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"OPTIMIZATION OF ENGINE PARAMETERS FOR THE SUITABILITY OF BIODIESEL"

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Abstract - This dissertation presents the optimization of injection timing and injection pressure of CI engine. By modifying the two engine parameters (injection timing & injection pressure) the engine performance has been determined. The several charts have been plotted between engine Load and various engine performance parameters such as B.P, I.P, & S.F.C.
By advancing and retarding the injection timing of fuel and by increasing and decreasing the injection pressure various data have been obtained. By observing all data obtained by the engine modification, an optimize situation injection timing and injection pressure has been set.
In the second half, the project fuel modification has been done by blending the conventional fuel with the biodiesel. I have used Jatropha biodiesel for the blending with diesel. B100 blends are used to determine the engine performance on various loads. B100 blend has been tested on 2-stroke single cylinder CI engine. Before starting the each and every test engine runs on no load condition for half an hour to obtain the actual running condition of an engine. The graphs between B.P, I.P, & S.F.C. and engine loads have been drawn for B100 and diesel. By comparing all charts I have made some conclusion that which blends performed best. Some blends having low emission of SOX, NOx but having less B.P reading, on another hand some blends having high B.P reading but they having high emission of SOX, NOx. I have made several compressions between loads and performance parameters of the engine and then finally made a conclusion that B20 blends is good in all aspects whether it is emission or power of engine. Jatropha plant can grow in barren farm so we can do the plantation of Jatropha in that kind of areas, farmers can utilize their farm and earn money as well.

1. INTRODUCTION

The IEA (International Energy Agency) projects at least a 50% increase in demand by 2030. The growth in consumption was 3% in 2011, but yearly increase of only 1.6% would lead to a 51% growth in consumption by 2030. China and India are both rapidly increasing their consumption of oil. The supply is not sufficient to meet the demand and the continuous increase
in global prices of crude petroleum is affecting the economy of a lot of countries. Therefore it is urgent to adjust to the depleting oil supply and turn to alternative sources of energy.

2. Body of Paper

Experimental Setup

Generator Specification

EFFICIENCY	:	40%
SPEED	:	1500 rpm
NO. OF CYLINDER	:	1

TYPE OF IGNITION	:	COMPRESSION IGNITION
METHOD OF LOADING	:	ELECTRICAL LOADING
METHOD OF STARTING	:	CRANK START

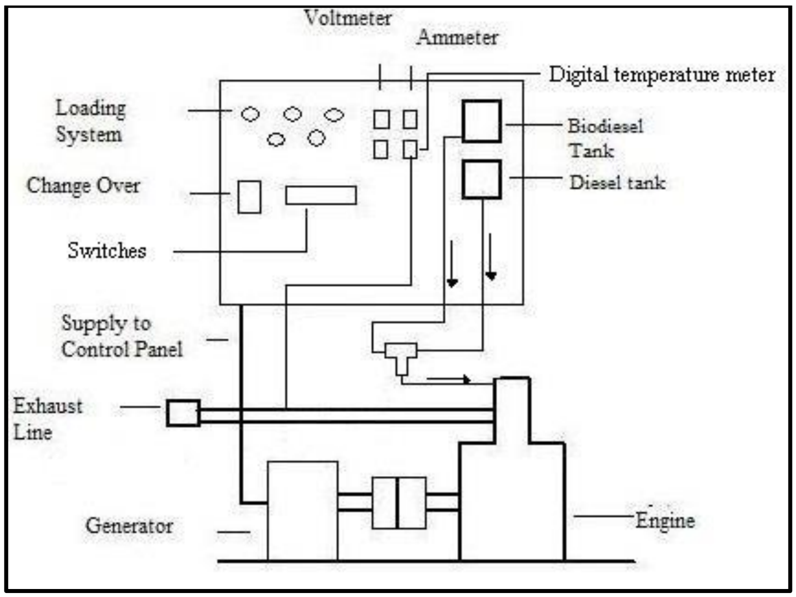

Fig.-Schematic diagram of experimental setup

Loading System

The test rig is coupled to D.C. compound generator and loaded by electric bulb. The fuel supplied from main fuel tank through a measuring jar. To measure the fuel consumption of the engine fill the jar by opening the cock marked tank into the manifold block, by starting a stop clock measure the time taken to consume 40ml of fuel.

B.P. = (V*I)/ (ηg*1000) kW V=
Voltage in volt

I= Current in amp.

