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Estimation of Performance and Emission of Castor Oil Biodiesel Blended With Sole Fuel in Diesel Engine

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Abstract: *Petroleum resources are depleting on a daily basis, and rising fuel demand, as well as stricter emission regulations, poses a challenge to science and technology. This has drawn attention to the need to conserve and stretch oil reserves by conducting alternative fuel research. As a result, the prospects are discussed in this paper. The possibility of using methyl esters of castor oil as engine fuel is investigated. In this project, tests were carried out. Diesel and various blends of castor oil biodiesel were tested on a four strokes, single cylinder DI diesel engine. The results of performance and emission tests for various blends of castor oil biodiesel and neat diesel are compared.The findings show that at blend B60, with the most exhaust gas, the brake specific energy consumption (BSEC) is the lowest. When compared to other blends, this one has the lowest temperature and smoke opacity.*

I. INTRODUCTION

Biodiesel and its derivatives have received a lot of attention in recent years for diesel engines, according to the current study. Biodiesel is an oxygenated diesel engine fuel made from vegetable oils or animal fats via transesterification, which converts triglycerides to esters. It has properties that are similar to those of fossil diesel. As a result of research into biodiesel derived from vegetable oils and animal fats, an alternative to petroleum-based diesel fuel has been investigated [1][2]. According to the findings of numerous studies, biodiesel can be used in diesel engines with little or no modifications and with nearly the same performance. It also reduces emissions of carbon monoxide (CO), unburned hydrocarbons (HC), and smoke. The majority of the results, however, statedan increase in the amount of nitrogen oxides in the atmosphere (NOx). The results vary depending on the base vegetable oil or animal fats, the biodiesel production process, and the properties of biodiesel fuel. As a result, various biodiesel and neat diesel blends were tested in diesel engines at various engine loads [3][4]. Biodiesel, on the other hand, has a high viscosity, density, calorific value, and non-volatility, which causes pumping issues, atomization issues, and poor combustion inside a diesel engine's combustion chamber. Long-term use of vegetable oils in diesel engines will almost certainly result in gumming, injector fouling, piston ring sticking, and lubricating oil contamination [5][9]. The high viscosity of vegetable oils is to blame for all of these issues. As a result, the viscosity of vegetable oil must be reduced to a level that is closer to that of diesel. The problems have been solved in a variety of ways, including Preheating the oils, mixing them with diesel, thermal cracking, and transesterification are just a few examples [5][7].

Transesterification is a chemical process in which an alcohol, such as methanol, ethanol, or butanol, is used in the presence of a catalyst, such as sodium hydroxide (Na OH) or potassium hydroxide (K OH), to break the molecule of raw renewable oil into methyl or ethyl esters of the renewable oil, with glycerol as a byproduct, reducing the viscosity of the oil. Biodiesel [10] is the name given to this oil because its properties are very similar to those of petroleum diesel.The biodiesel derived from castor seed oil was used in this research. Testing was carried out with a single cylinder compression ignition engine at an average constant speed of 1500 rpm at various loads and for various blends of petroleum diesel and castor oil biodiesel to determine the performance of biodiesel prepared from castor seed oil. Table 1 lists the properties of castor oil biodiesel.

Table 1: Castor oil biodiesel properties

Density at 15°C	0.9268 g/cm3
Flash point	109.7°C
Calorific value	37908 KJ/kg
Ash content	0.02%
Viscosity at 40°C	15.98 mm2/s
Pour point	-45°C
Visual appearance	viscous pale yellow

Cetane number	50

II. METHODOLOGY

Degumming is the first step in the castor oil refining process, and it lowers the phosphatides and metal content of the crude oil. Phosphatides can be found in the form of lecithin, cephalin, and phosphatidic acids in crude castor oil. 76 There are two types of phosphatides: hydratable and nonhydratable phosphatides77. For efficient removal of these phosphatides, a suitable degumming procedure (water degumming, acid degumming, and enzymatic degumming) must be used. Nonhydratable phosphatides account for about 10% of nonhydratable phosphatides in crude vegetable oil. 77 However, the amount can vary significantly depending on a number of factors, including the type of seed used, its quality, and the milling conditions used. While most hydratable phosphatides can be removed, Nonhydratable phosphatides can only be removed by acid or enzymatic degumming procedures, not by water degumming. 77Degumming of water in the early stages of oil refining, water degumming is a relatively simple and inexpensive process for removing as much gum as possible.

The crude oil is heated to around 60°C–70°C in this process. The crude oil is then added to the water, which is thoroughly mixed and allowed to stand for 30 minutes, during which time the phosphatides in the crude oil become hydrated and thus oil-insoluble. Decantation or centrifugation can be used to remove the hydrated phosphatides. Even small amounts of nonhydratable phosphatides can be removed with the hydratable phosphatides using water degumming. The gums that have been extracted can be used to make a variety of products. lecithin for use in food, feed, and technology.

