Performance Characteristics Of A Diesel Engine Using Diesel-Cashew Nut Shell Oil Blends

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Abstract--- The objective of the present work is to reveal the effects of crude cashew nut shell oil blends performance on a direct injection diesel engine. Operations of the test engine with cashew nut shell oil blends for a wide range of engine load conditions were performed. During the experiments, the performance characteristics of the test engine was analyzed and compared with the neat diesel fuel performance. The results were shown to be successful even without any engine modifications.
Keywords: Diesel engine, alternate fuel, cashew nut shell oil, performance.

I. INTRODUCTION

Increased environmental awareness and depletion of fossil fuel resources are driving the researchers, engineers and the fuel industry to develop alternative fuels that are environmentally more acceptable and renewable in nature [1]. The idea of using vegetable oils as fuel for diesel engine is not new. When Rudolf Diesel first invented the diesel engine, he demonstrated it with peanut oil as fuel [2]. Vegetable oils can be used in diesel engines either in raw form, or can be converted into biodiesel.

Many researchers investigated the potential of raw vegetable oil biodiesel as an alternate fuel in diesel engine in last several years. Deepak Agarwal et al [3] investigated the use of various vegetable oils like linseed oil, mahua oil and rice bran oil in a compression ignition engine and reported that use of vegetable oil and its derivative as diesel fuel substitutes has almost similar cost as that of mineral diesel. Lawrence et al [4] studied the performance and emissions of a compression ignition engine using prickly poppy biodiesel blends and found that the engine runs well in biodiesel blends and releases lesser carbon monoxide and unburned hydrocarbon emissions. Ilkilic et al [5] studied the performance and emission characteristics of a single cylinder diesel engine using safflower oil biodiesel blends and found that the CO, smoke and particulate matter emissions were reduced compared to diesel and the NOx and HC emissions were increased. Suryawanshi [6] investigated the compression ignition engine with coconut oil biodiesel and found similar results of diesel. Banapurmath et al [7] conducted experiments in a single-cylinder, direct injection diesel engine at a constant speed with neat jatropha, karanja, and sesame-oil-derived biodiesel and found decrease in brake thermal efficiency, ignition delay, smoke, CO and HC emissions. Deepanraj et al [8] investigated the performance and emission characteristics of a diesel engine using rice bran oil biodiesel blends and found that 20% by volume blend provides better engine performance and improved emission characteristics.

In this paper, performance characteristics of a single cylinder, four stroke, direct injection, compression ignition engine fuelled with cashew nut shell oil blends was evaluated experimentally and the results were discussed.

II. MATERIALS AND METHODS

Cashew nut shell oil was purchased from the local market in Panruti, Cuddalore district. Diesel was purchased from the local bunk. The properties of diesel and cashew nut shell oil are given in table 1.

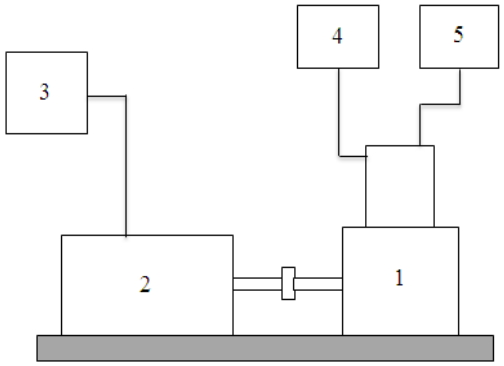
Property	Diesel	CNSO
Calorific value (MJ/kg)	42.8	40.69
Density (kg/m^3)	840	952
Viscosity (cSt)	3.6	9.4
Flash point (°C)	61	256
Fire Point (°C)	70	264

Table 1: Properties of diesel and CNSO

Experiments were carried out in a vertical, single cylinder, naturally aspirated, four stroke, constant speed, water cooled, direct injection diesel engine. The layout of experimental setup is shown in the figure 1.

III. RESULTS AND DISCUSSIONS

Fig. 2 shows the variation of brake thermal efficiency with respect to load. The brake thermal efficiency of the cashew nut shell oil blends are lower than the diesel in all the loads starting from no load to full load. This is due to poor mixture formation as a result of low volatility, higher viscosity and higher density of biodiesel compared with diesel. At maximum load, the brake thermal efficiency of 20, 40 and 60% CSNO blends are 9.41, 15.25, and 20.4% lower than diesel respectively.



