Experimental Investigation on Compression Ignition Engine runs on different blends of Neem oil

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ABSTRACT

Neem belonging to Meliaceae family is one of the most suitable and valuable tree species found in India. It can grow on any soils up to pH 10. Due to its multifarious uses, it has been cultivated by Indian farmers since vedic period. It is been experimentally investigated that the properties of Neem oil and found that ester of this oil can be used as environment friendly alternative fuel for diesel engine creating a greener environment in the future. In presented work experimentally investigated 10 H.P. C.I. Engine fluidic with B10 & B20 blends of Neem oil for different injecting pressure to make proper atomization of blended fuel. Due to poor viscosity and density than ordinary diesel fuel, it is desired to change some injecting parameters for proper combustion and enhance mechanical efficiency. Engine trial will be done with three different nozzle holes numbers and by vary injecting pressure. Accordingly this trial will be performed under two different blends of Neem bio diesel. Various results will be found by trail run to check engine performance.

Keyword: - *C.I.Engine1, Neem Bio Diesel2, Bio Diesel Blends3, and Injecting Parameters4*

1. NEEM

Neem oil is a vegetable oil pressed from the fruits and seeds of the neem (*Azadirachta indica*), an evergreen tree which is endemic to the Indian subcontinent and has been introduced to many other areas in the tropics. It is the most important of the commercially available products of neem for organic farming and medicines. [1] In India, it occurs throughout the country and can grow well in every agro-climatic zone except in high and cold regions and dam sites. In fact in India, Neem trees are often found growing scattered in the farmers' fields and on the boundaries of fields without affecting the crops. Farmers practice this system just to meet the local demand for timber, fodder, fuel wood and also for various medicinal properties. Due to its deep tap root system, it does not compete with annual crops for scarce soil moisture. As per data obtain from NABARD, closer spacing of 5mx5m accommodating 400 trees per ha while the wider spacing of 7mx7m accommodating about 200 trees per hectare. A mature tree produces 35-50 kg fruit/year. Oil yield varies from 40-43% of seed on dry weight basis.

1.1 Neem Bio-Diesel Sample

Table -1: Test Report of Neem Bio-Diesel

Test Parameter	Method	Result
Kinematic Viscosity	U-Tube	4.5 cSt
Density	Gravimetry	0.860 gm/cc
Calorific Value	Bomb-Calorimetry	8782 Kcal/Kg.
Ash Content	Gravimetry	0.01 % w/w
Carbon Content	Gravimetry	4.4 % w/w
Sulfur Content	**Nephelometry**	**0.01 % w/w**

Flash Point	**Open Cup**	**152° C**
Water Content	**KF**	**0.17 % w/w**

1.2 Blending of Neem Bio-Diesel

- Bio-diesel can be used either directly in to the CI engine or it can be blended with petro diesel in different proportions.
- B100 is 100% biodiesel.
- The B20 (20 % biodiesel and 80 % petrol/diesel fuel) & B10 blend is the most desired blend in use with current technology and regulations.
- Biodiesel of 20 % blend or below will work with any diesel engine without any modifications.
- **Factors affecting the performance of Diesel engine when using bio-diesel blend as fuel**
  Properties of fuel, Nozzle size and hole number, Injection pressure, compression ratio and injection timing, Droplet size, spray cone angle and spray tip penetration (spray characteristics) & Temperature

