Oriental Journal of Chemistry Vol. **26**(2), 509-516 (2010)

Characterization and performance of Bio-diesel and its blends in CI engines by studying combustion and emission characteristics

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(Received: January 02, 2010; Accepted: February 18, 2010)

ABSTRACT

In the present study biodiesel is collected from Bindle group and it blended in various proportions with diesel were studied. The torque, brake power and fuel consumption values associated with these fuels were determined under certain operating condition. Maximum brake power for all the blend as well as diesel is obtained in the speed range of 1520 rpm. Maximum Brake power for JB 80% is 1.83 Kw at 1500 rpm & for diesel is 1.82 Kw at 1444 rpm. Increase in power may be due to complete combustion of oxygenated fuel. With increase in speed, specific fuel consumption first decreases and than increases. Specific fuel consumption (sfc) also increases with increase in blend percentage. All the blend gave minimum sfc at 1444 rpm for diesel is 0.49 kg/kwh, JB 20% at 1490 rpm is 0.45 kg/kwh, JB 40% at 1480 rpm is 0.51 kg/kwh,JB60% at 1492 rpm is 0.52 kg/kwh, JB 80% at 1500 rpm is 0.49kg/kwh.. The products of Tran's esterification were evaluated by comparing physical characteristics of biodiesel oil. The biodesel were then tested in diesel engine to observe their actual performance emission. This paper introduces an elegant method for the above required analysis by establishing a definite relationship between fuel properties and engine performance.

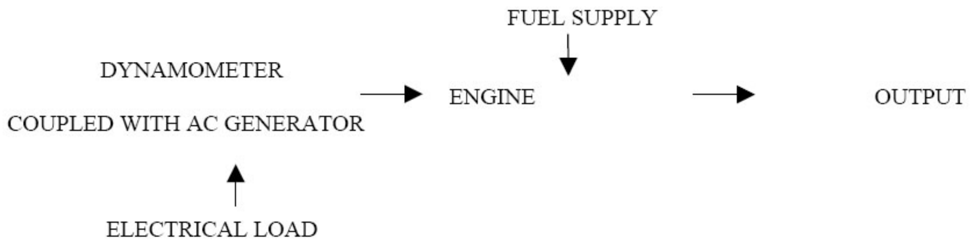
Key words: Biodiesel, blending, esterification, specific gravity, brake power, torque.

INTRODUCTION

In recent years there has been a growing recognition that more sustainable development approaches are required across both the private and public sector for developing alternative fossil fuels. To reduce the dependency on fossil fuel it is essential to trigger & promote the sustainable sources of energy that will be available for longer period of time. Fuel material and consumer goods has increased significantly and will continue to spiral upwards during the early part of the 21st century. The main driver for demand is not due to population increase, but the large increase in per capital consumption that accompanies the improving standards of living throughout the world. Biofuels are alternative renewable fuels that have received considerable attention in the recent past**.** With increasing demand on the use of fossil fuels greater threat to clean environment is being posed. Burning of fossil fuel is associated with emissions like $CO_{2,}$ CO, SOx, NOx and particulate matter that are global source of emission[2]. These emissions cause pollution and make the environment polluted. The ideal alternative fuel will be one in which the engine would burn much more clearly than conventional gasoline fuel and would at the same time require less modification. Bio-diesel was used as fuel of a direct injection CL engines. One of the biggest advantages of biodiesel compared to many other alternative transportation fuels is that it can be used in existing diesel engines with some modification, and can be blended in at any ratio with diesel. One of the important concerns about wide-scale development of biodiesel is if it would displace croplands currently used for food crops[4].

MATERIAL AND METHODS

Experiment is performed by using diesel and its prepared Atrophy bodies with different blends. The rig is instrumented to facilitate measurement of fuel - air consumption, exhaust temperature, coolant inlet-outlet temperature and flow rate. Engine is directly coupled to an electrical dynamometer, used to start the engine. Out of two-panel left one contains the electrical controls for controlling the dynamometer engine speed is measured with an electronic digital meter. Inlet and outlet temperature measured by thermocouples in the water jacket flow rate of water is noted by Rota meter. For measuring exhaust gas temperature one thermocouple is fixed to the exhaust gas pipe of the engine to measure and the temperature is displayed digitally[7].



Test procedure

Engine is started by cranking then after stabilizing measure rpm, inlet, outlet temperature of coolant, exhaust temperature, pressure; fuel consumption time in sec is measured by stop watch at no load condition. Repeat the process by increasing load.