ηg = Efficiency of generator

Fuel Measurement

The fuel supplied from the main fuel tank through a measuring burette with 3 way manifold system. To measure the fuel consumption of the engine fill the burette by opening the cork Marked "tank" in the manifold block, by starting a stop clock measure the time taken to consume 10 ml of fuel.

Mass of fuel (m_f) = (10*density of fuel*3600)/ (1000*time) Kg\hr Density of diesel 838 Kg\m^3

Density of biodiesel = 865 Kg\m3

Formulae Used

1. Brake power (B.P.) = (V*I) / (ηg *1000) kW
2. Mass of fuel consumed (m_f) = (10*ρ*3600) / (t_f*1000) kg/hr.
3. Specific fuel consumption (s.f.c.) = mf / B.P. kg/kW-hr
4. Brake thermal efficiency (ηbth) = (B.P*3600*100) / (m_f*c.v.) %
5. Gross calorific value (G.C.V.) = w*(t_2-t_1) / (wt. of fuel in gm.) cal/gm

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Results and Discussion

Observations

Time for 10 ml fuel consumption from jar = t_f

Voltage=V, Current=I

Exhaust Gas Temperature= E.G.T.

FOR NORMAL TIMING AND NORMAL PRESSURE (BIO-DIESEL)

Load(kW)	RPM	V(volt)	I (amp.)	t_f(sec)
0.5	771	218	1.7	51.64
1.0	764	221	2.0	40.087
1.5	742	223	3.6	26.86
2.0	722	227	5.0	22.21
2.5	705	236	6.2	17.006
3.0	687	250	7.8	14.65

Table-1

FOR HIGH PRESSURE AND NORMAL TIMINGS (BIO-DIESEL)

Load(kW)	RPM	V(volt)	I (amp.)	t_f(sec)
0.5	754	223	1.8	38.49
1.0	719	219	3.7	32.29
1.5	702	220	5.7	25.01
2.0	686	208	7.6	18.92
2.5	675	206	9.5	14.87
3.0	650	190	11.2	6.56

Table-2

FOR HIGH PRESSURE AND ADVANCE TIMINGS (BIO-DIESEL)

Load(kW)	RPM	V(volt)	I (amp.)	t_f(sec)
0.5	723	202	`1.8	31.46
1.0	718	214	3.6	30.81
1.5	710	222	5.7	26.09
2.0	690	214	7.5	21.18
2.5	685	210	9.7	19.57
3.0	670	198	11.8	16.78

Table-3

FOR NORMAL PRESSURE AND ADVANCE TIMINGS (BIO-DIESEL)

Load(kW)	RPM	V(volt)	I (amp.)	t_f(sec)
0.5	709	197	1.6	42.90
1.0	688	202	3.6	32.70
1.5	652	208	5.4	25.43
2.0	664	201	7.3	21.82
2.5	645	194	8.9	19.58
3.0	635	182	10.5	18.14

Table-4

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RESULT

FOR NORMAL PRESSURE AND NORMAL TIMINGS (BIO-DIESEL)

Load (kW)	B.P. (kW)	s.f.c. (kg/kW-hr)	B.T.E. (%)	E.G.T.(˚C)
0.5	.4632	1.3021	10.02	47
1.0	.5525	1.4060	9.92	58
1.5	1.003	1.1186	12.469	72
2.0	1.4187	.9565	14.58	85
2.5	1.8290	.9690	14.39	98
3.0	2.4375	.8715	12.023	107

Table-5

FOR HIGH PRESSURE AND NORMAL TIMINGS (BIO-DIESEL)

Load (kW)	B.P. (kW)	s.f.c. (kg/kW-hr)	B.T.E. (%)	E.G.T.(˚C)
0.5	.5	.86	16.21	68
1.0	1.017	.494	28.22	86
1.5	1.567	.4225	33.001	106
2.0	1.976	.443	31.47	130
2.5	2.416	.470	29.665	155
3.0	2.674	.9469	14.72	165

Table-6

FOR HIGH PRESSURE AND ADVANCE TIMINGS (BIO-DIESEL)

Load (kW)	B.P. (kW)	s.f.c. (kg/kW-hr)	B.T.E. (%)	E.G.T.(˚C)
0.5	.427	.983	14.18	58
1.0	.967	.544	25.58	76
1.5	1.58	.437	31.90	97
2.0	2.001	.390	35.75	121
2.5	2.546	.338	41.25	156
3.0	2.7	.297	28.75	166

