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Improving the Oxidation Stability of Biodiesels using Binary Biodiesel Blends

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Abstract—*The environmental threats posed by rapidly deleting the fossil fuels are currently a major global concern* and lead to the research of alternative energy resources. The biodiesel is considered as substitute of diesel but the biodiesel suffers with the disadvantage that the fuel quality is very much impacted by its oxidation stability. The present paper aims to improve the oxidation stability of biodiesels by binary blending. Waste cooking biodiesel (WCB) was blended with Jatropha curcas biodiesel (JCB) and found that WCB_{20} blend has oxidation stability in the range of ASTM specification. The results shows that WCB_{20} blend with JCB have significantly improved oxidation stability from x hrs to y hrs. So, WCB_{20} blend is recommended for direct use in diesel engine.

Keywords*: iodiesel; Oxidation stability; Blending; Transesterification.*

1. INTRODUCTION

The transport sector is a major contributor to Greenhouse Gas (GHGs) emissions resulting in global warming that directly affects the biological life [1-4]. The depleting crude oil resources and difficulties in extraction and processing leads to higher fuel prices. This situation has called for a search of an alternative and renewable source of liquid fuels like as bio-ethanol and biodiesel [5]. Biodiesel, methyl ester of oil/fat, produced from edible and non edible oil. If we can utilize, used vegetable or frying oil and reuse it as feedstock for production of bio diesel, it may help in reducing pollution caused from repudiated oil and will render a new way of transforming a waste product into transport energy. In the retail transport market, blends of bio diesel and conventional diesel which is hydrocarbon-based are the most frequently distributed fuels [6-7].

The main hinder with the use of biodiesel as fuel is its poor oxidation stability due to this biodiesel breaks into unwanted smaller chain compounds such as aldehydes, small chain esters which further causes the problem of choking of injector and fuel filter and formation of deposits in various components of the fuel system including combustion chamber [8]. This happens due to the presence of unsaturated fatty acids in biodiesel and reduces the stability of biodiesel [9]. To overcome and improve these problems, Dwivedi et al. [9] suggested methods like blending of biodiesel with diesel, use of antioxidant.

The main objective of this study is to improve the oxidation stability of waste cooking biodiesel by blending with other biodiesel whose stability is comparatively higher.

2. MEASUREMENT OF OXIDATION STABILITY

Oxidation stability, an important quality parameter, is expressed by induction period (IP). The IP is assessed by the Rancimat method EN 14112 for biodiesel and modified Rancimat method EN 15751 for biodiesel blends with diesel. Oxidation stability was measured by using Metrohm 873 Rancimat instrument. A micro-algal biodiesel sample of 3 g was analyzed under passing a constant air flow of 10 l/h, and a vessel contained distilled water as shown in Fig. 1.

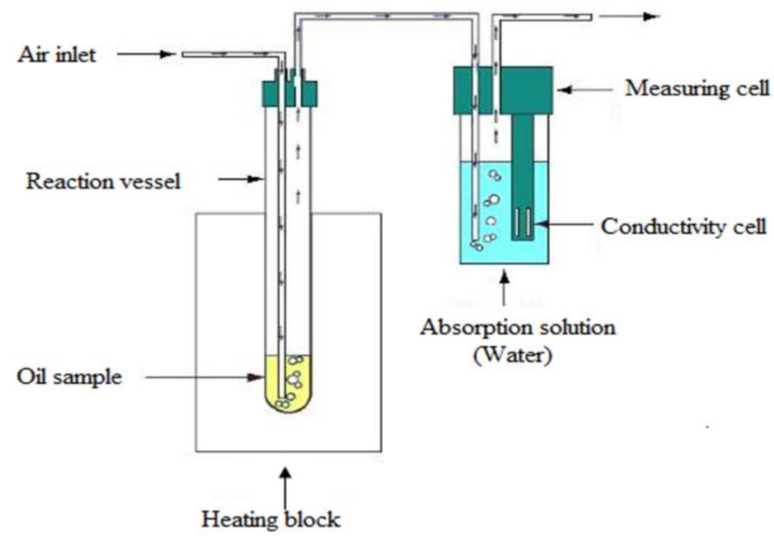

Fig. 1 Schematic diagram of Rancimat apparatus

The biodiesel sample is continuously heated at 110 ºC with a correction factor DT (different temperature) to be set to 1.5 ºC. The electrode is also connected to a measuring and recording device. The start of IP is indicted when conductivity starts increasing while end of IP is inducted when conductivity increases rapidly. The abrupt change in conductivity is due to dissociation of volatile carboxylic acids produced and absorbed in the distilled water. The oxidation curve is obtained by using conductivity and point of inflection are known as IP as shown in Fig. 2. The biodiesel could not be stored beyond this period due to the quality starts degrade and it will not be used for engine operation [10].