Sample Calculation

Blend used-100 %, 80%, 60%, 40%, 20% and pure diesel

Load given-	2-25
Time recorded for consumption of	20 ml of fuel
Bore dia (D)	80mm
Stroke length (L)	553cc
Speed	1500rpm

1. Power developed = (P* L*A*N*k)/ (60*n)
   K=no. of cylinder
   n=1 for 2 stroke engine
2. Torque N-m= (Power*1000*60)/ (2*ð*N)
3. Mass flow rate mf (Kg/sec) = (Density*Volume)/ time
4. Efficiencyη % =Power* 100/ (mf *CV)

Engine Specification

Stroke	110 mm
Speed	1500 rpm
No. of cylinders	01
Type of ignition	Compression Ignition
Type of cooling	water cooled

RESULTS AND DISCUSSION

Table1-6(a) Shows that brake power increases as the blend % increases, this is due to complete combustion of fuel, maximum brake power for all the blend as well as diesel is obtained in the speed range of 1520 rpm. Max. Brake power for JB 80% is 1.83 Kw at 1500 rpm & for diesel is 1.82 Kw at 1444 rpm. Increase in power may be due to complete combustion of oxygenated fuel.

Table 1-6 (b) Shows that with increase in speed, specific fuel consumption first decreases and than increases. Specific fuel consumption(sfc) also increases with increase in blend %.All the blend gave minimum sfc at 1444 rpm for diesel is 0.49 kg/kwh, JB 20% at 1490 rpm is 0.45 kg/kwh, JB 40% at 1480 rpm is 0.51 kg/kwh,JB60% at 1492 rpm is 0.52 kg/kwh, JB 80% at 1500 rpm is 0.49kg/kwh.

The products of Tran's esterification were evaluated by comparing physical characteristics of biodiesel oil (Table A). The specific gravity of B100 is 0.8802 and that of diesel is 0.8495, viscosity of B100 at 40 ^{o}C 6.11and of diesel is 2.98, flash point of B100 is 170 ^{o}C and of diesel 74 ^{o}C and pour point of B100 Is -10 ^{o}C and of diesel is -18 ^{o}C .The net calorific value of B100 is 37.82 (MJ/Kg) and that of diesel is 42.90 MJ/Kg.

Table 1(a): Diesel only

S. No	RPM of Crank shaft	Load (W-S)	Time for kg	T1 (^{0}C) 20ml fuel (sec)	T2 (^{0}C)	T3 (^{0}C)	T4 (^{0}C)	T5 (^{0}C)	H1-H2 (mm of water)	Water flow to Calorimeter LPM	Water flow to Engine LPM
1	1520	0	177	33	45	36	145	67	12	1.95	1.95
2	1524	0.5	152	33	46	37	153	69	12.5	1.95	1.95
3	1518	3.2	126	33	46	37	167	73	12.1	1.95	1.95
4	1510	5.8	100	33	47	37	186	77	11.8	1.95	1.95
5	1500	8.4	75	33	50	39	224	83	11.5	1.95	1.95
6	1492	11.2	72	33	55	39	249	93	11	1.95	1.95
7	1444	14.5	68	33	57	40	268	100	10.9	1.95	1.95

Table 1(b): Diesel Only

S. No	RPM of crank shaft	BP (watts)	Fuel consumption (Kg/Kwh)	Bsfc (kg/Kwh)	Bth eff	Air consumption (Kg/Sec)
1	1520	0	0.345762712			0.001537502
2	1524	66.56505	0.402631579	3.048693	1.4004	0.001569207
3	1518	424.3391	0.485714286	1.84637	7.4002	0.001543895
4	1510	765.0613	0.612	0.799936	10.589	0.001524636
5	1500	1100.682	0.816	0.741359	11.426	0.00150513
6	1492	1459.749	0.85	0.582292	14.547	0.001472046
7	1444	1829.054	0.9	0.492058	17.215	0.00146534

Table 2(a): 20% Biodiesel

S. No	RPM of Crank shaft	Load (W-S)	Time for kg	T1 (^{0}C) 20ml fuel (sec)	T2 (^{0}C)	T3 (^{0}C)	T4 (^{0}C)	T5 (^{0}C)	H1-H2 (mm of water)	Water flow to Calorimeter LPM	Water flow to Engine LPM
1	1524	0	184	33	46	36	135	65	12	2.1	1.95
2	1522	1.2	158	33	47	36	146	69	12.5	2.1	1.95
3	1520	2.5	130	33	47	36	156	72	12.1	2.1	1.95
4	1516	5	108	33	48	37	177	76	11.8	2.1	1.95
5	1510	7.5	89	33	50	38	198	81	11.5	2.1	1.95
6	1500	10.8	80	33	53	39	217	86	11	2.1	1.95
7	1490	13.2	78	33	55	39	243	92	10.9	2.11	1.95