Degumming with acid In general, if the crude oil contains a significant amount of nonhydratable phosphatides, the acid degumming process is the best alternative to the water degumming process. The crude castor oil is treated with an acid (phosphoric acid, malic acid, or citric acid) in the presence of water in the acid degumming process. Acid degumming is typically done at a high temperature, usually around 90°C. The precipitated gums are then separated by centrifugation, and the degummed oil is vacuum dried. Degumming with enzymes Enzymes can also be used to convert nonhydratable phosphatides into hydratable phosphatides. The enzyme solution, which is a mixture of citric acid, caustic soda, and enzymes in an aqueous solution, is dispersed into the filtered oil at mild temperatures, usually between 45°C and 65°C. For effective mixing of oil and enzyme, a high-speed rotating mixer is used.

After that, the oil is mechanically separated from the hydrated gum before being vacuum dried. These so-called "microbial enzymes" come in a variety of forms. The phospholipases A1 (Lecitase Novo and Ultra) were the first, followed by a phospholipase C (Purifine) more recently. In addition, a lipid acyl transferase (LysoMax) with PLA2 activity is now commercially available. These enzymes have been shown to specific functions and characteristics. The enzymes Lecitases and LysoMax, for example, can catalyse the hydrolysis of all common phosphatides. Purifine, on the other hand, is a phosphatidylcholine anphosphatidylethanolamine-specific enzyme.

EXPERIMENTS

Experiments were conducted on a single cylinder, vertical, 4-stroke cycle, single acting, completely enclosed, water-cooled compression ignition engine.The engine of the specifications listed in Table was tested with diesel, biodiesel (B100), and its blends B20, B40, B60, and B80. 2. At different engine loads (25 percent, 50 percent, 75 percent, and 100 percent of the load corresponding to the load at maximum power at an average engine speed of 1500 rpm), the engine's performance and emission characteristics were investigated. The engine was stabilised for 20 minutes after each load, and then measurement parameters were recorded. A Hartridge smoke-meter made by Netel was used to test the engine's exhaust. The eddy current dynamometer was used to load the engine.

Finally the graphs, BMEP vs BSEC, BMEP vs Exhaust gas temperature and BMEP vs smoke density are plotted based on the results obtained.

Specifications of engine used

Make	Kirloskar
Type	Single-cylinder, fourstroke, compression ignition diesel engine
Stroke	110 mm
Bore	80 mm
Compression ratio	16.5:1
BMEP at 1500 rpm	5.42 bar
Rated output	3.7 Kw
Rated speed	1500 rpm
Dynamometer	Eddy current,water-cooled with loading unit

III. DISCUSSION AND RESULTS

As shown in Fig. 1, brake specific energy consumption decreases with increasing brake mean effective pressure up to full load. B60 has the lowest BSEC at ambient temperature. It was discovered that as the percentage of biodiesel in the fuel increases, the BSEC decreases.

