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RESEARCH ARTICLE

Studies on Effect of Long Term Storage of Jatropha Oil, Blends of Jatropha Oil with Diesel and Bio-diesel on Quality

R.N. Singh[1], Shaishav Sharma[1] and D.K. Vyas[2]
[1]School of Energy and Environmental Studies, Devi Ahilya University, Indore (MP)
[2]College of Agricultural Engineering and Technology, Godhra (Gujarat)
Email: rnsingh.seema@gmail.com

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ABSTRACT

Storage of oil is an important factor that impacts the shelf life and quality of oil as well as its impact on the storage parts. A study was designed and carried out by making different blends of Jatropha oil and diesel in the proportion of 10:90, 20:80, 50:50, 80:20, 90:10, and 100:0 with 100% diesel as control. Freshly prepared bio-diesel from Jatropha oil was also kept for storage along with Jatropha oil- diesel blends. Blends and controls were stored for a period of one year. Storage studies indicated that while Jatropha oil could be stored for about 3 months and bio-diesel for about 12 months without much change in the viscosity and free fatty acid. Jatropha oil could safely be stored for one year when up to 20% oil was blended with diesel. Blending with higher than 20% of Jatropha oil, the viscosity and free fatty acid increased significantly. There was no significant change in the dimensions of the metallic components coming in contact with blends of Jatropha oil with diesel. However, the non-metallic components such as gasket and rubber washer were affected. No significant changes were observed in case of PVC pipe dipped in Jatropha oil-diesel blend up to 20%.

Key Words: *Blended Jatropha oil, Storage, Viscosity, Free fatty acids*

INTRODUCTION

The depleting resources of fossil fuels and increase in their price have created lot of interest on the use of plant oil, especially the Jatropha oil and its ester (Jo Han Ng *et al*, 2010). Plant oils, straight or modified have several advantages as engine fuel. These include better self-ignition characteristics, compatibility with fuel injection system of the CI engine, high-energy content, and safe processing and handling. Due to relatively simple and low-cost technology for expelling and filtering, the plant oil can be processed on the farm itself, thus saving the transport cost, time and energy [SPRERI Report 2007, Forson et.al 2004]. All properties of plant oils are relatively similar to diesel except the viscosity and volatility. High viscosity of the plant oils is considered to be the major constraint although high acid value and presence of wax/gums etc. also adversely affects the engine performance.

At higher temperature, the FFA is known to react with metals like zinc, lead, manganese, cobalt, tin, etc. Available information indicates that with increase in storage time, viscosity and FFA of plant oils are also increased, but the information is very limited. Study conducted by Singh et.al [Singh 2012] reveals that copper, aluminum, copper alloys (bronze), and elastomers caused significant levels of corrosiveness in biodiesel and biodiesel blend as opposed to low corrosion with petro-diesel. However no such information was available on blended Jatropha oil with diesel.

In view of the increasing use of blends of de-waxed and de-gummed Jatropha oil and bio-diesel with diesel it was felt necessary to study the effects of long term storage of Jatropha oil, its blends with diesel in different proportion and bio-diesel, on the quality in terms of changes in viscosity, density and FFA. Hence, a study was carried out on this aspect and results are discussed in this paper.

MATERIAL AND METHODS

Jatropha seeds were procured from open markets and oil was extracted using mechanical oil expeller. Fresh Jatropha oil was de-waxed and de-gummed as per standard procedure [Sharma, 2004]. Bio-diesel of Jatropha oil was prepared as per the procedure recommended by Gupta, 1984 [Gupta, 1984]. Later freshly extracted and de-waxed de-gummed Jatropha oil was used for preparation of blends of Jatropha oil with diesel. Different blends of Jatropha oil and diesel in ratio of 10: 90, 20:80, 50:50, 80:20, 90:10, and 100:0 with 100% diesel as control were used for storage studies. Freshly prepared bio-diesel from Jatropha oil was also kept for storage along with Jatropha oil- diesel blends. The quality of storage oil and bio-diesel were measured monthly in terms of free fatty acid (FFA), density and viscosity.

1. BLENDING OF OIL

De-waxed de-gummed Jatropha oil was blended with diesel on volumetric basic [Singh, 2007, Singh *et al*, 2007].