Table-7

FOR NORMAL PRESSURE AND ADVANCE TIMINGS (BIO-DIESEL)

Load (kW)	B.P. (kW)	s.f.c. (kg/kW-hr)	B.T.E. (%)	E.G.T.(˚C)
0.5	.394	.979	9.54	57
1.0	.909	.556	16.79	78
1.5	1.404	.4637	20.14	90
2.0	1.834	.4138	22.57	103
2.5	2.158	.3919	23.83	110
3.0	2.388	.3822	24.43	150

Table-8

CALCULATION FOR BIODIESEL

FOR NORMAL INJECTION TIMING AND NORMAL PRESSURE

1. Brake power

$$B.P = (V*I) / (\eta g*1000)\ kW$$

B.P. at 0.5 kW load = (218*2.7) / (0.4*1000) kW

= 0.7357 kW

Similarly,

B.P. at 1 kW load = 0.8680 kW

B.P. at 1.5 kW load = 1.3688 kW

B.P. at 2.0 kW load = 1.8522 kW

B.P. at 2.5 kW load = 2.3275 kW

B.P. at 3.0 kW load = 2.5932 kW

2. Mass fuel consumption

$$m_f = (10*\rho*3600) / (tf*1000)\ kg/hr$$

m_f at 0.5 kW load = (10*0.838*3600) / (73.3459*1000) kg/hr

= 0.41131 kg/hr

Similarly,

m_f at 1.0 kW load = 0.45596 kg/hr

m_f at 1.5 kW load = 0.60227 kg/hr

m_f at 2.0 kW load = 0.72719 kg/hr

m_f at 2.5 kW load = 0.951947 kg/hr m_f

at 3.0 kW load = 1.22257 kg/hr

3. Specific fuel consumption

s.f.c. = (m_f) / (B.P.) Kg/kW-hr

s.f.c. at 0.5 kW load = (0.41131)/(0.735) Kg/kW-hr

= 0.5596 Kg/kW-hr

Similarly,

s.f.c. at 1.0 kW load = 0.5253 Kg/kW-hr

s.f.c. at 1.5 kW load = 0.4400 Kg/KW-hr

s.f.c. at 2.0 kW load = 0.3926 Kg/KW-hr

s.f.c. at 2.5 kW load = 0.4090 Kg/KW-hr

s.f.c. at 3.0 kW load = 0.4714 Kg/KW-hr

4. Brake Thermal Efficiency

ηbth = (B.P*3600*100) / (m_f*c.v.) %

ηbth at 0.5 kW load = (0.7357*3600*100) /(0.4113*38545)

= 16.70 %

Similarly,

ηbth at 1.0 kW load = 17.78 % ηbth

at 1.5 kW load = 21.22 % ηbth at 2.0

kW load = 23.79 % ηbth at 2.5 kW load

= 22.83 % ηbth at 3.0 kW load = 19.8 %

5. Viscosity

υ = (A*T) – (B/T) stokes

= (0.0026*32.8) – (1.78/32.8) stokes

= 0.031 stokes

= 3.10 centistokes

6. Gross Calorific Value

G.C.V = w*(T_2-T_1) / (wt. of fuel in gm.) Cal. /gm.

= 2363.25*(25.59-21.70) / 1 Cal. /gm.

= 9208.5145 Cal. /gm.

