DETERMINATION OF CETANE NUMBER FOR JATROPHA BASED BIODIESEL AND PETRO-DIESEL BLENDS

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ABSTRACT

Biodiesel is a potential alternative for currently working Internal Combustion Engine. The engine performance of the currently working diesel engine can be compared with the engine characteristics such as Cetane number. Cetane number is determined using the correlation of it to the viscosity, flash point, calorific value and density. For these properties correlation is developed. For room temperature (298 K), cetane number is evaluated. It is observed that the cetane number is having linear correlation with all the above mentioned properties. For Jatropha based biodiesel and petro diesel blends, it is observed that with increase in blend percentage the cetane number is increasing.

Key Words: *Biodiesel, Fuel Properties, Cetane Number.*

1. Introduction

\With decrease in the oil reservoirs quantity and increase in environmental pollution, it is mandatory to find out the alternate source for the energy generation through fuel energy [1-3]. For diesel, as it is used in internal combustion engine, the potential alternative source is Biodiesel. The mixture of methyl esters with long chain fatty acids commonly known as the biodiesel made up from vegetable oils or animal fats. For current study we have considered Jatropha (non-edible) based biodiesel [2, 4]. The closed carbon cycle is the biggest advantage of biofuels. But as biodiesel is higher viscous and having higher density compared to petro-diesel, the current internal combustion engine is not suitable for it. To overcome this disadvantage, it is advisable to blend biodiesel to the petro-diesel [10].

Cetane number is useful characteristics to determine the quality of fuel for ignition. In auto-ignition engine the ignition delay was measured in terms of the Cetane number [5]. The Cetane number was calculated as the volume percentage of n-cetane in the mixture of n-cetane and α-methyl naphthalene which will give the same ignition performance as the fuel under test.

The properties needed for the determination of the Cetane are Density, Kinematic viscosity, flash point and calorific value [11, 12].

2. Material and methods

2.1 Materials:

For the current experimental purpose Jatropha based biodiesel was utilized with the blend of the marketable grade petro diesel. The mixture blends were prepared in different volume ratio with B00, B05, B10, B15, B20, B25, B30, B35, B40, B45, B50, B55, B60, B65, B70, B75, B75, B80, B85, B90, B95 and B100.

2.2 Methods[6-8]:

For the testing of biodiesel following methods were utilized:

2.2.1 Flash Point and fire point:

The flash point temperature of biodiesel fuel is the minimum temperature at which the fuel will ignite (flash) on application of an ignition source. Flash point varies inversely with the fuel's volatility. Minimum flash point temperatures are required for proper safety and handling of diesel fuel. Fire point is the lowest temperature at which a specimen will sustain burning for 5 seconds. These two parameters have great importance while determining the fire hazard (temperature at which fuel will give off inflammable vapour). Flash point of the samples were measured in the temperature range of 60 to 190°C by an automated Pensky-Martens closed cup apparatus.

2.2.2 Calorific Value:

Calorific value of a fuel is the thermal energy released per unit quantity of fuel when the fuel is burned completely and the products of combustion are cooled back to the initial temperature of the combustible mixture. It measures the energy content in a fuel. This is an important property of the bio-diesel that determines the suitability of the material as alternative to diesel fuels. The calorific value of vegetable oils and their methyl esters were measured in a bomb calorimeter according to ASTM D240 standard method. An oxygen-bomb was pressurized up to 20 atm a with an oxygen container. The bomb was fired automatically after the jacket and bucket temperature equilibrated to within accuracy of each other.

2.2.3 Density:

Density is an important property of biofuel. Density is the mass per unit volume of any liquid at a given temperature. Density measurements were carried out using a specific gravity bottle (ASTM D41) at a temperature of 298 K.

2.2.4 Viscosity:

It is measured using Anton Parr Rheometer MCR 52. The sample of 60 ml is inserted in the sampling crucible. The rotating float was inserted in the crucible. The heating is done with the external oil heating system. The sample was allowed to get equilibrium at the given temperature. For current Biodiesel- petro diesel blend viscosity was experimented at constant shear rate. Number of set point was taken as the constant points. For each sample reading were taken at 298 K.

