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Research Article

PHYSIOCHEMICAL PROPERTIES CHARACTERISTICS OF JATROPHA CURCAS BIODIESEL AND ITS BLENDS WITH TETRACHLOROETHYLENE ADDITION

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ABSTRACT

The mono-alkyl esters of vegetable oils and animal fats are an alternative diesel fuel that is steadily gaining attention and significance named as biodiesel. This paper deals the experimental investigations in addition of the tetrachloroethylene as additive on the biodiesel. The change of physiochemical properties is studied. The properties of the base fuel and the modified fuel formed by dispersing the additive particles are measured using ASTM standard test methods.

The effects of the tetrachloroethylene additive on the individual fuel properties, like Flash point, Cloud point, Pour point, Kinematic Viscosity, Total Acid Number, copper strip corrosion are studied, and the dosing level of the additive is optimized. Comparisons of the base fuel with petro-diesel and modified fuel is also presented. The cold temperature properties of biodiesel decreases significantly, due to addition of tetrachloroethylene. The viscosity of the biodiesel was found to decrease with the addition of tetrachloroethylene. While Copper strip corrosion test and TAN value does not show any significant variation, due to addition of tetrachloroethylene as additive. The flash point of biodiesel, which is an indication of the volatility increase after addition but their changes are not, too much significant.

Keywords: Jatropha biodiesel, Tetrachloroethylene additive, Physicochemical properties.

INTRODUCTION

The depletion of world petroleum reserves and the increased environmental concerns have stimulated the search for alternative sources for petroleum-based fuel, including diesel fuels [1]. Diesel engines are the most efficient prime movers. From the point of view of protecting global environment and concerns. For long-term energy security, it becomes necessary to develop alternative fuels with properties comparable to petroleum based fuels. Unlike the rest of the world, India's demand for diesel fuels is roughly six times that of gasoline, hence seeking alternative to mineral diesel is a natural choice [5]. The rapid depletion of petroleum reserves and rising oil prices has led to the search for alternative fuels. Non edible oils are promising fuels for agricultural applications. Vegetable oils have properties comparable to diesel and can be used to run CI engines with little or no modifications. Usage of biodiesel will allow a balance to be sought between agriculture, economic development and the environment [3] and [2].

An alternative fuel must be technically feasible, economically competitive, environmentally acceptable, and readily available. One possible alternative to fossil fuel is the use of oils of plant origin like vegetable oils and tree borne oil seeds. This alternative diesel fuel can be termed as biodiesel. This fuel is biodegradable and nontoxic and has low emission profiles as compared to petroleum diesel. Usage of biodiesel will allow a balance to be sought between agriculture, economic development and the environment.

Of the various alternate fuels under consideration, biodiesel, derived from vegetable oils, is the most promising alternative fuel to diesel due to the following reasons:

- Biodiesel can be used in the existing engine without any modifications.
- Biodiesel is made entirely from vegetable sources; it does not contain any sulfur, aromatic hydrocarbons, metals or crude oil residues.
- Biodiesel is an oxygenated fuel; emissions of carbon monoxide and soot tend to reduce.
- Unlike fossil fuels, the use of biodiesel does not contribute to Global warming as CO_2 emitted is once again absorbed by the Plants grown for vegetable oil/biodiesel production. Thus CO_2 Balance is maintained.
- The occupational safety and health administration classifies Biodiesel as a non-flammable liquid.
- The use of biodiesel can extend the life of diesel engines.
- Because it is more lubricating than petroleum diesel fuel.
- Biodiesel is produced from renewable vegetable oils/animal fats and hence improves the fuel or energy security and economy independence.
- Cetane number is significantly higher than that of conventional diesel fuel.
- Used alone or mixed in any ratio with petroleum diesel fuel. The most common blend is a mix of 20% bio-diesel with 80% petroleum diesel.