= 38545 kJ/kg

FOR NORMAL INJECTION TIMING AND HIGH PRESSURE

1. Brake power

B.P = (V*I) / (ηg*1000) kW

B.P. at 0.5 kW load = (218*2.7) / (0.4*1000) kW

= 0.7357 kW

Similarly,

B.P. at 1 kW load = 0.8680 kW

B.P. at 1.5 kW load = 1.3688 kW

B.P. at 2.0 kW load = 1.8522 kW

B.P. at 2.5 kW load = 2.3275 kW

B.P. at 3.0 kW load = 2.5932 kW

2. Mass fuel consumption

m_f = (10*ρ*3600) / (tf*1000) kg/hr

m_f at 0.5 kW load = (10*0.838*3600) / (73.3459*1000) kg/hr

= 0.41131 kg/hr

Similarly,

m_f at 1.0 kW load = 0.56596 kg/hr m_f

at 1.5 kW load = 0.60527 kg/hr

m_f at 2.0 kW load = 0.72319 kg/hr m_f at

2.5 kW load = 0.988947 kg/hr

m_f at 3.0 kW load = 1.52257 kg/hr

3. Specific fuel consumption

s.f.c. = (m_f) / (B.P.) Kg/kW-hr

s.f.c. at 0.5 kW load = (0.41131)/(0.735) Kg/kW-hr

= 0.8596 Kg/kW-hr

Similarly,

s.f.c. at 1.0 kW load = 0.5263 Kg/kW-hr

s.f.c. at 1.5 kW load = 0.4300 Kg/KW-hr

s.f.c. at 2.0 kW load = 0.3226 Kg/KW-hr

s.f.c. at 2.5 kW load = 0.4030 Kg/KW-hr

s.f.c. at 3.0 kW load = 0.4744 Kg/KW-hr

4. Brake Thermal Efficiency

ηbth = (B.P*3600*100) / (m_f*c.v.) %

ηbth at 0.5 kW load = (0.7357*3600*100) /(0.4113*38545)

= 17.70 %

Similarly,

ηbth at 1.0 kW load = 18.78 %

ηbth at 1.5 kW load = 23.22 %

ηbth at 2.0 kW load = 22.79 %

ηbth at 2.5 kW load = 22.83 %

ηbth at 3.0 kW load = 18.80 %

5. Viscosity

$$\upsilon = (A*T) - (B/T) \text{ stokes}$$
$$= (0.0026*32.8) - (1.78/32.8) \text{ stokes}$$
$$= 0.031 \text{ stokes}$$
$$= 2.10 \text{ centistokes}$$

6. Gross Calorific Value

$$G.C.V = w*(T_2-T_1) / (\text{wt. of fuel in gm.}) \text{ Cal. /gm.}$$
$$= 2363.25*(25.59-21.70) / 1 \text{ Cal. /gm.}$$
$$= 9208.5145 \text{ Cal. /gm.}$$
$$= 39545 \text{kJ/kg}$$

FOR ADVANCE INJECTION TIMING AND HIGH PRESSURE

1. Brake power

$$B.P = (V*I) / (\eta g*1000) \text{ kW}$$

$$\text{B.P. at 0.5 kW load} = (218*2.7) / (0.4*1000) \text{ kW}$$

$$= 0.7857 \text{ kW}$$

Similarly,

B.P. at 1 kW load = 0.8880 kW

B.P. at 1.5 kW load = 1.3658 kW

B.P. at 2.0 kW load = 1.8522 kW

B.P. at 2.5 kW load = 2.3235 kW

B.P. at 3.0 kW load = 2.5952 kW

2. Mass fuel consumption

m_f = (10*ρ*3600) / (tf*1000) kg/hr

m_f at 0.5 kW load = (10*0.838*3600) / (73.3459*1000) kg/hr

= 0.41151 kg/hr

Similarly,

m_f at 1.0 kW load = 0.45596 kg/hr m_f

at 1.5 kW load = 0.60227 kg/hr

m_f at 2.0 kW load = 0.72719 kg/hr m_f at

2.5 kW load = 0.951947 kg/hr

m_f at 3.0 kW load = 1.22257 kg/hr

3. Specific fuel consumption

s.f.c. = (m_f) / (B.P.) Kg/kW-hr

s.f.c. at 0.5 kW load = (0.41131)/(0.735) Kg/kW-hr

= 0.5996 Kg/kW-hr

Similarly,

s.f.c. at 1.0 kW load = 0.5253 Kg/kW-hr

s.f.c. at 1.5 kW load = 0.4400 Kg/KW-hr

s.f.c. at 2.0 kW load = 0.3926 Kg/KW-hr

s.f.c. at 2.5 kW load = 0.4090 Kg/KW-hr

s.f.c. at 3.0 kW load = 0.4814 Kg/KW-hr

4. Brake Thermal Efficiency

η_{bth} = (B.P*3600*100) / (m_f*c.v.) %

η_{bth} at 0.5 kW load = (0.7357*3600*100) /(0.4113*38545)

= 15.70 %

Similarly,

η_{bth} at 1.0 kW load = 18.78 % η_{bth}

at 1.5 kW load = 21.52 % η_{bth} at 2.0

kW load = 23.90 % η_{bth} at 2.5 kW load

= 22.13 % η_{bth} at 3.0 kW load = 19.8 %

5. Viscosity

υ = (A*T) – (B/T) stokes

= (0.0026*32.8) – (1.78/32.8) stokes

= 0.031 stokes

= 3.19 centistokes

6. Gross Calorific Value

G.C.V = w*(T_2-T_1) / (wt. of fuel in gm.) Cal. /gm.