2.2.5 Cetane Number:

The physical and chemical properties of fuel play very important role in delay period. The Cetane Number (CN) of the fuel is one such important parameter which is measurement for the delay period. Cetane number of a fuel is defined as the percentage by volume of n-cetane in a mixture of n-cetane and α-methyl naphthalene which has the same ignition characteristics (ignition delay) as the test fuel, when combustion is carried out in a standard engine under same operating condition. A fuel of higher cetane number gives lower delay period and provides smoother engine operation. Biodiesel has a higher CN than petrodiesel because of its higher oxygen content. Measuring method and instrument for testing:

Property	Measuring Instrument	Standard Test Method
Flash point	Penksy- Martin Appartus	ASTM D43
Calorific Value	Bomb Calorimeter	ASTM D240
Viscosity	Rheometer	ASTM D2196
Density	Specific Gravity	ASTM D941

3. Result and discussion:

The properties such as flash point, calorific value, viscosity and density were analyzed as per described procedure. The readings of each property are plotted against the volume fraction of biodiesel in blend of biodiesel and petro diesels are given below.

Tabel 1 Experimental Data at 298 K

Volume Fraction	**Viscosity (cP)**	**Flash Point(^{0}C)**	**Density (Kg/m^3)**	**Calorific Value (KJ/Kg)**
0.00	3.01	74.0	817.0	43601
0.05	3.05	75.8	819.4	43211
0.10	3.12	77.9	821.8	42426
0.15	3.20	80.4	825.5	41906
0.20	3.24	81.3	828.0	41307
0.25	3.31	82.4	830.6	40852
0.30	3.38	83.5	832.5	40213
0.35	3.45	84.8	835.3	40021
0.40	3.53	87.2	837.8	39661
0.45	3.60	88.6	840.3	39557
0.50	3.67	89.9	842.9	39052
0.55	3.74	91.3	845.5	38557
0.60	3.82	92.6	848.0	38618
0.65	3.89	93.8	850.5	38271
0.70	3.99	95.2	853.3	38038
0.75	4.10	96.4	855.8	37365
0.80	4.20	97.9	858.8	35571
0.85	4.34	98.9	861.4	37435
0.90	4.47	100.1	864.1	37332
0.95	4.61	101.8	866.3	37328
1.00	4.74	103.2	869.0	37124

