International Journal of Engineering Technology Science and Research
IJETSR
www.ijetsr.com
ISSN 2394 – 3386
Volume 5, Issue 1
January 2018

Experimental Studies on Performance of Diesel Engine with Neem Oil and Its Blends with Diesel as Alternative Fuel

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ABSTRACT

Now-a-days use of Alternative Fuels plays a prominent role throughout the world. Due to deficiency in levels of fossil fuels, to decrease the pollution affects causes by hydrocarbons and carbon monoxide which are exhausted from combustion of fuel; to reduce the cost of fuel and to increase the efficiency of performance alternative fuels are used.

In this regard experimentation is going on Neem oil and its blends with diesel. It reduces the imports of petroleum products and its expenditures of foreign currency.

Since it is not possible to use neem oil as a fuel for combustion due to its high viscosity and high firing point. So, In our project pure diesel and its blends in a percentage by volume 95%-5%, 90%-10%, 85%-15%, 80%-20%, 75%-25% with neem oil has been tested on a single cylinder high speed diesel engine and various performance characteristics are examined and compared with the performance of pure diesel.

Exhaust gases analysis was done by RTA of India approved computerized pollution checking centre. Smoke density of engine by using neem oil mixtures with diesel is compared to that of pure diesel.

INTRODUCTION

The use of vegetable oils for engine fuels may seems significant today, such oils became as important as petroleum, diesel and the other coal tar products in present days. An enormous increase in the number of automobiles in recent years has resulted in greater demand for petroleum products, with crude oils reserves estimated to last only for a few decades, therefore, effort are on way to reach now alternatives to diesel. Depletion of crude oil would cause a major impact on the transportation sector. The world is presently confronted with the twin crises of fossil fuels depletion and environmental degradation. Indiscriminate extraction and lavish consumption of fossil fuels have led to reduction in underground-based carbon resources.

The search for alternative fuels, which promise a harmonious correlation with sustainable development, energy conservation, efficiency and environmental preservation, has become highly pronounced in present context. The fuels of bio-origin can provide a feasible solution to this world wide petroleum crisis. Gasoline and diesel driven automobiles are the major sources of greenhouse gases emission (GHG). Scientists around the world have explored several alternative energy resources, which have the potential to quench the ever-increasing energy thirst of today’s population. Various bio fuel energy resources explored include biomass, biogas, primary alcohol, vegetable oils, biodiesel, etc.

ALTERNATIVE FUELS IN USE TODAY

- Compressed natural gas(CNG)
- Gasohol(gasoline + alcohol)
- E-Diesel(diesel + ethanol)
- Straight vegetable oils
- Hydrogen
- Biodiesel
- Alcohols(ethanol and methanol)
- Hythane (hydrogen + CNG)
- Liquefied natural gas(LNG)

DIESEL

Diesel fuel in general is any liquid used in operating diesel engines. Diesel fuel is a mixture of hydrocarbons with boiling points in the range of 150°c to 390°c, which are obtained from petroleum. So it is often regarded as petro diesel or petroleum diesel. In general, applications, diesel refers to the fossil fuel based products, obtained after the purifications of crude oil.

There are also alternative sources of diesel such as algae, vegetable oils, plants and animal fats. Based on the raw materials, such types of products are known as biodiesels or biomass to liquid diesel. Petroleum diesel is produced by refining crude oil. Let's discuss how diesel is fuel made for commercial release.

NEEM OIL:

Neem oil is a vegetable oil pressed from the fruits and seeds of the neem (Azadirachata indica), an ever green tree which is endemic to the Indian sub continent 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. Empirical formula for neem oil $C_{35}H_{44}O_{16}$

Method of Neem oil extraction:

Extraction with ram press and expeller are referred to as cold pressing extraction. Expellers are the most popular oil extraction engines. They are designed into small output devices that can cater for small scale extraction. Oil seed ram press is simply a piston inside a cage. With the seeds placed inside the cage, the piston can compress the seeds and force out the oil. Sometimes the operating force of the ram can be from a manual pump lift.