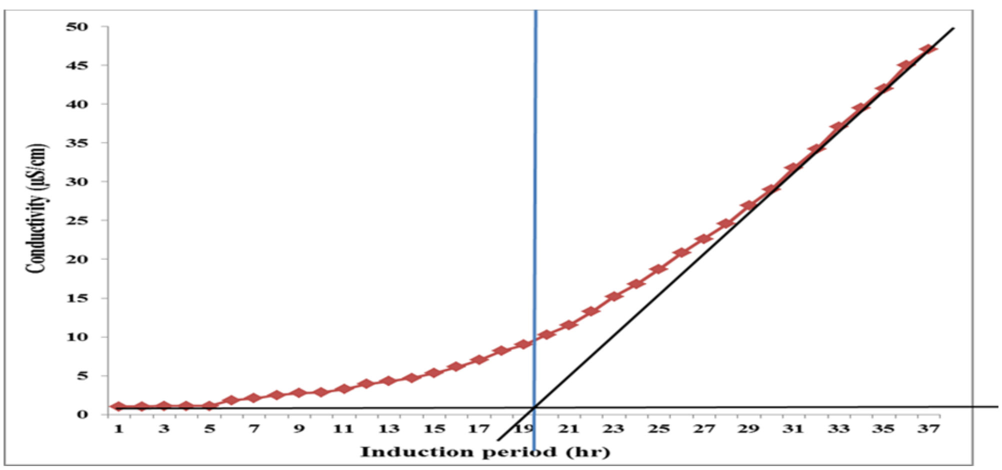

Fig. 2: Graphical determination of induction time (t) by the tangent method.

3. Material and Methodology

3.1 Material

WCO was obtained from hostel mess. Jatropha oils was used to prepare biodiesels as per methodology adopted earlier. All chemicals used were of Analytical Research Grade and 99% pure. The fuel properties of oils and their biodiesels as determined by standards methods [7, 15, 16] are given in Table 1.

Table 1: Fuel properties of WCO and JCO

Properties	WCO	JCO
Viscosity (cst) @40°C	25	31.5
Density (kg/m3)	912	915
Calorific value (MJ/kg)	41	40
Flash Point (°C)	230	242
FFA Content (%)	2.8	21

As from the Table 1 it is found that the FFA content in WCO is low while it is high in JCO. Table 2 compares the fuel properties of WCB and JCB with diesel and different biodiesels standards.

Table 2: Fuel properties of WCB and JCB

Biodiesel	JCB	WCB	Diesel	ANP Specification for biodiesel	Standards
Oxidation stability (h)	12	4	-	6.0 min.	EN ISO 14112
Kinematic viscosity at 40 °C (mm2 s-1)	5.40	4.8	2.5	3.0-6.0	ASTM D445
Density at 20 °C (Kg m-3)	887	887	840	820-900	ASTM D4052
Calorific Value (MJ/Kg)	39.27	40.15	43	-	-
Acid value (mg KOH g-1)	0.2	0.2	-	0.5 max.	ASTM D664
Flash point (°C)	156	140	72	100 min.	ASTM D93
Cloud Point (°C)	8	6	0	-	ASTM D2500
Pour Point (°C)	6	4	-3	3 (winter) Max. 15 (summer)	ISO 3016

The table shows that WCB have poor oxidation stability while JCB have excellent oxidation stability. Therefore, the binary blends of WCB with JCB has been undertaken to bring overall oxidation stability in the range of various standards.

3.2 Measurement of oxidation stability

In order to improve the oxidation stability of biodiesel we have prepare binary blends of WCB with JCB and the details is given in Table 3.

Table 3- Fuel properties of WCB and JBD Blends

Properties Blends WCB:JBD	Calorific Value (MJ/Kg)	Viscosity at 40 °C (mm^2 s^{-1})	Density at 15 °C (Kg m^{-3})	Acid value (mg KOH g^{-1})	Flash point (°C)	OS (h)	CP (^{O}C)	PP (^{O}C)
100:0	40.15	4.8	890	0.2	140	**4**	6	4
90:10	40.062	4.86	890	0.2	141.6	**4.75**	6.2	4.2
80:20	39.974	4.92	890	0.2	143.2	6	6.4	4.4
70:30	39.886	4.98	890	0.2	144.8	8	6.6	4.6
60:40	39.798	5.04	890	0.2	146.4	9	6.8	4.8
50:50	39.71	5.1	890	0.2	148	9.5	7	5
40:60	39.622	5.16	890	0.2	149.6	10	7.2	5.2
30:70	39.534	5.22	890	0.2	151.2	10.75	7.4	5.4
20:80	39.446	5.28	890	0.2	152.8	11	7.6	5.6
10:90	39.358	5.34	890	0.2	154.4	11.75	7.8	5.8
0:100	39.27	5.4	890	0.2	156	12	8	6
DIESEL	45	2.5	840	30	72	32	-1	-3.5
Indian Standard 15607:2005	-	2.5-6.0	860-900	0.5 max.	120 min.	6.0 min.	0(W) 12(S) max.	3(W) 15(S) max.