2. FREE FATTY ACID (FFA) ESTIMATION

Fatty acid composition is the most important factor which determines oil susceptibility to oxidation [Akowuah et. al, 2012]. The risk of oxidation is high in Jatropha seed due to its high fatty acid content, especially oleic fatty acid [Kartika 2010]. Free Fatty acid estimation in the sample was done as per standard procedure [McKillican, 1966 and Sharma 1986]**.**

3. ESTIMATION OF KINETIC VISCOSITY AND DENSITY

Higher viscosity is a major problem in using straight vegetable oil as fuel for diesel engines. Due to higher viscosity, the straight vegetable oil causes poor fuel atomization, incomplete combustion and carbon deposition on the injector and valve seats resulting in serious engine fouling (Sahoo and Das, 2009; Mustafa *et al*, 2009).

However, higher density means more mass of fuel per unit volume for vegetable oil compared to diesel oil. The higher mass of fuel would give higher energy available for work output per unit volume.

The method suggested by Sangha *et al*, 2000 & 2004 was used for estimation of kinetic viscosity and density of blended Jatropha oil, its bio-diesel and diesel.

4. EFFECT OF BLENDED JATROPHA OIL ON ENGINE COMPONENTS

Since the engine was run on blended Jatropha oil, its bio-diesel and diesel, it was considered desirable to study the effect of blended Jatropha oil and bio-diesel on the changes, if any, on the engine components in terms of change in shape, colour, diameter, thickness, weight and length etc. during long term storage.

The metallic components chosen for study were copper washer, aluminum washer, iron washer and steel components. Non-metallic component chosen for the study were rubber washer, rubber pipe, plastic pipe and gaskets.The components were kept dipped in the blended Jatropha oils and diesel (control) for three months and parameters were measured every month.

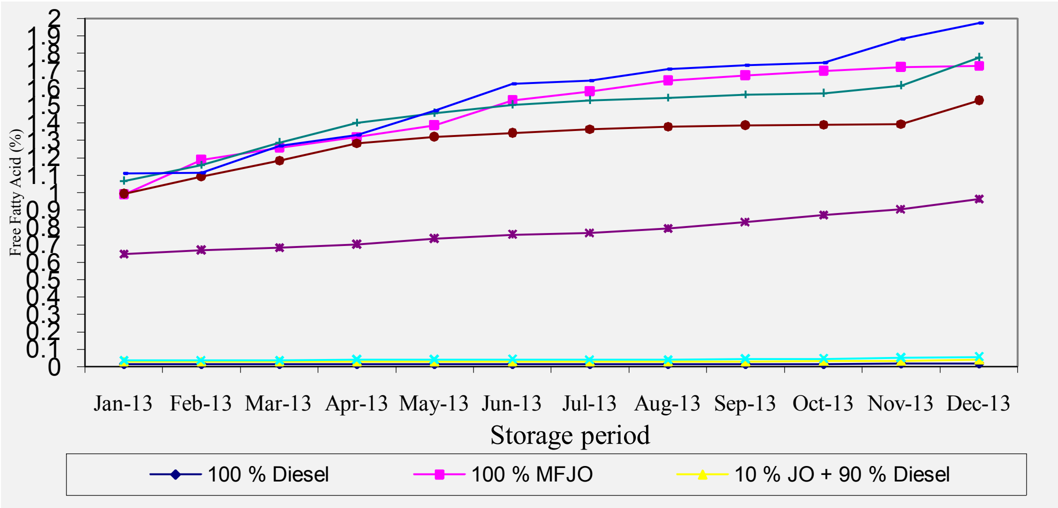
RESULTS AND DISCUSSION

1. Effect of Storage on FFA, Viscosity and Density of Oil and Ester

Long-term storage studies conducted for 12 months revealed that:

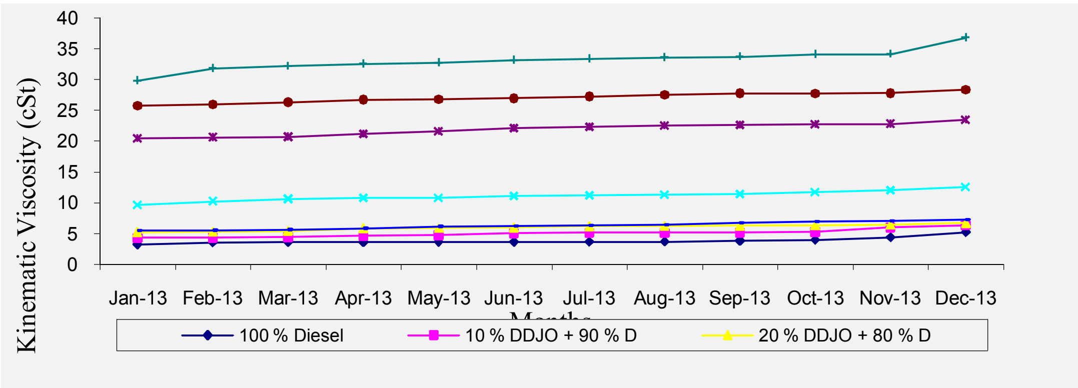
1. FFA value increased with the increase in storage time (Fig 1). However the increase in FFA of blends of Jatropha oil with diesel in the proportion of 10: 90 and 20:80 were 0.029% - 0.039% and 0.037%– 0.053% respectively. This was much less as compared to the blends of 50:50, 80:20, 90:10 and 100:0. In case of Jatropha ester (Bio-diesel), the increase in FFA in 12 months storage time was from 0.987% to 1.729%.

Fig. 1: Variation in free fatty acid with respect to time



2. The viscosity of the blends of Jatropha oil with diesel also increased with increase in time in different proportion (Fig 2). The increase in viscosity in the blends of Jatropha oil in the proportion of 10: 90 and 20:80 were 4.32 - 6.35 cSt and 5.23-6.73 cSt respectively. These were much less as compared to blends of 50:50, 80:20, 90:10 and 100:0. In case of Jatropha ester (Bio-diesel) the increase in viscosity during 12 months storage time was from 5.55 cSt - 7.30 cSt.

Fig. 2: Variation in viscosity with respect to time



3. The density of the blends of Jatropha oil with diesel also increased with the increase in storage time in different proportion (Fig 3). The increase in density in the blends of Jatropha oil in the proportion of 10: 90 and 20:80 were 880.0 - 822.5 kg m^{-3} and 812.36 - 826.45 kg m^{-3} respectively. These were less as compared to blends of 50:50, 80:20, 90:10 and 100:0. In case of Jatropha oil ester (Bio-diesel) the increase in density during 12 months storage time was about 0.55%.

From the studies, it could be safely concluded that the storing of blended Jatropha oil in the blends of 10:90 (Jatropha oil: diesel) or 20:80 (Jatropha oil: diesel) is safer rather than storing pure Jatropha oil for longer duration. It was also observed that the increase in FFA in case of Jatropha oil ester (bio-diesel) and 10 % and 20 % blended Jatropha oil with diesel over a one-year span was below the BIS recommendations (0.5%). However, after one year, the FFA content of Jatropha oil crossed the BIS recommendation levels (Sangha *et al*, 2004). Increase in FFA content of Jatropha oil was found higher compared to their esters. The increase in FFA was reported due to inherent lipase activity. It was also observed that viscosity value of Jatropha oil and their esters increased 40.59 %, and 23.97 % respectively during the storage period of twelve months.