Table 1: Properties of Diesel & Neem oil

S.No	Physical Property	DIESEL Value	NEEM oil Value
01	Cetane number	45-55	31
02	Specific gravity	0.83	0.968
03	Viscosity (20°C)	4.7	37.42
04	Calorific value	45380	35125
05	Carbon per cent	86	78.92
06	Hydrogen per cent	14	13.41

Table 2: Combined properties of Neem oil and Diesel blends

S.No	Blends of oil	Specific gravity (c.c)	Calorific value (KJ/Kg)
01	Pure Neem Oil	0.9160	35125.00
02	Pure Diesel	0.8280	45380.00
03	05% Neem oil- 95% Diesel	0.8320	42596.35
04	10% Neem oil- 90% Diesel	0.8366	43361.20
05	15% Neem oil- 85% Diesel	0.8424	43846.86
06	20% Neem oil- 80% Diesel	0.8462	43329.00
07	25% Neem oil- 75% Diesel	0.8519	42816.25

Table 3: Flash points and Fire points of Neem oil and Diesel

S.No	Blends of oil	Flash point (°C)	Fire point (°C)
01	Pure Neem Oil	196	208
02	Pure Diesel	57	61
03	05% Neem oil- 95% Diesel	59	63
04	10% Neem oil- 90% Diesel	61.2	64.6
05	15% Neem oil- 85% Diesel	62.4	65.8
06	20% Neem oil- 80% Diesel	65	68
07	25% Neem oil- 75% Diesel	68.2	71

Calorific value of the diesel = 45354 KJ/Kg

EXPERIMENTATION

SPECIFICATIONS OF ENGINE:

Four stroke, single cylinder, vertical, water cooled, cold start, compression ignition, high speed diesel engine.

- ***Make*** – kirloskar
- ***Bore*** –80mm
- ***Stroke*** – 110mm
- ***R.P.M*** – 1500
- ***B.H.P*** – 5 (single cylinder)
- ***Compression ratio*** – 16.5:1
- ***Loading type*** – mechanical
- ***Brake drum diameter*** – 0.315m
- ***Fuel*** – high speed diesel oil

Load test is conducted to study the performance of single cylinder diesel engine at various loads under constant speed maintaining at 1500 rpm. At a constant speed power loss due to friction i.e., frictional power at a particular speed is obtained between brake power and the fuel consumption per hour at a particular speed. The tangent to the curve drawn between brake power and the fuel consumed per hour is called WILAN's line. An intercept made by this line on the negative side of the brake power axis will give frictional power of engine at that particular speed of the engine.

PROCEDURE:

- The fuel and lubricating oil are fitted at the required level.
- The three way cock is opened such that oil flows to the engine.
- Cooling water is supplied throughout the inlet pipe.
- The engine is started and was allowed to run at different loads and at each load time taken for 10cc of the fuel consumption and smoke analysis readings are taken.
- The experiment is repeated for pure diesel and blends of neem oil with diesel are carried out.

DESCRIPTION OF FIVE GAS ANALYZER:

INDUS model PEA205 is a 5 gas analyzer meant for monitoring CO, CO_2, HC, O_2 and NO in automotive exhaust. It meets OIML class specifications. CO, CO_2 and HC are measured by NDIR technology and O_2 and NO by electro chemical sensors. It is also supplied as 4-gas analyzer which can be upgraded easily to 5-gas version by the addition of an NO sensor. It has many control features to prevent faculty measurements. A built in dot matrix printer is provided to print out a hard copy of the results. It conforms to CMVR 115/116 and is certified by ARAI, PUNE

BLENDS

The neem oil blends with various proportions are taken are as follows.