Table 2(b): 20% biodiesel

S. No	RPM of crank shaft	BP (watts)	Fuel consumption (Kg/Kwh)	Bsfc (kg/Kwh)	Bth eff	Air consumption (Kg/Sec)
1	1524	0	0.332608696			0.001537502
2	1522	159.5465	0.387341772	2.427768	3.489	0.001569207
3	1520	331.9517	0.470769231	1.418186	5.9728	0.001543895
4	1516	662.1563	0.566666667	0.85579	9.898	0.001524636
5	1510	989.3035	0.687640449	0.695075	12.187	0.00150513
6	1500	1415.163	0.765	0.540574	15.67	0.001472046
7	1490	1718.1112	0.4615385	0.456673	18.548	0.00146534

Table 3(a): 40% Biodiesel

S. No	RPM of Crank shaft	Load (W-S)	Time for kg	T1 (^{0}C) 20ml fuel (sec)	T2 (^{0}C)	T3 (^{0}C)	T4 (^{0}C)	T5 (^{0}C)	H1-H2 (mm of water)	Water flow to Calorimeter LPM	Water flow to Engine LPM
1	1526	0	181	33	45	36	134	66	12.5	2.1	1.95
2	1520	1.1	154	33	46	36	144	70	12.4	2.1	1.95
3	1514	2.7	131	33	47	36	1576	73	12.6	2.1	1.95
4	1512	5.1	104	33	49	37	177	78	11.8	2.1	1.95
5	1500	7.4	89	33	50	38	197	83	11.7	2.1	1.95
6	1490	10.6	78	33	53	38	216	88	11.4	2.1	1.95
7	1480	13.4	69	33	55	39	243	95	10.6	2.1	1.95

Table 3(b): 40% biodiesel

S. No	RPM of crank shaft	BP (watts)	Fuel consumption (Kg/Kwh)	Bsfc (kg/Kwh)	Bth eff	Air consumption (Kg/Sec)
1	1526	0	0.338121547			0.001569207
2	1520	146.0588	0.397402597	1.920841	3.1132	0.001562917
3	1514	357.0927	0.467175573	1.308275	6.4746	0.001575471
4	1512	673.6174	0.588461538	0.873584	9.6964	0.001524636
5	1510	976.1128	0.687640449	0.704468	12.024	0.001518162
6	1490	1379.696	0.784615385	0.568687	14.895	0.001498572
7	1480	1732.439	0.886956522	0.51197	16.5445	0.001445034

Table 4(a): 60% Biodiesel

S. No	RPM of Crank shaft	Load (W-S)	Time for kg 20ml fuel (sec)	T1 (^{0}C)	T2 (^{0}C)	T3 (^{0}C)	T4 (^{0}C)	T5 (^{0}C)	H1-H2 (mm of water)	Water flow to Calorimeter LPM	Water flow to Engine LPM
1	1536	0	159	34	48	35	124	57	9.7	2	1.95
2	1528	1.4	143	33	49	35	145	65	9.5	2	1.95
3	1524	3.1	123	33	50	36	165	72	9.3	2	1.95
4	1520	5.8	99	33	52	37	195	81	9	2	1.95
5	1514	8.3	85	33	54	38	223	88	8.8	2	1.95
6	1500	11.2	76	33	56	39	260	102	8.6	2	1.95
7	1492	13.2	68	34	59				8.4	2	1.95

Table 4(b): 60% biodiesel

S. No	RPM of crank shaft	BP (watts)	Fuel consumption (Kg/Kwh)	Bsfc (kg/Kwh)	Bth eff	Air consumption (Kg/Sec)
1	1536	0	0.39490566			0.001575471
2	1528	186.87	0.427972028	1.690196	3.6986	0.001556602
3	1524	412.7	0.497560976	1.205614	7.026	0.001543895
4	1520	770.13	0.618181818	0.8027	10.553	0.001531083
5	1514	1097.7	0.72	0.655899	12.914	0.001485368
6	1500	1473.4	0.805263158	0.546517	15.499	0.001485368
7	1492	1720.4	0.9	0.523129	16.192	0.00146534