2. EFFECT OF BLENDED JATROPHA OIL ON METALLIC COMPONENTS OF ENGINE

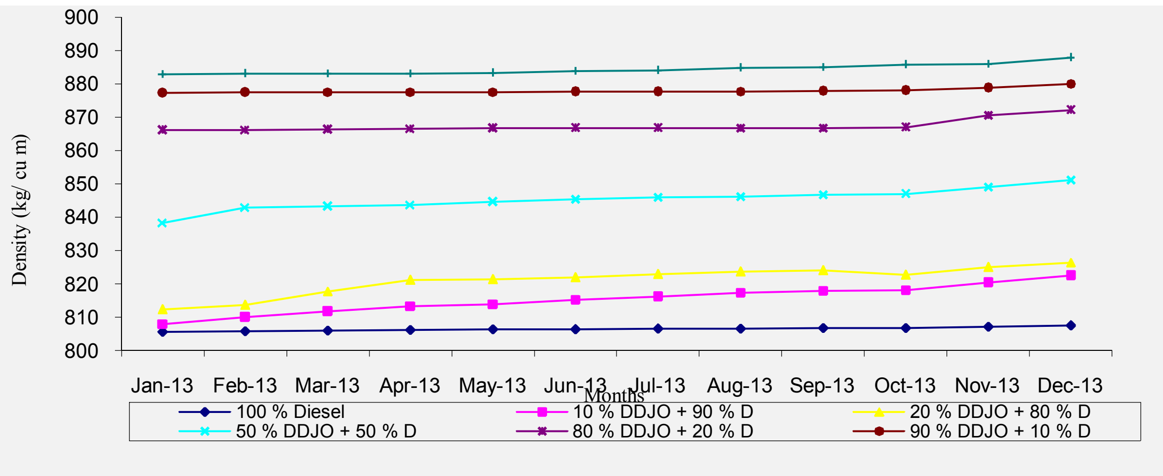
The metallic components selected for study were steel components and washers of copper, aluminium and iron. Effect of blended Jatropha oil on various parameters such as diameter, thickness, weight and length were observed. The study was carried out for three months with observations recorded at regular interval of one month. No significant changes were observed in any of the parameters studied. Diesel was taken as control in case of all these studies (Table1).

Table 1: Effect of storage on metallic and non-metallic component of CI engine in blended Jatropha oil

Parameter		DDJO10				DDJO20				DDJO50				DDJO100				Diesel			
		April	May	June	July	April	May	June	July	April	May	June	July	April	May	June	July	April	May	June	July
Cu Washer	Dia, mm	18.18	18.18	18.18	18.18	18.14	18.14	18.14	18.14	18.22	18.22	18.22	18.22	17.97	17.97	17.97	17.97	18.08	18.08	18.08	18.08
	Th, mm	1.55	1.55	1.55	1.55	1.62	1.62	1.62	1.62	1.50	1.50	1.50	1.50	1.56	1.56	1.56	1.56	1.63	1.63	1.63	1.63
	Wt, gm	1.32	1.32	1.32	1.32	1.20	1.20	1.20	1.20	1.19	1.19	1.19	1.19	1.14	1.14	1.14	1.14	1.24	1.24	1.24	1.24
Al Washer	Dia, mm	19.88	19.88	19.88	19.85	20.18	20.18	20.18	20.18	19.88	19.88	19.88	19.88	20.18	20.18	20.18	20.18	25.18	25.18	25.18	25.18
	Th, mm	1.56	1.56	1.56	1.56	1.38	1.38	1.38	1.39	0.39	0.39	0.39	0.39	0.31	0.31	0.31	0.31	0.57	0.57	0.57	0.57
	Wt, gm	0.60	0.60	0.60	0.60	0.526	0.526	0.526	0.527	0.87	0.87	0.87	0.87	1.15	1.15	1.15	1.15	0.61	0.61	0.61	0.61
Iron Washer	Dia, mm	24.56	24.56	24.56	24.57	24.87	24.87	24.87	24.86	21.59	21.59	21.59	21.59	20.70	20.70	20.70	20.70	28.52	28.52	28.52	28.52
	Th, mm	2.47	2.47	2.47	2.47	2.10	2.10	2.10	2.07	2.57	2.57	2.57	2.57	2.85	2.85	2.85	2.85	2.36	2.36	2.35	2.35
	Wt, gm	6.280	6.28	6.28	6.26	6.86	6.84	6.84	6.84	3.86	3.86	3.86	3.86	3.53	3.53	3.53	3.53	7.83	7.83	7.83	7.83
Steel Washer	Dia, mm	16.96	16.96	16.97	16.96	10.95	10.95	10.95	10.95	10.96	10.96	10.96	10.96	16.96	16.96	16.96	16.96	10.97	10.97	10.97	10.97
	Th, mm	8.81	8.81	8.81	8.81	2.06	2.06	2.06	2.06	1.98	1.98	1.98	1.98	3.18	3.18	3.18	3.18	2.02	2.02	2.02	2.02
	Wt, gm	8.807	8.807	8.807	8.807	3.80	3.80	3.80	3.80	3.72	3.72	3.72	3.72	8.78	8.78	8.78	8.78	3.75	3.75	3.75	3.75
Rubber Washer	Th, mm	2.05	2.14	2.28	2.31	2.05	2.15	2.204	2.24	2.08	2.14	2.20	2.22	3.74	3.76	3.77	3.77	3.70	3.78	3.82	3.82
	Wt, gm	0.259	0.279	0.285	0.295	0.253	0.275	0.28	0.29	0.255	0.272	0.278	0.281	0.920	0.923	0.927	0.927	1.055	1.129	1.129	1.129
Gasket	Th, mm	0.72	0.92	1.00	1.07	0.77	0.98	1.10	1.11	0.69	0.92	.980	1.00	0.69	0.86	0.97	0.97	0.68	0.79	0.82	0.82
	Wt, gm	1.057	1.336	1.51	1.521	1.054	1.387	1.414	1.514	1.792	2.336	2.403	2.423	1.872	2.318	2.401	2.401	1.768	2.069	2.181	2.181
PVC Pipe	Dia, mm	13.72	13.71	3.72	3.72	13.57	13.47	13.38	13.34	13.73	13.66	13.56	13.52	13.67	13.52	13.45	13.45	13.73	13.75	13.79	13.79
	Th, mm	2.92	2.92	2.92	2.92	3.06	3.02	3.01	3.01	3.13	3.09	3.05	3.01	2.96	2.91	2.95	2.95	2.88	2.81	2.85	2.85
	Wt, gm	4.509	4.488	4.509	4.509	4.297	4.295	4.288	4.28	3.907	3.913	3.903	3.901	3.410	3.366	3.388	3.388	3.95	3.935	3.904	3.904
Rubber Pipe	Dia, mm	12.58	11.80	11.76	11.76	12.37	11.46	11.40	11.37	11.60	11.66	11.69	11.71	11.99	11.89	11.91	11.91	11.14	11.11	11.12	11.10
	Th, mm	2.30	2.27	2.24	2.14	2.37	2.21	2.18	2.14	2.11	2.00	1.94	1.90	2.13	1.98	2.01	2.00	2.16	2.10	2.02	2.01
	Wt, gm	2.772	2.761	2.683	2.583	2.745	2.669	2.598	2.498	2.949	2.883	2.789	2.780	3.016	2.46	2.248	2.218	2.839	2.567	2.412	2.402