= 2363.25*(25.59-21.70) / 1 Cal. /gm.

= 9808.5145 Cal. /gm.

= 3556 kJ/kg

FOR ADVANCE INJECTION TIMING AND NORMAL PRESSURE

1. Brake power

B.P = (V*I) / (ηg*1000) kW

B.P. at 0.5 kW load = (218*2.7) / (0.4*1000) kW

= 0.7357 kW

Similarly,

B.P. at 1 kW load = 0.8680 kW

B.P. at 1.5 kW load = 1.3688 kW

B.P. at 2.0 kW load = 1.8522 kW

B.P. at 2.5 kW load = 2.3275 kW

B.P. at 3.0 kW load = 2.5932 kW

2. Mass fuel consumption

m_f = (10*ρ*3600) / (tf*1000) kg/hr

m_f at 0.5 kW load = (10*0.838*3600) / (73.3459*1000) kg/hr

= 0.41131 kg/hr

Similarly,

m_f at 1.0 kW load = 0.45596 kg/hr

m_f at 1.5 kW load = 0.60227 kg/hr

m_f at 2.0 kW load = 0.72719 kg/hr

m_f at 2.5 kW load = 0.951947 kg/hr

m_f at 3.0 kW load = 1.22257 kg/hr

3. Specific fuel consumption

s.f.c. = (m_f) / (B.P.) Kg/kW-hr

s.f.c. at 0.5 kW load = (0.41131)/(0.735) Kg/kW-hr

= 0.5596 Kg/kW-hr

Similarly,

s.f.c. at 1.0 kW load = 0.5253 Kg/kW-hr

s.f.c. at 1.5 kW load = 0.4400 Kg/KW-hr

s.f.c. at 2.0 kW load = 0.3926 Kg/KW-hr

s.f.c. at 2.5 kW load = 0.4090 Kg/KW-hr

s.f.c. at 3.0 kW load = 0.4714 Kg/KW-hr

4. Brake Thermal Efficiency

ηbth = (B.P*3600*100) / (m_f*c.v.) %

ηbth at 0.5 kW load = (0.7357*3600*100) /(0.4113*38545)

= 26.70 %

Similarly,

ηbth at 1.0 kW load = 16.78 % ηbth

at 1.5 kW load = 22.22 % ηbth at 2.0

kW load = 24.79 % ηbth at 2.5 kW load

= 23.83 % ηbth at 3.0 kW load = 19.00

%

5. Viscosity

υ = (A*T) – (B/T) stokes

= (0.0026*32.8) – (1.78/32.8) stokes

= 0.031 stokes

= 2.10 centistokes

6. Gross Calorific Value

G.C.V = w*(T_2-T_1) / (wt. of fuel in gm.) Cal./gm.

= 2363.25*(25.59-21.70) / 1 Cal. /gm.

= 9208.5145 Cal. /gm.

= 39586kJ/kg

CALCULATION FOR BLENDED BIODIESEL FUEL (B100) FOR NORMAL TIMING AND NORMAL PRESSURE

1. Brake power

B.P = (V*I) / (ηg*1000) kW

B.P. at 0.5 kW load = (218*1.7) / (0.4*1000) kW

= 0.4632 kW

Similarly,

B.P. at 1.0 kW load = 0.5525 kW

B.P. at 1.5 kW load = 1.0030 kW

B.P. at 2.0 kW load = 1.4187 kW

B.P. at 2.5 kW load = 1.8290 kW

B.P. at 3.0 kW load = 2.4375 kW

2. Mass fuel consumption

m_f = (10*ρ*3600) / (tf*1000) kg/hr

m_f at 0.5 kW load = (10*0.865*3600) / (51.6465*1000) kg/hr

= 0 .6029 kg/hr

Similarly,

m_f at 1.0 kW load = 0 .7768 kg/hr

m_f at 1.5 kW load = 1.1219 kg/hr

m_f at 2.0 kW load = 1.3570 kg/hr

m_f at 2.5 kW load = 1.7723 kg/hr m_f

at 3.0 kW load = 2.1244 kg/hr

3. Specific fuel consumption

s.f.c. = (m_f) / (B.P.) Kg/kW-hr

s.f.c. at 0.5 kW load = (0 .6029)/(0.463) Kg/kW-hr

= 1.3021 Kg/kW-hr

Similarly,

s.f.c. at 1.0 kW load = 1.4060 Kg/kW-hr

s.f.c. at 1.5 kW load = 1.1186 Kg/KW-hr

s.f.c. at 2.0 kW load = 0.9565 Kg/KW-hr

s.f.c. at 2.5 kW load = 0.9690 Kg/KW-hr

s.f.c. at 3.0 kW load = 0.8715 Kg/KW-hr

4. Brake Thermal Efficiency

ηbth = (B.P*3600*100) / (m_f*c.v.) %

ηbth at 0.5 kW load = (0.4632 *3600*100) /(0 .6029*25818)