A number of experimental investigations have been reported with a wide variety of metal additives to improve the fuel properties and the engine performance, as well as to reduce emissions. The effect of calcium, barium, iron, and nickel naphthenates have been studied, concluding that calcium and barium most efficiently reduce soot, by both suppressing soot formation and enhancing soot oxidation . Based on experimental investigations, Guru et al. concluded that manganese, as a fuel additive, has a greater effect in the reduction of the freezing point of the fuel, than copper, magnesium, or calcium. Emission measurements with manganese as a fuel additive demonstrated that O_2 and CO could be decreased by 0.2% and 14.3%, respectively, SO_2 emission could be reduced, and the overall impact of all these effects was found to lead to an increase of 0.8% in the net operating efficiency. Valentine et al. experimentally observed that bimetallic Platinum and cerium diesel fuel borne catalyst reduces the engine emissions and improves the performance of the diesel particulate filter. Shi et al. [8] reported that the particulate matter emission decreases with increasing oxygenate content in the fuels, but nitrogen oxides emissions increase. De et al. [9] experimentally observed that the presence of ethanol and ethyl ter-butyl ether (ETBE) significantly alters the characteristics of volatility and reduces the Cetane number, impairing the fuel's performance in engine tests. The effect of methanol-containing additive (MCA) on the emission of carbonyl compounds generated from the diesel engine was studied by Chao et al. [10] and it was observed that the emission factors for some of the carbonyl compounds with the use of MCA are higher than the values for those without the use of MCA.

Metal oxides such as those of copper, iron, cerium, and cobalt have been extensively used as fuel additives. The effect of cerium on the size distribution and composition of diesel particulate matter has been studied by Skill as et al. , indicating a reduction in the accumulation mode, but an increase in ultra fines. Lahaye et al. studied the effect of cerium oxide on soot formation and post oxidation and observed that the soot yield is not ejected significantly by the presence of cerium oxide in the fuel for given oxygen content. Based on experiments, Jung et al. observed that the addition of cerium to diesel fuel causes significant changes in the number concentration of particles in the accumulation mode, light o. temperature, and the kinetics of oxidation. Even though the oxidation rate increased significantly with the addition of cerium to the fuel, the dosing level was found not to have much influence . With fossil fuels getting depleted, a number of investigation are being undertaken on alternate fuels like bio diesels derived from various natural sources such as vegetable oils. Use of biodiesel and its modifications has been reported extensively in the literature. It has been reported that single fuel operation with neat Jatropha oil in diesel engine resulted in a slightly reduced thermal efficiency, higher HC and CO emissions as compared to diesel. Using a Jatropha oil-methanol blend as in place of neat Jatropha oil resulted in a slight increase in the brake thermal efficiency, a significant reduction in the exhaust gas temperature and a reduction of HC and CO emissions. Experimental investigations have been reported to evaluate the eject of anticorrosion additives in palm oil-based biodiesel on the engine performance, emissions, and wear characteristics.

The present experimental study is aimed at investigating the effect of the use of additive on the physiochemical properties of biodiesel. The fuel properties tested in the study include Flash point, Cloud point and Pour point, Kinematic Viscosity, Copper Strip Corrosion and Total Acid Number. The parameters values in the pure form and in the presence of various dosing level of the additive are presented. Tetrachloroethylene dosing levels could possibly exhibit high fuel efficiency. With this background, extensive investigation on changes in physiochemical properties of biodiesel with the inclusion of pure Tetrachloroethylene in the specified volume in the fuel constitutes the theme of the present research work. Specifically, the objective of the research was that by doing research in this area, researchers on biodiesel will be able to decide the most efficient way to improve the green fuel. The research done will help one to see that a blend of atrophy biodiesel with range of additive will be almost as versatile as diesel fuel, but will significantly reduce air pollution and help to meet new more stringent performance standards. The data generated from these test will help with the decision of what the most useful blends for efficient use in industry are. The possibility of sourcing an effective alternative fuel from jatropha curcas oil is hereby investigated. The ASTM Standard test to determine various physiochemical properties of the base fuel as well as the modified fuels were carried out under identical laboratory condition.