Dia= Diameter, Th= Thickness, Wt= Weight

Fig. 3: Variation in density with respect to time



3. EFFECT OF BLENDED JATROPHA OIL ON NON-METALLIC COMPONENTS OF ENGINE

The non-metallic components selected for study were rubber washer, pipes of plastic and rubber, and gaskets. Diesel was taken as control. The study was carried out for three months. Among the non-metallic components, maximum changes were observed in case of gaskets followed by rubber washer and rubber pipes. No significant changes were observed in case of PVC pipes (Table 1). In the case of gasket dipped in diesel, which was taken as control, thickness and weight of gasket increased by 20.58% and 23.36% respectively by the end of three months. However, for rubber washer dipped in diesel thickness and weight increased by 3.4% and 7.0% respectively. When the gasket was dipped in various blends of Jatropha oil with diesel, a significant percentage of increase in thickness and weight (28.26 % - 43.89%) was observed in gaskets depending upon the blends. However the percentage increase in weight of rubber washer varied from 7.6% -13.89%. It was more as compared to the changes observed in case of gasket and rubber washer dipped in diesel. No significant changes were observed in case of PVC pipe dipped in Jatropha oil-diesel blends up to 20%.

CONCLUSION

Storage studies indicated that while Jatropha oil could be stored for about 3 months and bio-diesel for about 12 months without much change in the viscosity and free fatty acid. Jatropha oil could safely be stored for one year when up to 20% oil was blended with diesel. Blending with higher than 20% of Jatropha oil, the viscosity and free fatty acid increased significantly. There was no significant change in the dimensions of the metallic components coming in contact with blends of Jatropha oil with diesel. However, the non-metallic components such as gasket and rubber washer were affected. No significant changes were observed in case of PVC pipe dipped in Jatropha oil-diesel blend up to 20%.

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