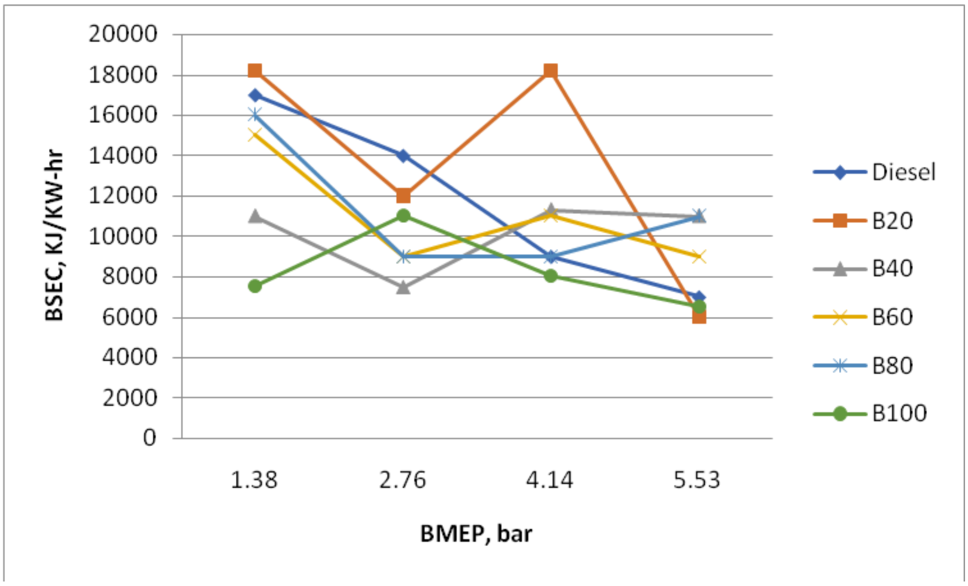

Figure 1 . BMEP vs BSEC

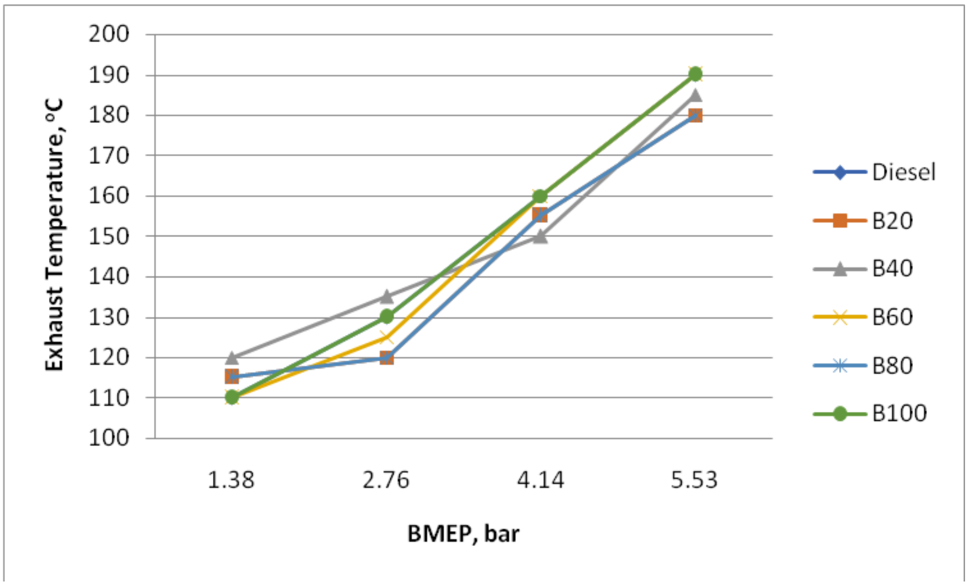

Figure 2. BMEP vs Exhaust gas temperature

Figure 2 depicts the variation in exhaust gas temperature with respect to applied loads for various blends. It has been observed that as the load increases, the temperature of the exhaust gas rises as well. This indicates that effective combustion occurs early in the strokes and that the amount of energy lost in the exhaust gas is reduced. When the biodiesel concentration is increased, the exhaust gas temperature rises by the same amount, but blend B80 shows a different trendAt all loads, the exhaust gas temperature is kept low.

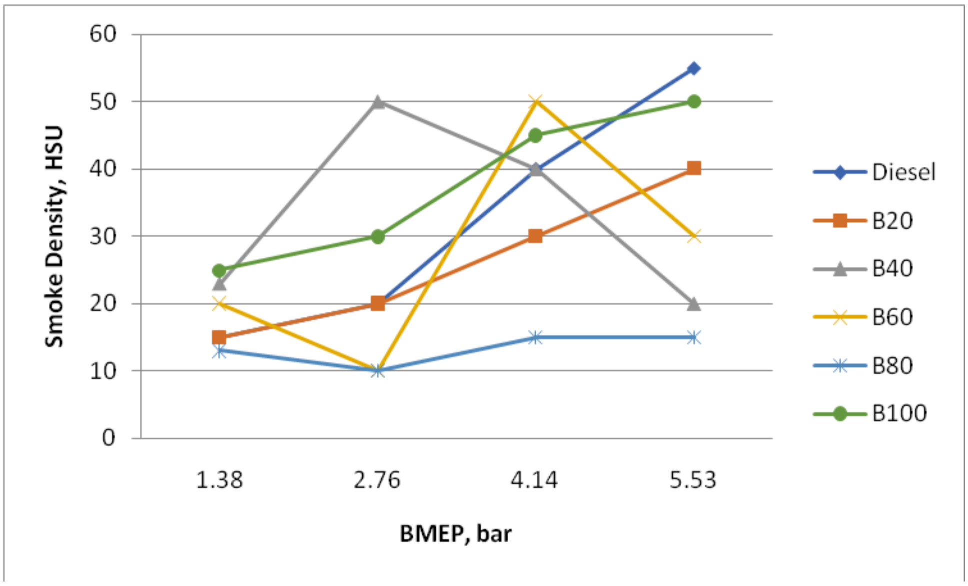

Figure 3. BMEP vs Smoke Density

At full load, the B60 blend produces the highest exhaust gas temperature. The higher exhaust gas temperature could be due to better castor methyl ester consumption, as it contains oxygen molecules that aid in proper consumption. Figure 3 shows the variation in smoke opacity with respect to BMEP. The opacity of smoke increases as the brake mean effective pressure rises. When compared to other blends, B60 has less smoke opacity at ambient temperatures.

IV. CONCLUSION

The goal of the research is to investigate the performance and emissions of castor biodiesel and its various blends with diesel, in order to determine the best blend for use in diesel engines. B60 performs best in compression ignition engines when exposed to ambient temperatures. Castor oil biodiesel and diesel have similar overall characteristics. As a result, biodiesel is a "New Era Fuel" of the future, reducing our reliance on oil-producing countries. These plants don't require as much water as other plants and can be grown on dry land. Unemployed youth could be leased a large portion of barren government land, and the yield could be sold at a lower price to produce a large amount of biodiesel. This will make the country self-sufficient and less dependent on foreign aid. Apart from the savings in valuable foreign exchange, they are reliant on imported fuel.

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