- 5% neem oil + 95% diesel (**B5**)
- 10% neem oil + 90% diesel (**B10**)
- 15% neem oil + 85% diesel (**B15**)
- 20% neem oil + 80% diesel (**B20**)
- 25% neem oil + 75% diesel (**B25**)

Table 4: Load Test on High Speed Diesel Engine Using Pure Diesel

S. No	Load W_1 (Kg)	Spring Load W_2 (Kg)	Net Load (W_1-W_2) (Kg)	Time taken for 10 c.c fuel consumption (sec)	Speed (rpm)	EXHAUST GAS ANALYSIS			
						CO % Vol	HC PPM	CO_2 % Vol	NO_x % Vol
01	0	0	0	74.47	1530	0.05	37	1.0	4
02	2	0.4	1.6	67.66	1520	0.056	46	1.6	11
03	4	0.6	3.4	57.37	1510	0.065	58	2.2	12
04	6	0.8	5.2	51.80	1500	0.076	62	2.8	13
05	8	1.0	7.0	45.26	1490	0.082	77	3.1	14
06	10	1.2	8.8	40.75	1480	0.094	100	3.7	16

Table 5: Performance Parameters of Pure Diesel

S.NO	BP (KW)	FCH (Kg/Hr)	FP (KW)	IP (KW)	SFC (Kg/KW-Hr)	B_{mep} (Bar)	I_{mep} (Bar)	η_{bth} %	η_{ith} %	η_{mech} %
01	0	0.4003	1.5	1.5	-	0	2.1277	0	29.73	0
02	0.3935	0.4405	1.5	1.8935	1.1194	0.5618	2.7036	7.09	34.10	20.78
03	0.8307	0.5196	1.5	2.3307	0.6255	1.1939	3.3499	12.68	35.58	35.64
04	1.2620	0.5754	1.5	2.7620	0.4559	1.8259	3.9962	17.40	38.08	45.69
05	1.6876	0.6586	1.5	3.1876	0.3964	2.4581	4.6430	20.01	38.39	52.94
06	2.1073	0.7315	1.5	3.6073	0.3471	3.0902	5.2898	22.85	39.12	58.42

Table 6: Load Test on High Speed Diesel Engine Using 05% Neem-95% Diesel

S. No	Load W_1 (Kg)	Spring Load W_2 (Kg)	Net Load (W_1-W_2) (Kg)	Time taken for 10 c.c fuel consumption (sec)	Speed (rpm)	EXHAUST GAS ANALYSIS			
						CO % Vol	HC PPM	CO_2 % Vol	NO_x % Vol
01	0	0	0	78.10	1536	0.055	31	2.3	0
02	2	0.3	1.7	68.78	1520	0.065	37	2.8	1
03	4	0.5	3.5	58.56	1514	0.077	53	3.8	3
04	6	0.7	5.3	51.99	1508	0.073	76	4.4	7
05	8	1.0	7.0	46.35	1490	0.072	86	5.1	9
06	10	1.9	8.1	43.06	1476	0.064	99	5.9	10

Table 7: Performance Parameters of B5

S.NO	BP (KW)	FCH (Kg/Hr)	FP (KW)	IP (KW)	SFC (Kg/KW-Hr)	B_{mep} (Bar)	I_{mep} (Bar)	η_{bth} %	η_{ith} %	η_{mech} %
01	0	0.3835	1.6	1.6	-	0	2.2607	0	35.26	0
02	0.4181	0.4355	1.6	2.0181	1.0416	0.5970	2.8815	8.11	39.16	20.72
03	0.8574	0.5115	1.6	2.4574	0.5966	1.2291	3.5226	14.17	40.60	34.89
04	1.2932	0.5761	1.6	2.8932	0.4455	1.8611	4.1638	18.97	42.44	44.70
05	1.6876	0.6462	1.6	3.2876	0.3829	2.4581	4.7886	22.07	43.99	51.33
06	1.9344	0.6955	1.6	3.5344	0.3595	2.8443	5.1969	23.51	42.95	54.73

