An Experimental Analysis of Di Diesel Engine Using Cashew Nut Shell Oil

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Abstract*-As for the current scenario of rapid increase in the usage of automobiles, the demand for the fuel also increases drastically. This demand can be partly satisfied by using the Cashew Nut Shell Oil as an alternative fuel. By using CNSO as fuel the emission is reduced according to the percentage of blend. The percentage of money saving and fuel saving is increased with the increase in percentage of CNSO in diesel.In the present investigation the performance and emission characteristics of single cylinder four stroke direct injection diesel engine using cashew nut shell oil (CNSO) as an alternate fuel is evaluated. Here cashew nut shell oil is used in the form of blends at various proportions with diesel. High viscosity is one important difference between cashew nut shell oil and commercial diesel fuel. Bio-diesel is prepared from cashew nut shell oil using double Trans esterification process. A single cylinder, four stroke, constant speed, water cooled, direct injection diesel engine is used for the experiment The performance of the engine will be measured using electrical dynamometer and the emissions such as CO2, CO, HC& NOx will be measured using exhaust gas analyzer. After acquiring the experimental data they will be analyzed for various parameters such as thermal efficiency, brake specific fuel consumptions (BSFC). The engine is expected to run with reduced emission levels with acceptable engine performance.*

Keywords: Cashew Nut Shell Oil, Biodiesel, alternate fuel.

I. INTRODUCTION

In today's world the majority of automotive and transportation vehicles are powered by compression ignition engines. The compression ignition engine moves a large portion of the world's goods & generates electricity more economically than any other device in their size range. All most all the CI engines use diesel as a fuel, but the diesel is one of the largest contributors to environmental pollution problems Crude oil reserved is limited, but the oil consumption rate is increasing at an alarming rate. The agriculture food production systems depend heavily on liquid fuels particularly diesel fuel. The role of agriculture as a source of energy resources is gaining importance. Therefore agricultural scientists are more concerned about finding an alternate for diesel fuel. An India produce oil seed like groundnut, coconut, sunflower, rapeseed, mustard, karanja, Jatropha, Neem, rubber seed, cotton seed, rice bran and cashew nut shell liquid etc.Biodiesel are an alternative diesel fuel consisting of alkyl monoesters of fatty acids derived from vegetable oil or animal fats. Because of its reproducibility, no toxicity, and sulphur-free property, a considerable amount of recent research has focused on the use of biodiesel on diesel engines. Furthermore, due to its similar physical properties to diesel fuel, there is no need to modify the engine when the engine is fuelled with its blends .The emissions and engine performance of diesel engines fuelled with biodiesels have been examined by many investigators [8]. The biodiesels used in the experiments performed by these investigators reported that emissions of CO, smoke,HC and PM exhibits a reduction trend with biodiesel and blends of biodiesel–diesel fuels compared to pure diesel fuel in expense of higher NOx emissions. However, there are some investigations reporting that the power output increases and NOx emissions decrease with the use of biodiesel. The differences in power and NOx emissions can be attributed to the engine modifications, the fuelling method, exhaust gas treatment, test procedures and test conditions.

The engine performance with the biodiesel and the vegetable oil blends of various origins was similar to that of the neat diesel fuel with nearly the same brake thermal efficiency, showing higher specific fuel consumption. The experimental results especially on emissions of various studies are not uniform and show different results as can be seen in the literature. In the present work, we intend to produce CNSO biodiesel from the waste cashew nut shell and improve the fuel's properties. Diesel fuel and a blend of CNSO biodiesel 20% byvolume mixed in the volume ratio of 5, 10, and 15 percentages were tested in a direct injection diesel engine at full load conditions.

II. MATERIALS AND METHODOLOGY

The CNSO biodiesel is utilized to prepare the blends, the volume ratio of CNSO biodiesel and diesel,20/80 is called B20, and the volume ratio of B20 blend.The properties of biodiesel andblends are given

Table 1 Properties of the fuel blends

properties	Diesel	B20	B100
Kinematic Viscosity cSt	2.82	4.53	29.77
Density kg/m3	840	858	884
Cetane Number	46	51	54
Flash Point ◦C	70	64	157

The engine used is Kirloskar make single cylinder, naturally aspirated, four stroke, watercool, 16.5:1 compression ratio, direct injection diesel engine, and the maximum engine power is3.7 kW at 1500 rpm. A Kirloskar A.C Generator with resistance bank loading arrangement isalso incorporated. The outlet temperatures of cooling water and exhaust gas were measureddirectly from the thermocouples (Cr–Al) attached to the corresponding passages. The engine exhausts NO, CO, HC, CO2 were measured with gas analyzer, and the exhaust emissions were measured at 250 mm from the exhaust valve and it specificationsare given in Table 2. The smoke opacity was measured by smoke meter afterreducing the pressure and temperature in the expansion chamber. The performance and emissioncharacteristics were evaluated for three trails and average are taken for analysis