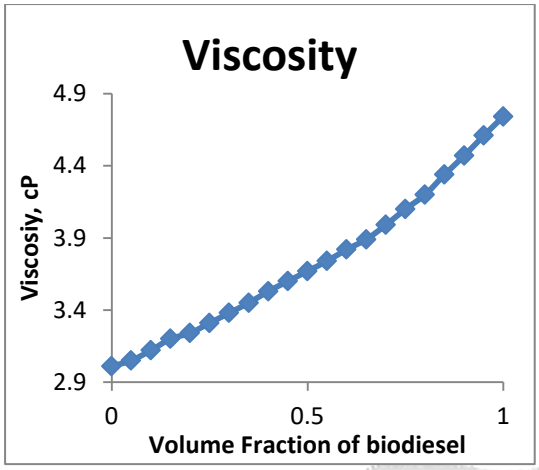


Figure 1: Experimental Data of viscosity

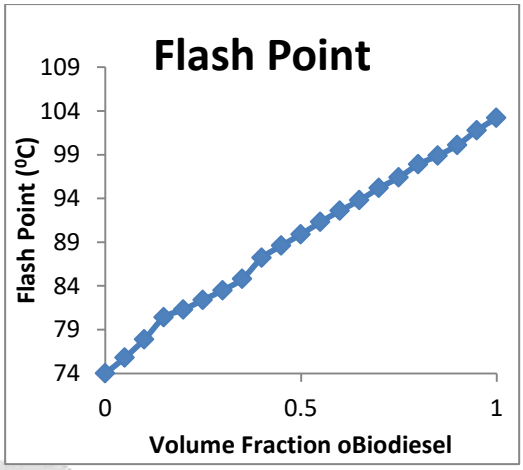
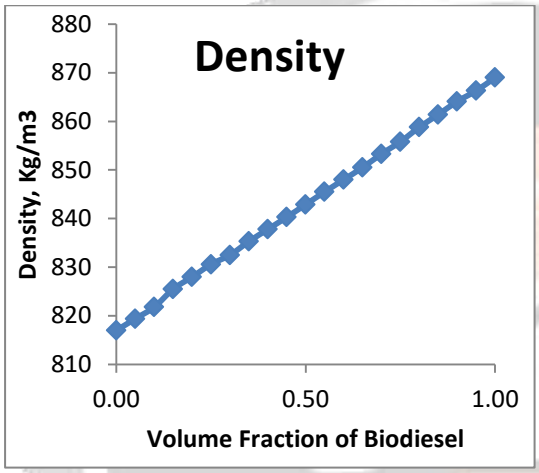
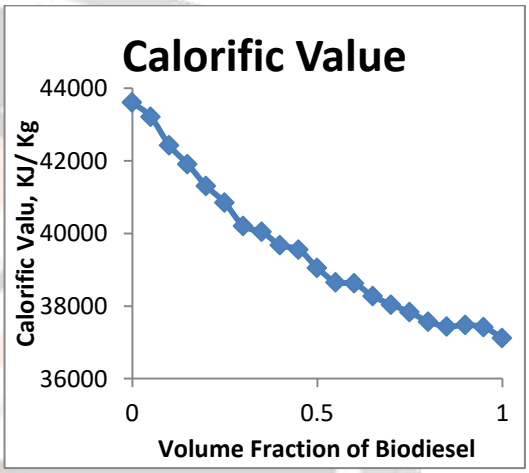


Figure 2: Experimental Data of F.P.



Figures 3: Experimental Data of Density



Figures 4: Experimental Data of C.V.

It is observed that the viscosity of pure biodiesel is higher than the petro diesel. The density of the diesel is also increases with the increase in the volume fraction of the biodiesel in the blend of biodiesel. The heating value of the pure biodiesel is lesser as compare to currently working petro diesel.

4. CETANE NUMBER

Based on the experimental data, the correlation generated for the each property, the Cetane number was calculated using Matlab program and correlation is:

$$CN = K_5 + K_4 \times \gamma + K_3 \times H.V. + K_2 \times F.P. + K_1 \times \rho \qquad (1)$$

Here, CN = Cetane Number, γ= kinematic viscosity (mm^2/s), H.V. = Calorific Value (KJ/Kg), F.P. = Flash Point (^0C), ρ= Density (Kg/m^3).

Tabel 2 Predicted Values of Cetane Number

Biodiesel Blend	Cetane Number
B00	47.68
B05	48.05
B10	48.50
B15	49.08
B20	49.53

B25	49.97
B30	50.34
B35	50.75
B40	51.13
B45	51.48
B50	51.95
B55	52.35
B60	52.72
B65	53.12
B70	53.51
B75	53.89
B80	54.34
B85	54.72
B90	55.05
B95	55.33
B100	55.67