Table 8: Load Test on High Speed Diesel Engine Using 10% Neem-90% Diesel

S. No	Load W_1 (Kg)	Spring Load W_2 (Kg)	Net Load (W_1-W_2) (Kg)	Time taken for 10 c.c fuel consumption (sec)	Speed (rpm)	EXHAUST GAS ANALYSIS			
						CO % Vol	HC PPM	CO_2 % Vol	NO_x % Vol
01	0	0	0	91.69	1542	0.055	41	2.2	0
02	2	0.4	1.6	73.44	1530	0.069	47	3	2
03	4	0.6	3.4	60.59	1515	0.067	63	3.7	4
04	6	0.9	5.1	53.31	1502	0.063	71	4.6	6
05	8	1.3	6.7	47.28	1494	0.058	95	5.3	8
06	10	1.8	8.2	43.50	1470	0.060	101	6	9

Table 9: Performance Parameters of B 10

S.NO	BP (KW)	FCH (Kg/Hr)	FP (KW)	IP (KW)	SFC (Kg/KW-Hr)	B_{mep} (Bar)	I_{mep} (Bar)	η_{bth} %	η_{ith} %	η_{mech} %
01	0	0.3284	1.7	1.7	-	0	2.3927	0	42.98	0
02	0.3961	0.4101	1.7	2.0961	1.0353	0.5619	2.9733	8.02	42.43	18.90
03	0.8334	0.4971	1.7	2.5334	0.5965	1.1939	3.6292	13.92	42.31	32.90
04	1.2394	0.5649	1.7	2.9394	0.4558	1.7908	4.2472	18.21	43.20	42.16
05	1.6196	0.6370	1.7	3.3196	0.3933	2.3527	4.8223	21.11	43.26	48.79
06	1.9503	0.6923	1.7	3.6503	0.3550	2.8794	5.3893	23.39	43.77	53.42

Table 10: Load Test on High Speed Diesel Engine Using 15% Neem-85% Diesel

S. No	Load W_1 (Kg)	Spring Load W_2 (Kg)	Net Load (W_1-W_2) (Kg)	Time taken for 10 c.c fuel consumption (sec)	Speed (rpm)	EXHAUST GAS ANALYSIS			
						CO % Vol	HC PPM	CO_2 % Vol	NO_x % Vol
01	0	0	0	89.47	1545	0.066	39	2.3	1
02	2	0.4	1.6	69.35	1532	0.065	45	2.5	3
03	4	0.6	3.4	62.35	1510	0.066	54	3	5
04	6	0.9	5.1	53.13	1498	0.071	57	4.3	6
05	8	1.2	6.8	47.53	1490	0.068	73	5	7
06	10	1.7	8.3	44.72	1472	0.063	98	5.5	10

Table 11: Performance Parameters of B 15

S.NO	BP (KW)	FCH (Kg/Hr)	FP (KW)	IP (KW)	SFC (Kg/KW-Hr)	B_{mep} (Bar)	I_{mep} (Bar)	η_{bth} %	η_{ith} %	η_{mech} %
01	0	0.3389	1.55	1.55	-	0	2.1773	0	37.55	0
02	0.3966	0.4373	1.55	1.9466	1.1026	0.5618	2.7576	7.45	36.55	20.37
03	0.8307	0.4864	1.55	2.3807	0.5855	1.1939	3.4217	14.02	40.19	34.89
04	1.2361	0.5708	1.55	2.7861	0.4618	1.7908	4.0365	17.78	40.07	44.37
05	1.6393	0.6380	1.55	3.1893	0.3892	2.3878	4.6454	21.10	41.04	51.40
06	1.9768	0.6781	1.55	3.5268	0.3430	2.9146	5.1999	23.93	42.70	56.05

Table 12: Load Test on High Speed Diesel Engine Using 20% Neem-80% Diesel

S. No	Load W_1 (Kg)	Spring Load W_2 (Kg)	Net Load (W_1-W_2) (Kg)	Time taken for 10 c.c fuel consumption (sec)	Speed (rpm)	EXHAUST GAS ANALYSIS			
						CO % Vol	HC PPM	CO_2 % Vol	NO_x % Vol
01	0	0	0	88.59	1540	0.067	43	2.4	3
02	2	0.4	1.6	69.06	1522	0.068	52	2.8	5
03	4	0.7	3.3	58.97	1512	0.070	61	3.6	6
04	6	0.9	5.1	53.25	1502	0.072	70	4.5	8
05	8	1.1	6.9	46.78	1490	0.073	90	5.4	10
06	10	1.5	8.5	44.28	1476	0.075	106	6.3	12