1. Engine, 2. Dynamometer, 3. Dynamometer control, 4. Air box, 5. Fuel tank
Fig 1: Experimental setup

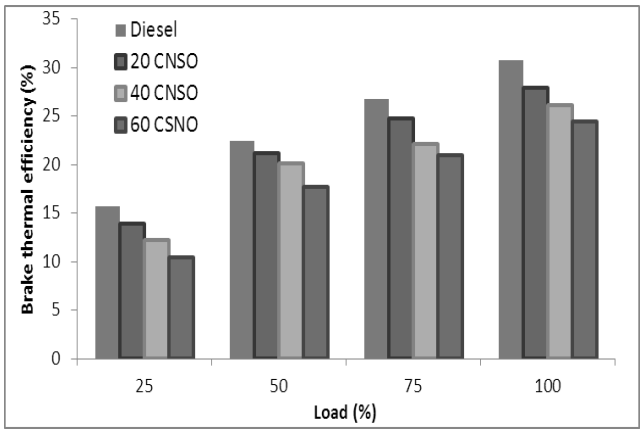


Fig. 2: Brake thermal efficiency vs. Load

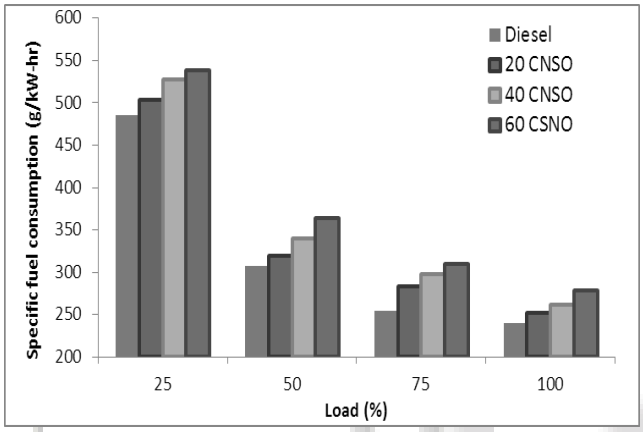


Fig. 3: Specific fuel consumption vs. Load

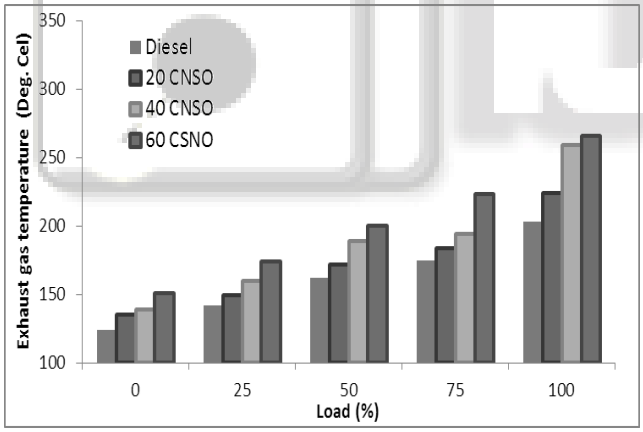


Fig. 4: Exhaust gas temperature vs. Load

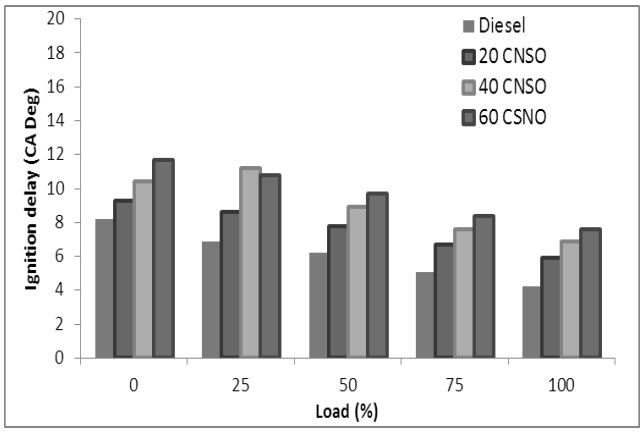


Fig. 5: Ignition delay vs. Load

Figure 3 shows the variation of specific fuel consumption with respect to load. The specific fuel consumption of cashew nut shell oil blends is higher than that of diesel in all loads. The specific fuel consumption varies depends upon the mass flow rate of hydrogen. The mass flow rate of hydrogen is low for cashew nut shell oil whereas for diesel, it is slightly high. So it leads to increase in specific fuel consumption.

Fig. 4 shows the variation of exhaust gas temperature with respect to load. The exhaust gas temperature increases with increase in load. The cashew nut shell oil blends produces higher exhaust gas temperature than diesel because of oxygen content which enables the combustion process and hence the exhaust gas temperature is higher. At maximum load, the exhaust gas temperature of 20, 40 and 60% cashew nut shell oil blends are 9.3, 21.6, and 23.68% higher than diesel respectively.

Fig. 5 shows the variation of ignition delay with respect to load. The ignition delay decreases with increase in load. The cashew nut shell oil blends produces higher ignition delay than diesel because of higher viscosity. At maximum load, the ignition delay of 20, 40 and 60% cashew nut shell oil blends are 29.2, 39.1, and 44.7% higher than diesel respectively.

IV. CONCLUSION

Experiments were conducted successfully in a single cylinder, water cooled direct injection compression ignition diesel engine and it was shown that cashew nut shell oil blends as alternative diesel engine fuels can be used successfully to operate the engine without modifications to the engine.

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