= 10.02 %

Similarly,

ηbth at 1.0 kW load = 9.92 %

ηbth at 1.5 kW load = 12.46 %

ηbth at 2.0 kW load = 14.58 %

ηbth at 2.5 kW load = 14.39 %

ηbth at 3.0 kW load = 16 %

5. Viscosity

υ = (A*T) – (B/T) stokes

= (0.0026*36.7) – (1.78/36.7) stokes

= 0.0469 stokes

= 4.70 centistokes

6. Gross Calorific Value

G.C.V = w*(T_2-T_1) / (wt. of fuel in gm.) Cal. /gm.

= 2363.25*(24.32-21.71) / 1 Cal. /gm.

= 6168.0825 Cal. /gm.

FOR NORMAL TIMING AND HIGH PRESSURE

1. Brake power

B.P = (V*I) / (ηg*1000) kW

B.P. at 0.5 kW load = (218*1.7) / (0.4*1000) kW

= 0.4644 kW

Similarly,

B.P. at 1.0 kW load = 0.5335 kW

B.P. at 1.5 kW load = 1.0030 kW

B.P. at 2.0 kW load = 1.4187 kW

B.P. at 2.5 kW load = 1.8290 kW

B.P. at 3.0 kW load = 2.4375 kW

2. Mass fuel consumption

m_f = (10*ρ*3600) / (tf*1000) kg/hr

m_f at 0.5 kW load = (10*0.865*3600) / (51.6465*1000) kg/hr

= 0 .6229 kg/hr

Similarly,

m_f at 1.0 kW load = 0 .7558 kg/hr m_f

at 1.5 kW load = 1.1219 kg/hr

m_f at 2.0 kW load = 1.3570 kg/hr m_f at

2.5 kW load = 1.7723 kg/hr m_f at 3.0 kW

load = 2.1244 kg/hr

3. Specific fuel consumption

s.f.c. = (m_f) / (B.P.) Kg/kW-hr

s.f.c. at 0.5 kW load = (0 .6029)/(0.463) Kg/kW-hr

= 1.3331 Kg/kW-hr

Similarly,

s.f.c. at 1.0 kW load = 1.4066 Kg/kW-hr

s.f.c. at 1.5 kW load = 1.1188 Kg/KW-hr

s.f.c. at 2.0 kW load = 0.9544 Kg/KW-hr

s.f.c. at 2.5 kW load = 0.9666 Kg/KW-hr

s.f.c. at 3.0 kW load = 0.8789 Kg/KW-hr

4. Brake Thermal Efficiency

ηbth = (B.P*3600*100) / (m_f*c.v.) %

ηbth at 0.5 kW load = (0.4632 *3600*100) /(0 .6029*25818)

= 10.66%

Similarly,

ηbth at 1.0 kW load = 10.92 %

ηbth at 1.5 kW load = 13.46 %

ηbth at 2.0 kW load = 15.58 %

ηbth at 2.5 kW load = 15.39 %

ηbth at 3.0 kW load = 17 %

CONCLUSIONS

Experimental trials are conducted to evaluate the performance of biodiesels compared to diesel on single cylinder, water cooled, and C.I. engine. The measurements of engine speeds, engine loads, exhaust gas temperatures and fuel consumptions are taken. The result from the test can be summarizing as follows.

- At normal injection timing and high pressure the B.P power of engine is almost same for both cases.
- At advance injection timing and normal pressure the B.P power of engine is almost same for both cases.
- At advance injection timing and high pressure the B.P power of the engine is almost same for both cases.
- At normal injection timing and high pressure the specific fuel consumption is almost same for both cases.
- At advance injection timing and normal pressure the specific fuel consumption is almost same for both cases.
- At advance injection timing and high pressure the specific fuel consumption is almost same for both cases.
- At advance injection timing and high pressure the E.G.T of engine is almost same for both cases
- At advance injection timing and high pressure the thermal efficiency of engine is smooth and same for both cases.

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