MATERIALS AND METHODS

The experimental investigations were carried out in two phases. In first phase, the various physiochemical properties of pure jatropha biodiesel were determined. The properties studied were the Flash point, Cloud point and Pour point, Kinematic Viscosity, Copper Strip Corrosion and Total Acid Number. Standard ASTM test procedures were used in the experiments. In second phase, blending of biodiesel is done with known concentration of additive tetrachloroethylene. After that change in respective physiochemical properties were analyzed as compared to base jatropha curcas biodiesel. The method of preparation of the biofuel with the additive tetrachloroethylene along with the experimental methods for obtaining the fuel properties are presented below:-

Preparation of Modified Fuels

The fuel used for the current investigation is a biodiesel product , derived from jatropha.The Flash point , Cloud point and Pour point, Kinematic Viscosity, Copper Strip Corrosion and Total Acid Number of the biodiesel were measured using standard equipment. The fuel additive used in this investigation is tetrachloroethylene, in the form of commercially available organic liquid form. The dosing level of the tetrachloroethylene in the base fuel was varied from 4% to 14% respectively. The required quantity of the additive sample required for each dosing level was measured using graduated measuring cylinders and mixed with the fuels in glass beakers of 250 ml after making blends label them and store them in storage containers (plastic bottles or water bottles). The blending composition is as follows:-

Table 01: Pure Biodiesel And Additive Blending Ratio

S. no	Sample No.	RATIO OF BIODIESEL AND TETRACHLORO ETHYLENE
1	I	100% BIODIESEL + 0% TETRACHLOROETHYLENE
2	II	96% BIODIESEL + 4% TETRACHLOROETHYLENE
3	III	92 % BIODIESEL + 8 % TETRACHLOROETHYLENE
4	IV	90% BIODIESEL + 10 % TETRACHLOROETHYLENE
5	V	88% BIODIESEL + 12 % TETRACHLOROETHYLENE
6	VI	86% BIODIESEL + 14 % TETRACHLOROETHYLENE

Determination of fuel properties

The properties studied were the Flash point; Cloud point and Pour point, Kinematic Viscosity, Copper Strip Corrosion and Total Acid Number were measured using standard test methods. The test methods are mentioned as under ASTM Standard.

Table 02: shows some ASTM standards, which are used as the measuring standards for development of the testing instruments.

Property	ASTM Standard / No.
Flash Point	ASTM-D93
The Pour point and Cloud point	ASTM D.97 D.2500
Kinematic Viscosity	ASTM-D445
Total Acid Number	ASTM D.664
Copper Strip Corrosion	ASTM D.130 Method

RESULTS AND DISSCUSSION

The standard values for biodiesel are specified as under. And the values of Jatropha Biodiesel and modified biodiesel physiochemical properties are compared with these values.

Table 03: ASTM D-6751 standards for Bio-diesel

Flash point (closed cup)	**130°C min. (150°C average)**
Water and sediment	0.050% by vol., max.
Kinematic viscosity at 40°C	1.9-6.0 mm^2/s
Rams bottom carbon residue, % mass	0.10
Sulfated ash	0.020% by mass, max.
Sulfur	0.05% by mass, max.
Copper strip corrosion	No. 3 max
Cetane	47 min.
Carbon residue	0.050% by mass, max.
Acid number -- mg KOH/g	0. 80 max.
Free glycerin	0.020 % mass
Total glycerin (free glycerin and unconverted glycerides combined)	0.240% by mass, max.
Phosphorus content	0.001 max % mass
Distillation	90% @ 360°C

Table 04: Comparison between the Physical & chemical properties of Jatropha Oil & Petro-Diesel

Property	Jatropha curcas Oil	Diesel Oil
Viscosity (cp) (30°C)	5.51	3.60
Specific gravity (15°C/4°C)	0.917/ 0.923(0.881)	0.841 / 0.85
Solidifying Point (°C)	2.0	0.14
Cetane Value	51.0	47.8 to 59
Flash Point (°C)	110 / 340	80
Carbon Residue (%)	0.64	< 0.05 to < 0.15
Distillation (°C)	284 to 295	< 350 to < 370
Sulfur (%)	0.13 to 0.16	< 1.0 to 1.2
Acid Value	1.0 to 38.2	
Saponification Value	188 to 198	
Iodine Value	90.8 to 112.5	
Refractive Index (30°C)	1.47	

Table 05: Variation of Physiochemical Properties of Pure Biodiesel and Modified fuel with Additive