Table 2 Gas analyzer specifications

Measured quantity	Measuring range /resolution	Accuracy
CO	0…10%Volume/0.01% volume	± 0.03% volume
CO_2	0…20% volume/ 0.1% volume	±0.4% volume
HC	0…20000PPM/1PPM/10 PPM	±10 PPM
O_2	0…22% volume/0.01volume	±0.1% volume
NO	0…5000PPM/1 PPM	±50 PPM

III. RESULTS

3.1EnginePerformance

The Brake Specific Fuel Consumption (BSFC) was found to increase with the increasing proportion of biodiesel blends with diesel, whereas it decreased sharply with increase in load for all blends. For biodiesel and various percentages of ethanol blends, the BSFC are higher than that of diesel. The increase of BSFC can be explained by Lei Zhu et al. [10] this is because the lower calorific value with increases in ethanol percentage in the blends compared with diesel fuel. The brake thermal efficiency (BTE) obtained for different volumetric blends were recorded in Figure 1. This could be attributed to the presence of increased amount of oxygen in the blends, which might have resulted in its improved combustion as compared to pure diesel, hence the brake thermal efficiencies comes very close to that of diesel . In general the exhaust gas temperature (EGT) increases with increase in engine loading for all the fuels tested.This increase in exhaust gas temperature with load is obvious from the simple fact that more amount of fuel was required in the engine to generate that extra power needed to take up the additional loading. But exhaust gas temperature was found to decrease with the increasing concentration of the blends.

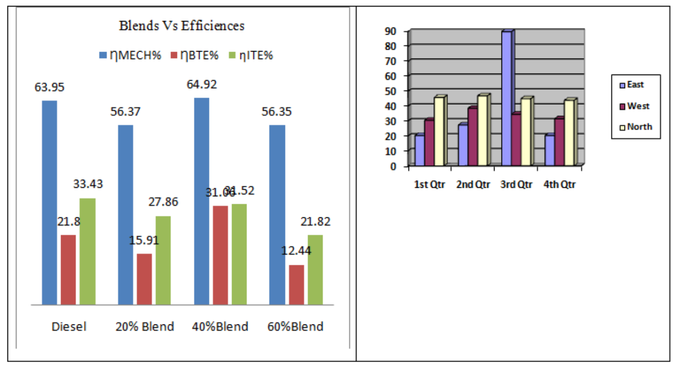

Figure 1 overall views of efficiencies

3.2 Engine Exhaust Emission

A. Hydrocarbon

The hydrocarbon emission is seen in Fig.2 the unburned hydrocarbon emission of blends of CNSO is more compared to that for neat diesel for all loads. This is because of poor mixture formation tendency of blends of CNSO. In addition to the other factors, the lower thermal efficiency with these blends also is responsible for this trend. It may be noted that a lower thermal efficiency with these blends will lead to injection of higher quantities for the same load condition

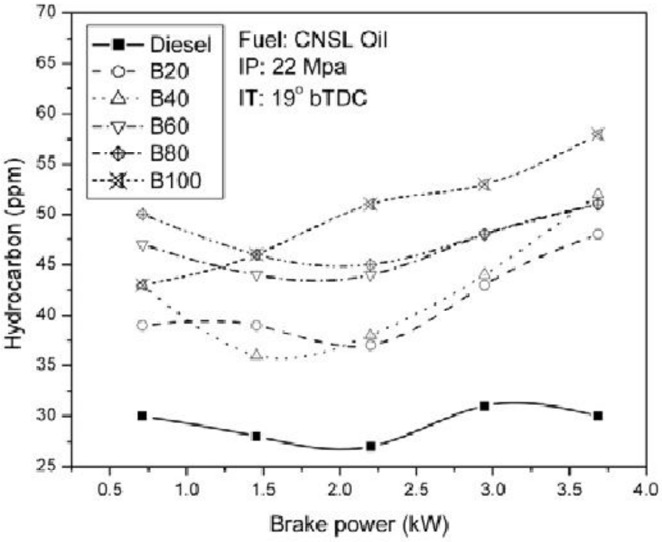

Fig. 2 Comparison of Hydrocarbon

B. Carbon monoxide

Fig.3 shows the plots of carbon monoxide emissions of the CNSO and various blends of biodiesel operation at the rated engine speed of 1500 rpm at various load conditions.