The fuel properties particularly the oxidation stability of each blends is determined and the results are discussed in the following sections.

3. RESULTS AND DISCUSSION

3.1 Binary Blends of WCB with JCB

As shown in Table 2, WCB has poor while JCB has the excellent oxidation stability. In oreder to improve the oxidation stability of WCB, the binary blends of WCB with JCB were prepared and their oxidation stability as shown in Fig 3 shows that as the proportion of JCB is increased in WCB-JCB binary blends, there is significantly improvement in oxidation stability i.e. WCB_{20} binary blend with JCB has oxidation stability of 6 hrs which is significantly improved compared to WCB_{100}. Accordingly, the WCB_{20} binary blend with JCB can be used directly in engine.

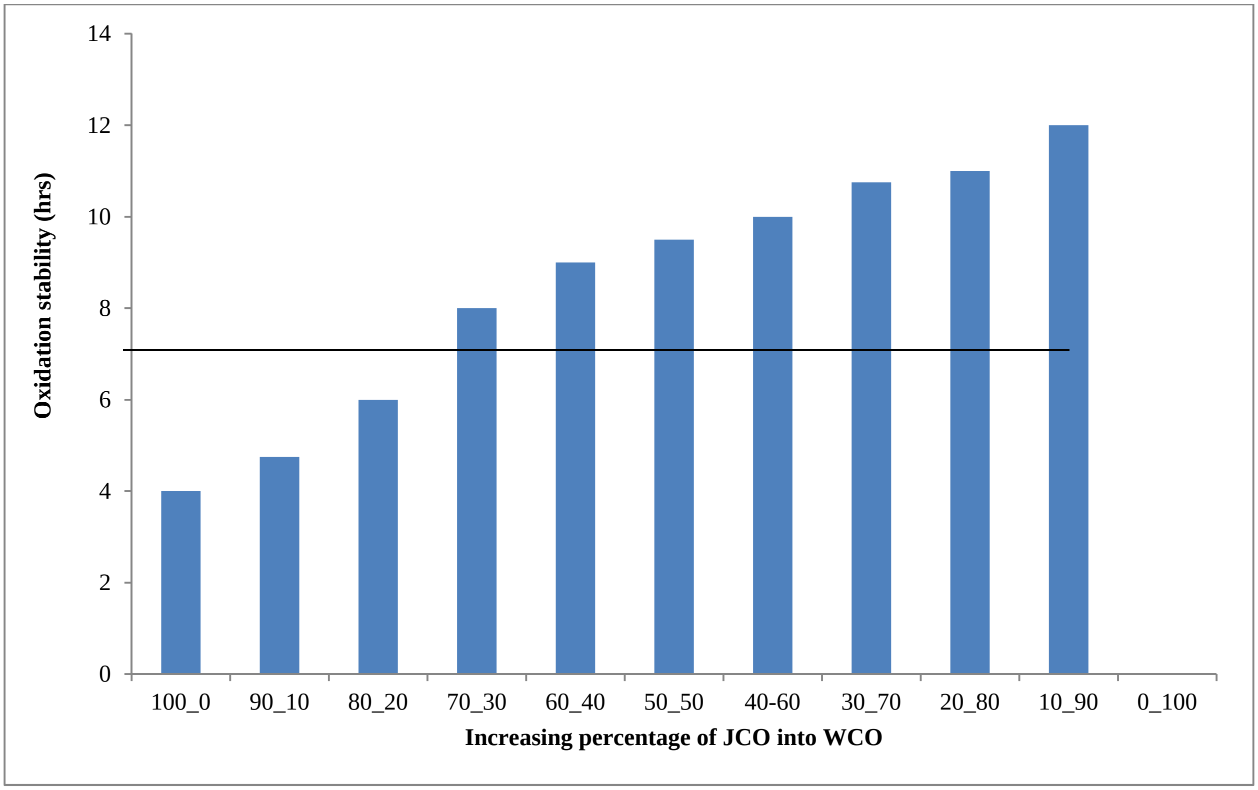

Fig. 3: Variation of oxidation stability for binary Blends of WCB with JCB

4. CONCLUSION

The present study deals with the properties of Jatropha biodiesel waste cooking oil biodiesel and the analysis of their binary blends and their performance on diesel engine.

From the above work, following key conclusions can be drawn:

1. Jatropha biodiesel have excellent oxidation stability in comparison to waste cooking biodiesel.
2. Almost all fuel properties of wcbmeets the standard values of biodiesel except oxidation stability.
3. Different biodiesel blends (JCB and WCB) are prepared in different proportion to obtain the desired fuel properties for use in diesel engine.
4. It is found that WCO:JCB(80:20) blend is best blend in terms of fuel properties and engine application.

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