S. No	Parameter	Sample I	Sample II	Sample III	Sample IV	Sample V	Sample VI
1	Flash Point(⁰C)	208	>250	>250	>250	>250	>250
2	Cloud Point(⁰C)	10	9	9	8	6	5
3	Pour Point (⁰C)	1	-3	-4	-4	-4	-6
4	Kinematic Viscosity40⁰c (cSt)	6.3	5.7	4.9	4.7	4.5	4.2
5	Copper strip Corrosion test	1	1	1	1	1	1
6	Total Acid No. (TAN) mg KOH//g	1.1	1.1	0.9	0.8	1.6	0.9

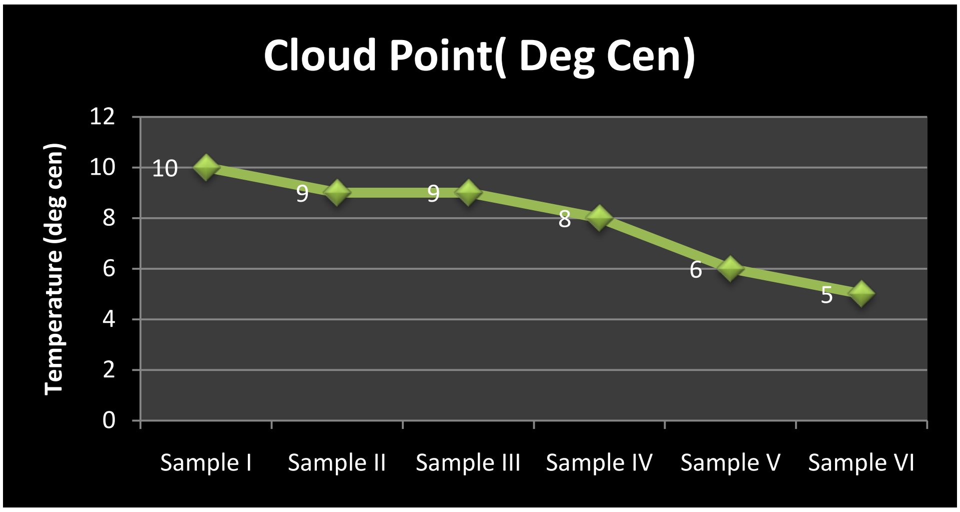

Chart 01: Variation of Cloud point with Tetrachloroethylene dosing level for biodiesel

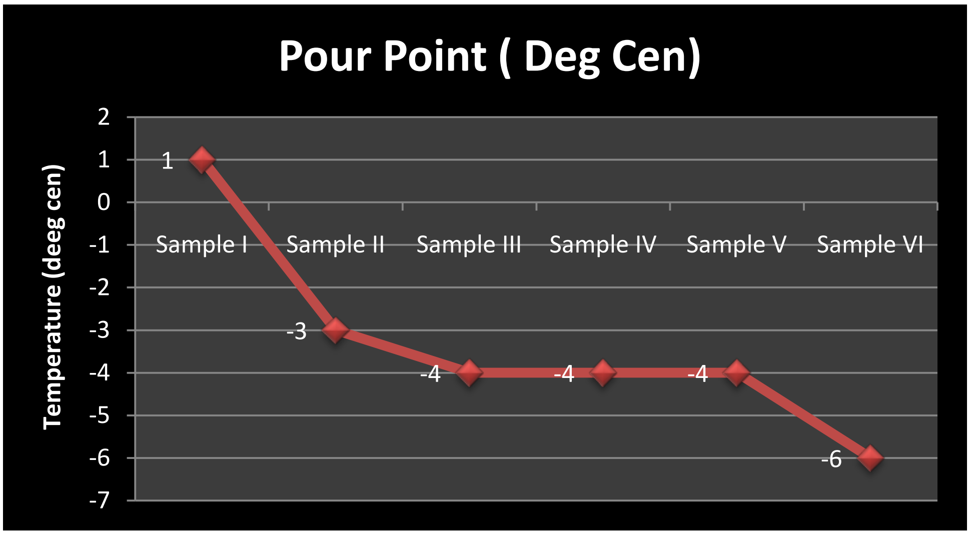

Chart 02: Variation of Pour point with Tetrachloroethylene dosing level for biodiesel