The CO emissions increase as the air fuel ratio becomes greater than the stoichiometric value. CO concentration in the exhaust emission is negligibly small when a homogeneousmixture is burned at stoichiometric air–fuel ratio mixture or on the lean side stoichiometric. With increasing CNSO percentage, CO emission level increases. In the case of, 100%CNSO, the carbon monoxide emission is higher than that of diesel blends. This is due higher viscosity and poor atomization tendency of CNSO leads to poor combustion and higher carbon monoxide emission

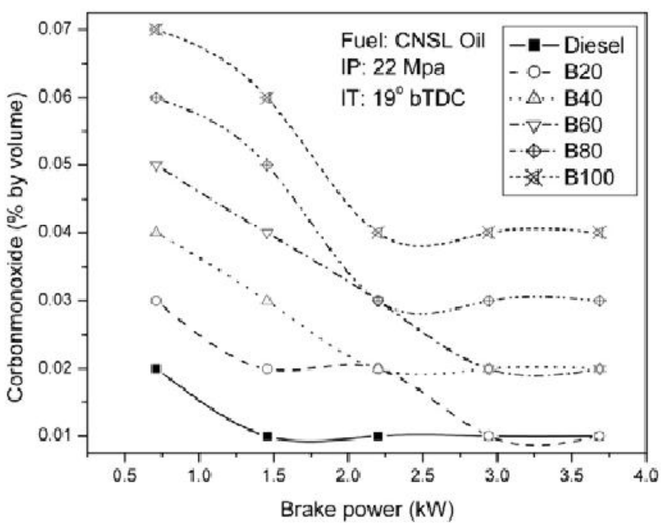

Fig. 3 Comparison of Carbon monoxide

C. Smoke density

The variation of smoke density with respect to different fuels is considered and depicted in Fig. 13 Smoke density for CNSO blends is noticed to be generally higher than that of the diesel oil. This is due to the heavier molecular structure, poor atomization, presence of high carbon residue. The viscosity of blends is comparatively lower than neat CNSO tested. Due to this, the spray pattern and fuel penetration are improved. The smoke density of neat diesel and B20 blend is almost same compared to neat CNSO this is because of less viscosity and improved atomization of fuel.

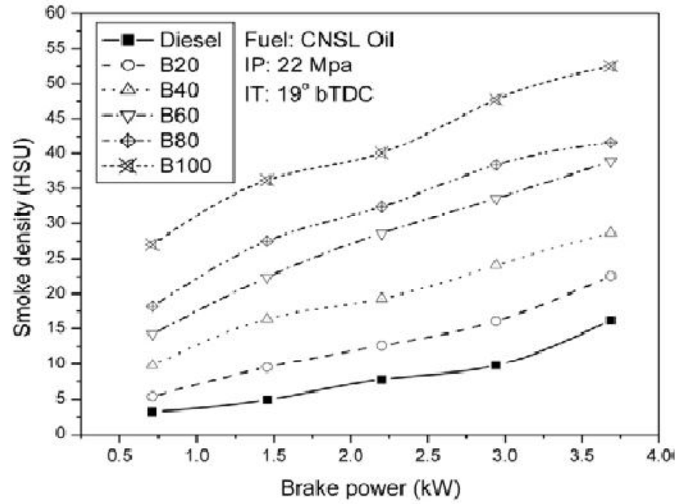

Fig. 4 Comparison of Smoke density

D. Oxides of nitrogen

Fig.5 indicates that blends of CNSO shows lower NOx emission compared to neat diesel fuel. This is due to poor atomization of CNSO leads to poor combustion and leadower NOx emission.

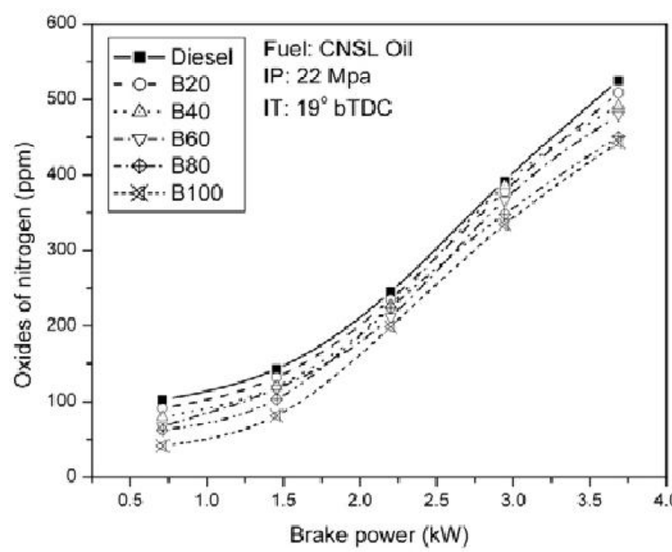

Fig. 5 Comparison of Oxides of nitrogen.

IV. CONCLUSION

With the reference of the later process we can easily come to a conclusion that performance, emission decreases the best achieved by B40.

This not only helps in the effective utilization of Cashew Nut Oil as a transportation fuel, but also improves the life of the cashew farmers.

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