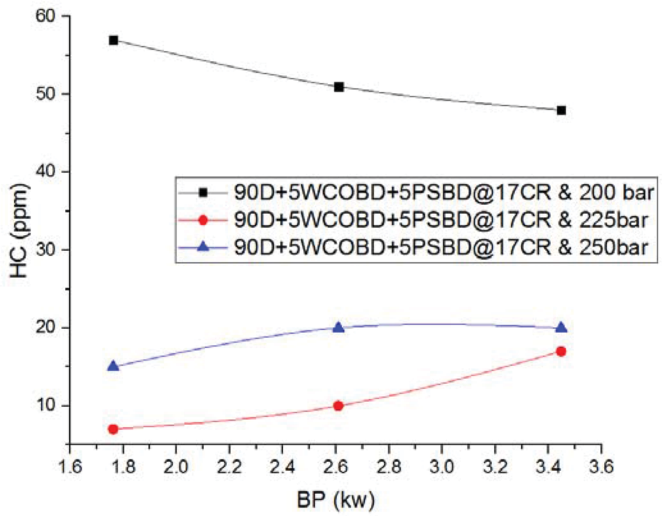

Fig.7. HC(ppm) v/s BP(kw) for a 10%blended diesel from two different feedstock @ different injection pressure

The optimum value for the injection pressure in contest to emission of CO is 225bar where its component

VI. CONCLUSION

The experimental investigation revealed that the emission of the engine when powered by biodiesel and its blends with petroleum diesel is far better and eco friendly compare to its emission when powered by 100% petroleum diesel, exception being in NOx which extend the trend reversely.

Biodiesel are viable alternative to mineral diesel as fuel in Compression Ignition engine. Biodiesel can be prepared from different renewable feedstocks like cooking oil and palm oil, but they contribute directly to human food chain hence their byproducts such as waste cooking oil and palm stearin oil can burnt in engine after tranesterification.

The well known fact that engine performances of biodiesel are comparable to that of mineral diesel and emission characteristics of biodiesel are better than diesel fuel except NOx emission. The carbon monoxide, un-burned hydrocarbonare found to be less in the tail pipe emissions due to the enrichment of oxygen. But and oxides of nitrogen are found to be slightly greater in exhaust in case of biodiesel compared to mineral diesel. The higher viscosity of bioiesel also enhances the lubricating property and excess oxygen content results better combustion for biodiesel.

VII. ACKNOWLEDGEMENTS

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