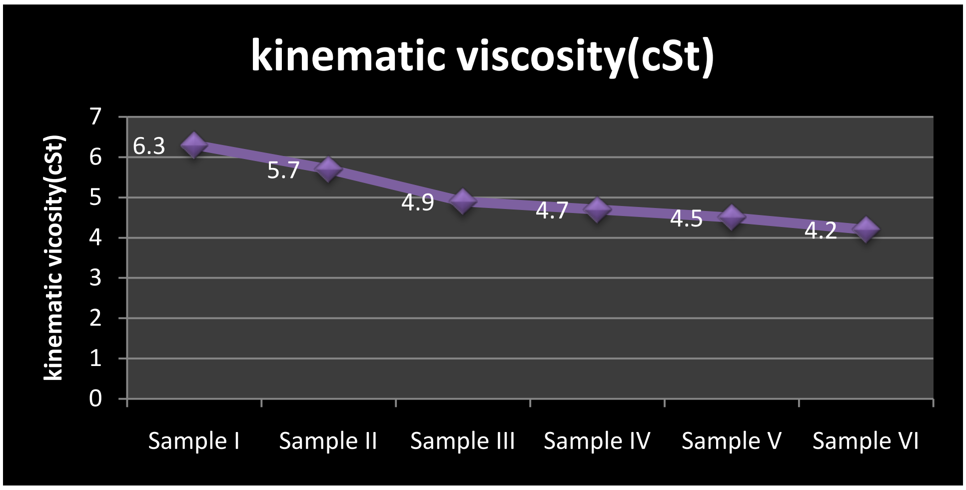

Chart 03: Variation of Kinematic Viscosity (cSt) with Tetrachloroethylene dosing level for biodiesel

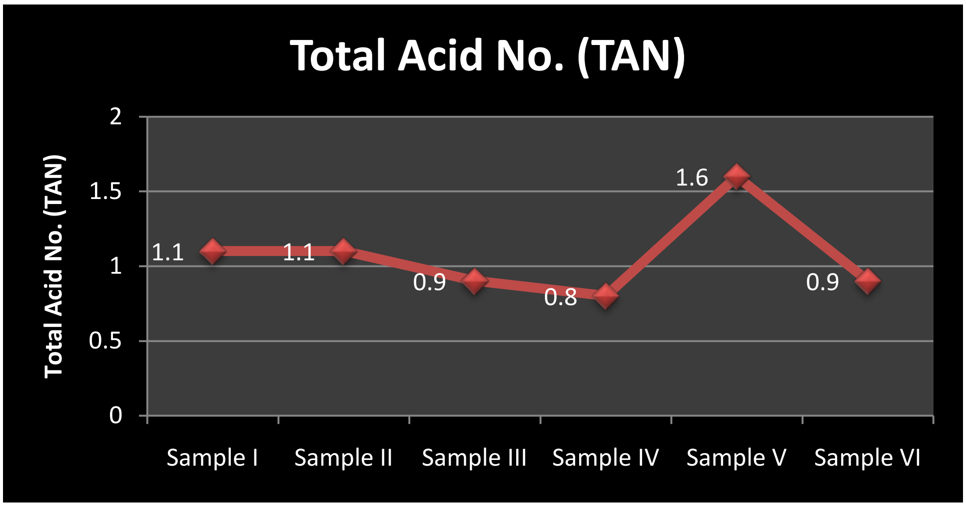

Chart 04: Variation of TAN with Tetrachloroethylene dosing level for biodiesel

CONCLUSION

One of the methods to vary the physiochemical properties of a hydrocarbon fuel is use of additive, which is found to be especially effective in liquid form, due to enhancement in area to volume ratio. ASTM standard tests for the fuel property measurements were reported in this thesis for biodiesel modified by the addition of tetrachloroethylene volumes. Experiments were carried out at different dosing levels of the additives, to investigate the influences on the physiochemical properties. The major observations ad inferences are listed below.

The flash point of biodiesel, which is an indication of the volatility increase after addition but their changes are not, too much significant.

The cold temperature properties of biodiesel decreases significantly, due to addition of tetrachloroethylene. The viscosity of the biodiesel was found to decrease with the addition of tetrachloroethylene. While Copper strip corrosion test and TAN value does not show significant variation, due to addition of tetrachloroethylene as additive.

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