Table 5(a): 80% Biodiesel

S. No	RPM of Crank shaft	Load (W-S)	Time for kg 20ml fuel (sec)	T1 (^{0}C)	T2 (^{0}C)	T3 (^{0}C)	T4 (^{0}C)	T5 (^{0}C)	H1-H2 (mm of water)	Water flow to Calorimeter LPM	Water flow to Engine LPM
1	1536	0	169	33	50	35	124	57	9.7	2	1.95
2	1532	1.4	138	33	53	35	145	65	9.5	2	1.95
3	1526	3.3	119	33	56	36	165	72	9.3	2	1.95
4	1518	6	92	33	60	37	195	81	9	2	1.95
5	1510	8.6	78	33	62	38	223	88	8.8	2	1.95
6	1506	11.8	71	33	67	39	260	102	8.6	2	1.95
7	1500	14	68	33					8.4	2	1.95

Table 5(b): 80% biodiesel

S. No	RPM of crank shaft	BP (watts)	Fuel consumption (Kg/Kwh)	Bsfc (kg/Kwh)	Bth eff	Air consumption (Kg/Sec)
1	1536	0	0.362130178		0	0.001382328
2	1532	187.12	0.443478261	1.870072	3.574	0.001368003
3	1526	439.91	0.514285714	1.49081	7.2455	0.001353526
4	1518	795.64	0.665217391	0.836083	10.131	0.001331516
5	1510	1134.4	0.784615385	0.691656	12.247	0.001316638
6	1506	1552.4	0.861971831	0.555258	15.255	0.00130159
7	1500	1834.5	0.9	0.490605	17.266	0.00128636367

Table 6(a): 100% Biodiesel

S. No	RPM of Crank shaft	Load (W-S)	Time for kg	T1 (^{0}C) 20ml fuel (sec)	T2 (^{0}C)	T3 (^{0}C)	T4 (^{0}C)	T5 (^{0}C)	H1-H2 (mm of water)	Water flow to Calorimeter LPM	Water flow to Engine LPM
1	1520	0	157	52	45	54	140	76	9.8	1	2
2	1516	1.6136	136	57	46	73	135	86	9.6	1	2
3	1504	3.4103	103	62	52	88	178	95	9.4	1	2
4	1480	890	90	75	57	100	207	108	9.4	1	2

Table 6(b): 100% biodiesel

S. No	RPM of crank shaft	BP (watts)	Fuel consumption (Kg/Kwh)	Bsfc (kg/Kwh)	Bth eff	Air consumption (Kg/Sec)
1	1520	0	0.389808917			0.001389435
2	1516	211.89	0.45	2.123743	3.9885	0.001375184
3	1504	446.7	0.594174757	1.330136	6.3682	0.001360784
4	1480	1034.3	o.9	0.657455	12.884	0.001360784

CONCLUSION

Application of bio-diesel and its blend cannot be limited only as a fuel in CL engines. In future biodiesel can also be used as an alternative for coal, in thermal power plant; the need is to estimate the cost requirement and the set up requirement to use biodiesel in the thermal plant. Invention of new methodologies may be required so as to suit the interest and make the system compatible. This paper sets a new dimension for the research so that the utility of bio-diesel can be enhanced.

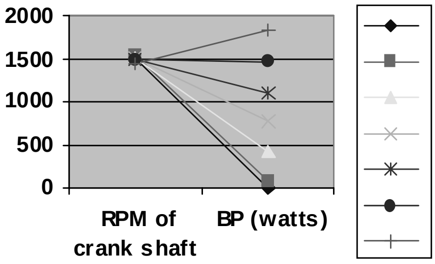
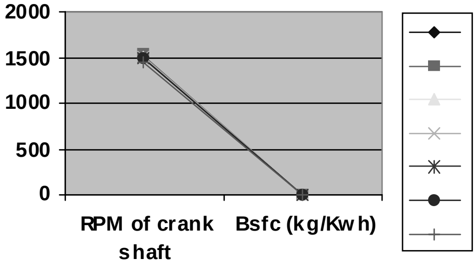


Fig. 1(a):



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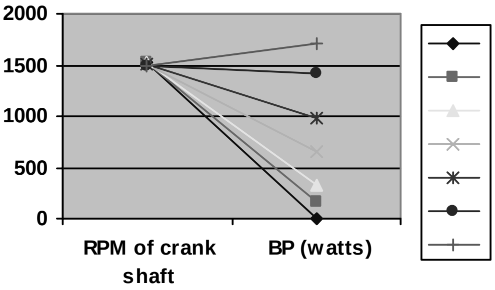