2. EXPERIMENT SET-UP

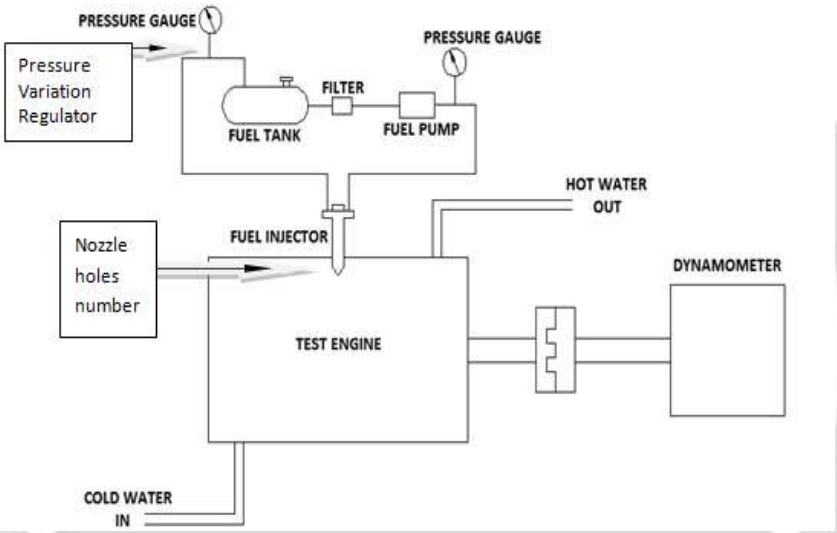

Fig -1: Line Diagram of Experiment Set-up

Fig -2: Engine Setup during Trial

2.1 Engine Specification

Table -2: Engine Specification

Make & Model	**PITER type Engine 54A**
General Details	Four stroke single cylinder diesel engine
Bore	102 mm
Stroke	110 mm
Capacity	898 cm^3
Compression Ratio	15:1
Type	Water cooled
Specific fuel consumption	251 g/kWh
Maximum H.P.	10HP

2.2 Experiment Process

1. The engine is started by rotating the crank by means of hand crank lever by throwing of the decompression lever at sufficient speed
2. The engines is allowed and adjusted to pick the speed and run at rated speed, smoothly for few seconds at rated speed check speed by using the tachometer.
3. Record the time taken for 10cc fuel consumption at no load and check the rpm by digital tachometer.
4. Then the engine pulley is loaded by rope wound on pulley attached with different loads and takes time 10cc of fuel consumption.
5. Repeat the experiment at different loads at different fuel injection pressures. Original pressure 220 bars and 240 bars.
6. Change the nozzle from the nozzle holder and take reading for different bio diesel blend with diesel fuel. Nozzle holes number three, four, and five.

2.3 Engine Trial

- **Fuel Type**: Diesel, B-10, B-20
- **Engine RPM**: 1500 (Fix)
- **Engine Load**: 25%, 50%, 75% & 100%
- **Pulley radius of rope brake dynamometer(r)** = 0.3048 m (Fix)
- **Rope radius wound on pulley(r')** = 0.0381 m (Fix)
- **Injection Pressure**: 220 bar (original), 240 bar
- **Injector Nozzle**: 3, 4 or 5 Hole
- **Time taken for 10cc fuel consumption (t)** = Readings in sec.

3. RESULT

3.1 Engine Performance

Engine performance is one of the most important things in the Internal Combustion Engine for best economy. We have conducted engine trial changing the injection pressure and injection nozzle for Neem oil B10 and B20 blend obtained various reading. From the reading, we calculated brake thermal efficiency, brake specific fuel consumption, brake specific energy consumption, indicated thermal efficiency and mechanical efficiency. This data on engine performance are shown in tables 3 to 6

Table -3: Engine Trial Result at B-10 blend and 220 bar Pressure

Sr No.	Fuel Sample Quantity (cc)	Time for 10 cc Fuel Consumption (t) (sec)	Speed (N) (RPM)	Brake Load (L) (kg)	Brake Power (BP) (kW)	Brake Thermal Efficiency (BTE) (%)	Brake Specific Fuel Consumption (BSFC) (kg/kW-hr)	Brake Specific Energy Consumption (BSEC) (MJ/kW-hr)	Indicated Thermal Efficiency(ITE) (%)	Mechanical Efficiency (%)
3 Hole Nozzle										
1	10	36	1500	11.2	1.69	16.85	0.49	21.36	53.74	**31.35**
2	10	31	1500	16.8	3.59	29.84	0.27	11.68	62.60	**49.25**
3	10	21	1500	23	5.81	35.40	0.24	10.65	55.31	**61.09**
4	10	18	1500	28	7.13	37.52	0.23	10.13	53.99	**65.83**
4 Hole Nozzle										
1	10	34	1500	11.2	1.69	15.91	0.52	22.62	77.13	**20.63**
2	10	28	1500	16.8	3.59	27.85	0.30	12.93	78.26	**35.59**
3	10	24	1500	23	5.81	38.62	0.21	9.32	81.82	**47.19**
4	10	20	1500	28	7.13	39.49	0.21	9.12	75.50	**52.31**
5 Hole Nozzle										
1	10	36	1500	11.2	1.69	16.85	0.49	21.36	62.72	**26.87**
2	10	29	1500	16.8	3.59	28.84	0.29	21.48	65.79	**43.84**
3	10	2	1500	23	5.81	35.39	0.23	10.17	63.43	**55.81**
4	10	19	1500	28	7.13	37.51	0.22	9.60	61.73	**60.78**