Table 13: Performance Parameters of B 20

S.NO	BP (KW)	FCH (Kg/Hr)	FP (KW)	IP (KW)	SFC (Kg/KW-Hr)	B_{mep} (Bar)	I_{mep} (Bar)	η_{bth} %	η_{ith} %	η_{mech} %
01	0	0.3439	1.7	1.7	-	0	2.3958	0	41.07	0
02	0.3940	0.4411	1.7	2.0940	1.1195	0.5618	2.9859	7.42	39.44	18.81
03	0.8073	0.5166	1.7	2.5073	0.6399	1.1588	3.5989	12.98	40.32	32.20
04	1.2394	0.5721	1.7	2.9394	0.4616	1.7908	4.2472	18.00	42.69	42.16
05	1.6196	0.6512	1.7	3.3196	0.4021	2.3591	4.8352	20.66	42.35	48.79
06	1.9503	0.6880	1.7	3.6503	0.3528	2.8677	5.3674	23.55	44.08	53.42

Table 14: Load Test on High Speed Diesel Engine Using 25% Neem-75% Diesel

S. No	Load W_1 (Kg)	Spring Load W_2 (Kg)	Net Load (W_1-W_2) (Kg)	Time taken for 10 c.c fuel consumption (sec)	Speed (rpm)	EXHAUST GAS ANALYSIS			
						CO % Vol	HC PPM	CO_2 % Vol	NO_x % Vol
01	0	0	0	84.87	1552	0.067	46	2.5	4
02	2	0.4	1.6	69.97	1528	0.069	55	2.9	5
03	4	0.6	3.4	61.12	1510	0.071	66	3.5	8
04	6	0.9	5.1	53.18	1482	0.072	80	4.7	10
05	8	1.1	6.9	48.32	1470	0.074	97	5.6	14
06	10	1.5	8.5	42.81	1460	0.073	121	6.5	16

Table 15: Performance Parameters of B 25

S.NO	BP (KW)	FCH (Kg/Hr)	FP (KW)	IP (KW)	SFC (Kg/KW-Hr)	B_{mep} (Bar)	I_{mep} (Bar)	η_{bth} %	η_{ith} %	η_{mech} %
01	0	0.3613	1.75	1.75	-	0	2.4472	0	40.72	0
02	0.3956	0.4383	1.75	2.1456	1.1079	0.5619	3.0475	7.59	41.16	18.44
03	0.8307	0.5018	1.75	2.5807	0.6041	1.1939	3.7092	13.92	43.24	32.19
04	1.2229	0.5767	1.75	2.9729	0.4716	1.7908	4.3536	17.83	43.34	41.13
05	1.6411	0.6347	1.75	3.3911	0.3867	2.4229	5.0066	21.74	44.92	48.39
06	2.0079	0.7164	1.75	3.7579	0.3568	2.9847	5.5861	23.56	44.10	53.43

International Journal of Engineering Technology Science and Research
IJETSR
www.ijetsr.com
ISSN 2394 – 3386
Volume 5, Issue 1
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RESULTS AND DISCUSSIONS