Fig. 2(a): 20%

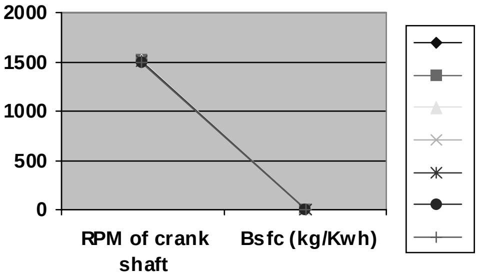

Fig. 1(b): 20%

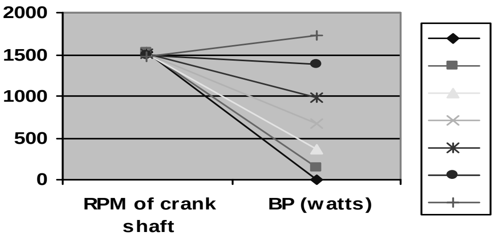

Fig. 3(a): 40%

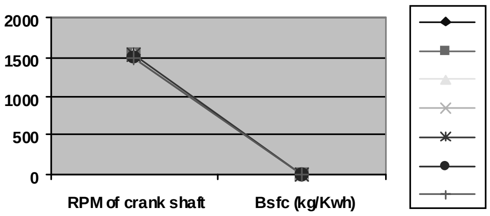

Fig. 3(b): 40%

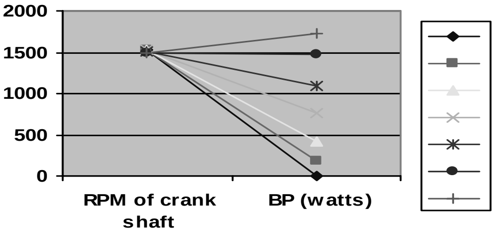

Fig. 4(a): 60%

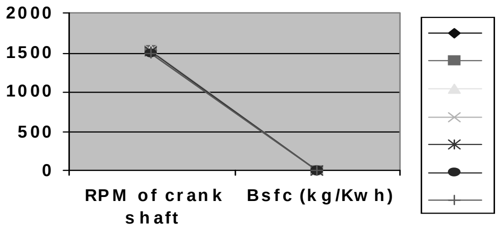

Fig. 4(b): 60%

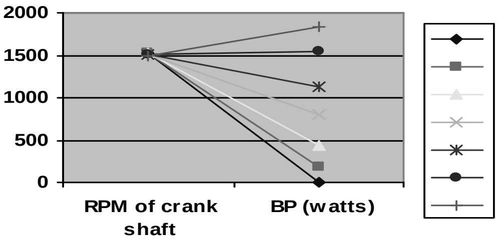

Fig. 5(a): 80%

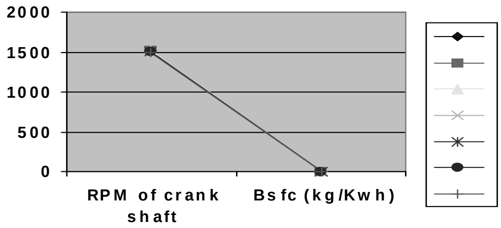

Fig. 5(b): 80%

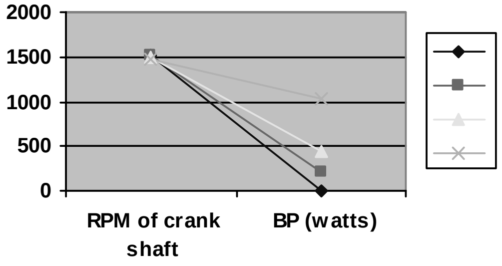

Fig. 6(a): 100%

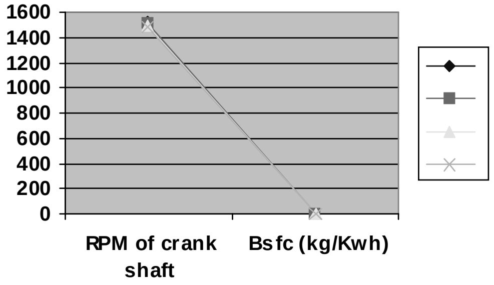

Fig. 6(b): 100%

ACKNOWLEDGEMENTS

The authors are thankful to Director and Head of Mechanical Dept. MITM for providing the working facilities and also thankful to Mr. Arun Bindal (Industrialist) for providing the biodisel for the research.

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