Table -4: Engine Trial Result at B-20 blend and 220 bar Pressure

Sr No.	Fuel Sample Quantity (cc)	Time for 10 cc Fuel Consumption (t) (sec)	Speed (N) (RPM)	Brake Load (L) (kg)	Brake Power (BP) (kW)	Brake Thermal Efficiency (BTE) (%)	Brake Specific Fuel Consumption (BSFC) (kg/kW-hr)	Brake Specific Energy Consumption (BSEC) (MJ/kW-hr)	Indicated Thermal Efficiency(ITE) (%)	Mechanical Efficiency (%)
3 Hole Nozzle										
1	10	36	1500	11.2	1.69	16.81	0.51	21.42	55.60	30.23
2	10	30	1500	16.8	3.59	3076	0.29	12.09	62.10	47.94
3	10	22	1500	23	5.81	33.71	0.25	10.09	59.02	59.83

4	10	19	1500	28	7.13	35.46	0.23	9.62	57.90	64.64
4 Hole Nozzle										
1	10	35	1500	11.2	1.69	16.34	0.53	22.03	59.86	27.30
2	10	29	1500	16.8	3.59	28.78	0.30	12.51	64.83	44.38
3	10	22	1500	23	5.81	35.31	0.25	10.19	62.67	56.35
4	10	19	1500	28	7.13	37.43	0.23	9.62	61.05	61.31
5 Hole Nozzle										
1	10	38	1500	11.2	1.69	17.74	0.49	20.29	55.54	31.95
2	10	30	1500	16.8	3.59	29.76	0.29	12.09	59.61	49.94
3	10	24	1500	23	5.81	38.52	0.22	9.34	62.40	61.74
4	10	20	1500	28	7.13	39.39	0.22	9.14	59.29	66.45

Table -5: Engine Trial Result at B-10 blend and 240 bar Pressure

Sr No.	**Fuel Sample Quantity (cc)**	**Time for 10 cc Fuel Consumption (t) (sec)**	**Speed (N) (RPM)**	**Brake Load (L) (kg)**	**Brake Power (BP) (kW)**	**Brake Thermal Efficiency (BTE) (%)**	**Brake Specific Fuel Consumption (BSFC) (kg/kW-hr)**	**Brake Specific Energy Consumption (BSEC) (MJ/kW-hr)**	**Indicated Thermal Efficiency(ITE) (%)**	**Mechanical Efficiency (%)**
3 Hole Nozzle										
1	10	40	1500	11.2	1.69	18.72	0.44	19.23	59.71	31.35
2	10	29	1500	16.8	3.59	28.85	0.29	12.48	58.56	49.25
3	10	24	1500	23	5.81	38.62	0.21	9.32	63.21	61.09
4	10	20	1500	28	7.13	39.49	0.21	9.12	59.99	65.83
4 Hole Nozzle										
1	10	40	1500	11.2	1.69	18.72	0.44	19.23	66.36	28.21
2	10	30	1500	16.8	3.59	29.84	0.28	12.06	65.57	45.51
3	10	25	1500	23	5.81	40.23	0.21	8.95	70.00	57.47
4	10	21	1500	28	7.13	41.47	0.20	8.68	66.48	62.38

5 Hole Nozzle										
1	10	33	1500	11.2	1.69	15.45	0.54	23.31	60.23	25.64
2	10	27	1500	16.8	3.59	26.86	0.31	13.40	63.50	42.29
3	10	21	1500	23	5.81	33.79	0.24	10.65	62.29	54.25
4	10	18	1500	28	7.13	35.54	0.23	10.13	59.97	59.27