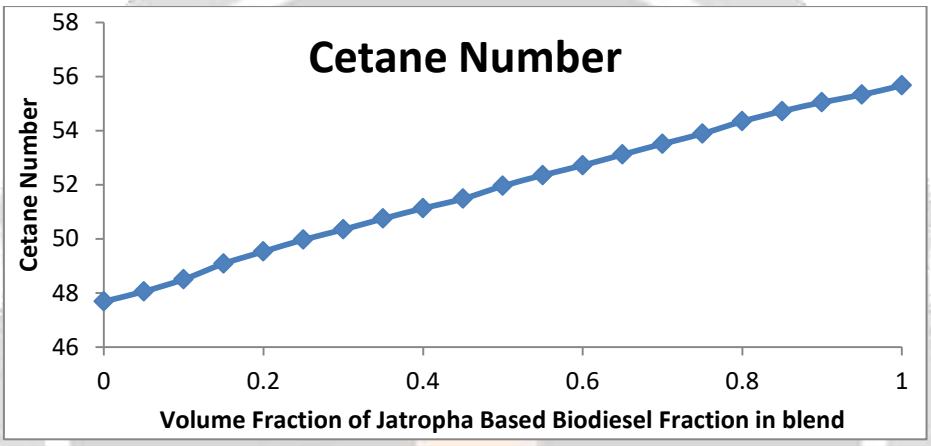


Figure 5: Predicted Values for Cetane Number

5. CONCLUSION:

The experimental values clearly suggest that the biodiesel is viscous as compared to petro diesel. The density of biodiesel is also very high at the given room temperature conditions, which suggests that the there need to be better pumping and fluel ignition system require for the engine running.

The blend of the biodiesel suggests that the Cetane number is increasing with increase in the biodiesel fraction for the given Jatropha oil based biodiesel. Cetane number has linear relationship with kinematic viscosity, density, Flash point and calorific value.

The predicted values of Cetane number for pure component are very nearer to reported values. So we can say it gives high accuracy prediction correlation.

6. REFERENCES:

1. Gerpen JV, “Biodiesel processing and production”, Fuel process Technol. 86, 2005, 1097-1107
2. Tomasevic AV and Marinkovic SS.. “Methanolysis of used frying oil” , Fuel Process Technol, 2003,81,16
3. K. Shivramakrishnan, P. Ravikumar, “ Determination of cetane number of Biodiesel and its influence on physical properties”, APRN Journal of Engneering and Applied Science,7(2), 2012, 205-211.

4. Lang X, Dalai AK, Bakhshi NN, Reaney MJ, Hertz PB., "Preparation and characterization of bio-diesels from various bio-oils." Bioresource Technology, 80, 2001, 53–62.
5. Paul Mania," Investigation of fuel properties and engine analysis of Jatropha biodiesel of Kenyan origin", Journal of Engineering in South Africa,25(2), 2014, 163-168.
6. M. Mofijur, H.H. Masjuki, M.A.Kalam, A.E.Atbani, "Evaluation of biodiesel blending, engine performance and emission characteristics of Jatropha curcas methyl ester: Malaysian perspective", Energy 55, 2013, 879-887.
7. Sunil Kumar, Alok Chaube, Shashi Kumar Jain, "Sustainability issues for promotion of Jatropha biodiesel in Indian scenario:A review", Renewable and Sustainable Energy Reviews 16,2012, 1089–1098.
8. Jinlin Xue, Tony E. Grift, Alan C. Hansen, "Effect of biodiesel on engine performances and emissions", Renewable and Sustainable Energy Reviews 15, 2011, 1098–1116.
9. Abebe K. Endalew, Yohannes Krios, Rolando Zansi , "Heterogeneous catalysis for biodiesel production Jatropha Curcas Oil(JCO)", Energy 36, 2011, 2693-2700
10. Ashwani Kumar, Satyawati Sharma, "An evaluation of multipurpose oil seed crop for industrial uses(Jatropha Carcus):A review", Industrial crops and products 28, 2008, 1-10
11. K.S. Pant, Vijay Khosla, Dinesh Kumar and Sumeet Gairola, "Seed oil content variation in Jatropha curcas Linn. in different altitudinal ranges and site conditions in H.P. India", A journal of ecology and application, volume 11(2),2006, 283-289.
12. Neyda C Om Tapanes, Donato A. Gomes Aranda, Jose. W de. Mesquita Carneiro, Octavio A. ceva Antunes, "Transesterification of Jatropha curcas oil glycerids: Theoretical and experimental studies of biodiesel reaction", Fuel 87, 2008,2286-2295