Table -6: Engine Trial Result at B-20 blend and 240 bar Pressure

Sr No.	**Fuel Sample Quantity (cc)**	**Time for 10 cc Fuel Consumption (t) (sec)**	**Speed (N) (RPM)**	**Brake Load (L) (kg)**	**Brake Power (BP) (kW)**	**Brake Thermal Efficiency (BTE) (%)**	**Brake Specific Fuel Consumption (BSFC) (kg/kW-hr)**	**Brake Specific Energy Consumption (BSEC) (MJ/kW-hr)**	**Indicated Thermal Efficiency(ITE) (%)**	**Mechanical Efficiency (%)**
3 Hole Nozzle										
1	10	41	1500	11.2	1.69	19.15	0.45	18.80	66.72	28.69
2	10	31	1500	16.8	3.59	30.76	0.28	11.70	66.74	46.09
3	10	26	1500	23	5.81	41.73	0.21	8.63	71.91	58.04
4	10	22	1500	28	7.13	43.34	0.20	8.31	68.87	62.93
4 Hole Nozzle										
1	10	40	1500	11.2	1.69	18.68	0.46	19.27	55.15	33.87
2	10	29	1500	16.8	3.59	28.78	0.30	12.51	55.22	52.11
3	10	23	1500	23	5.81	36.92	0.23	9.75	57.89	63.77
4	10	19	1500	28	7.13	37.43	0.23	9.62	54.75	68.36
5 Hole Nozzle										
1	10	34	1500	11.2	1.69	15.88	0.55	22.68	49.70	31.95
2	10	27.5	1500	16.8	3.59	27.29	0.32	13.19	54.64	49.94
3	10	20	1500	23	5.81	32.10	0.27	11.21	52.00	61.74

4	10	17	1500	28	7.13	33.49	0.26	10.75	50.40	66.45

3.2 Result of Test Trial

Table -7: Result at 220 bar Pressure

Performance Parameters	3 holes	4 holes	5 holes	Blends
Break Specific Fuel Consumption	GOOD	EXCELLENT (0.21)	VERY GOOD	B10
	GOOD	VERY GOOD	EXCELLENT (0.22)	B20
Break Specific Energy Consumption	GOOD	EXCELLENT (9.12)	VERY GOOD	B10
	GOOD	VERY GOOD	EXCELLENT (9.14)	B20
Break Thermal Efficiency	VERY GOOD	EXCELLENT (39.49)	GOOD	B10
	GOOD	VERY GOOD	EXCELLENT (39.39)	B20
Indicated Thermal Efficiency	GOOD	EXCELLENT (81.82)	VERY GOOD	B10
	GOOD	EXCELLENT (64.83)	VERY GOOD	B20
Mechanical Efficiency	EXCELLENT (65.83)	GOOD	VERY GOOD	B10
	VERY GOOD	GOOD	EXCELLENT (66.45)	B20

Table -8: Result at 240 bar Pressure

Performance Parameters	3 holes	4 holes	5 holes	Blends
Break Specific Fuel Consumption	VERY GOOD	EXCELLENT (0.20)	GOOD	B10
	EXCELLENT (0.20)	VERY GOOD	GOOD	B20
Break Specific Energy Consumption	VERY GOOD	EXCELLENT (8.68)	GOOD	B10

	EXCELLENT (8.31)	VERY GOOD	GOOD	B20
Break Thermal Efficiency	VERY GOOD	EXCELLENT (41.47)	GOOD	B10
	EXCELLENT (43.34)	VERY GOOD	GOOD	B20
Indicated Thermal Efficiency	GOOD	EXCELLENT (70)	VERY GOOD	B10
	EXCELLENT (71.91)	VERY GOOD	GOOD	B20
Mechanical Efficiency	EXCELLENT (65.83)	VERY GOOD	GOOD	B10
	GOOD	EXCELLENT (68.36)	VERY GOOD	B20

4. CONCLUSIONS

1) Brake Specific Fuel Consumption (BSFC) is excellent at 240 bars injection pressure and 4 holes nozzle. The value is 0.20 kg/kWh.(B10)
2) Brake Specific Energy Consumption (BSEC) is excellent at 240 bars injection pressure and 3 holes nozzle. The value is 8.31 MJ/kWh.(B20)
3) Brake Thermal Efficiency (BTE) is excellent at 240 bars injection pressure and 3 holes nozzle. The value is 43.34%.(B20)
4) Indicated Thermal efficiency (ITE) is excellent at 220 bars original injection pressure and 4 holes nozzle. The value is 81.82%.(B20)
5) Mechanical Efficiency (ME) is excellent at 240 bars injection pressure and 4 holes nozzle. The value is 68.36%.(B20)

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