EFFECT ON SPECIFIC FUEL CONSUMPTION

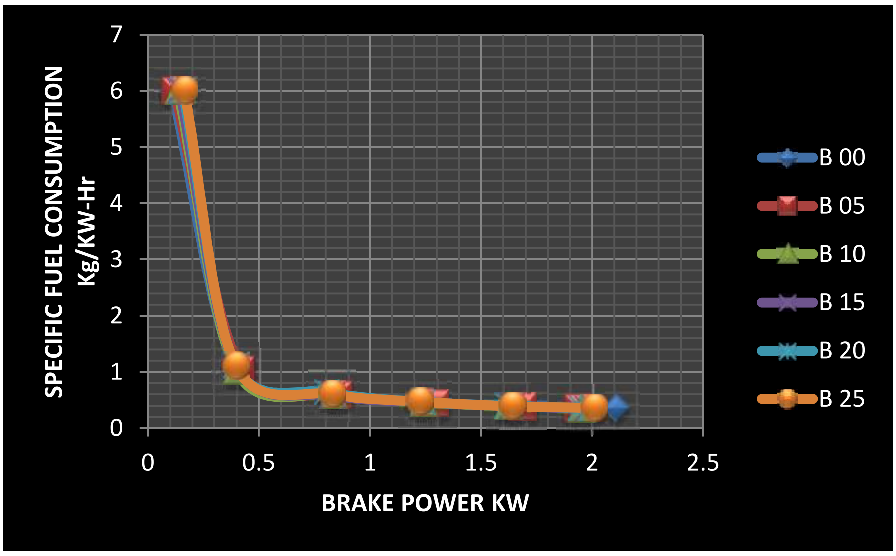

Figure1. Brake Power Vs Specific fuel consumption

- The comparative graphs for pure diesel & blends of neem oil and diesel between the brake power and specific fuel consumption follow same trend, i.e, specific fuel consumption decreases with increase in brake power.
- We can observe that S.F.C for blends of neem oil and diesel are slightly more than that of pure diesel, it is because of calorific value of neem oil is less than that of diesel.

EFFECT OF BRAKE THERMAL EFFICIENCY

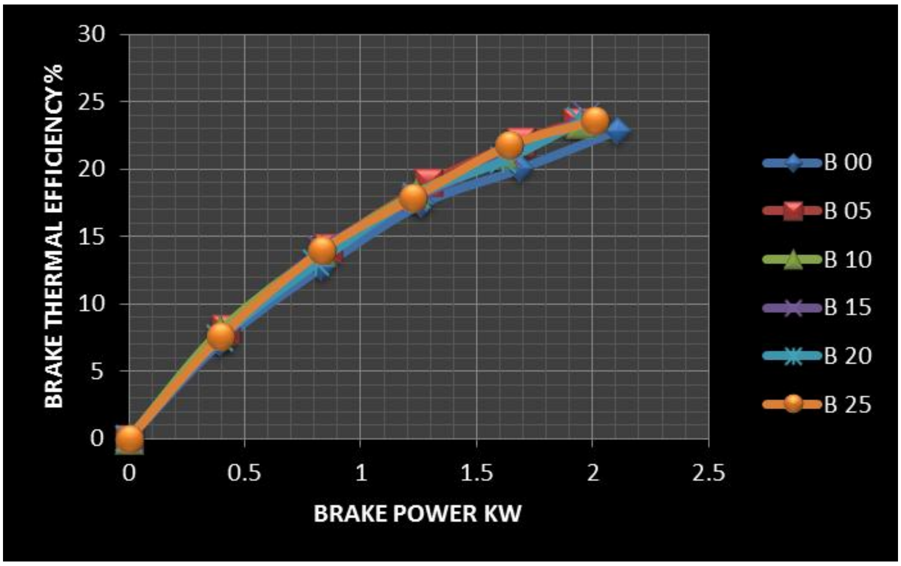

Figure 2. Brake power Vs Brake thermal efficiency

- Brake thermal efficiency increases with increase in brake power.
- At a fixed brake power we can observe that blends of neem oil and diesel have more brake thermal efficiency as that of pure diesel, it is because of calorific value of neem oil is less than that of pure diesel.

International Journal of Engineering Technology Science and Research
IJETSR
www.ijetsr.com
ISSN 2394 – 3386
Volume 5, Issue 1
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- B 05(5%neem – 95% diesel has more brake thermal efficiency so it is used as best alternate to diesel for diesel engines.

EFFECT OF INDICATED THERMAL EFFICIENCY

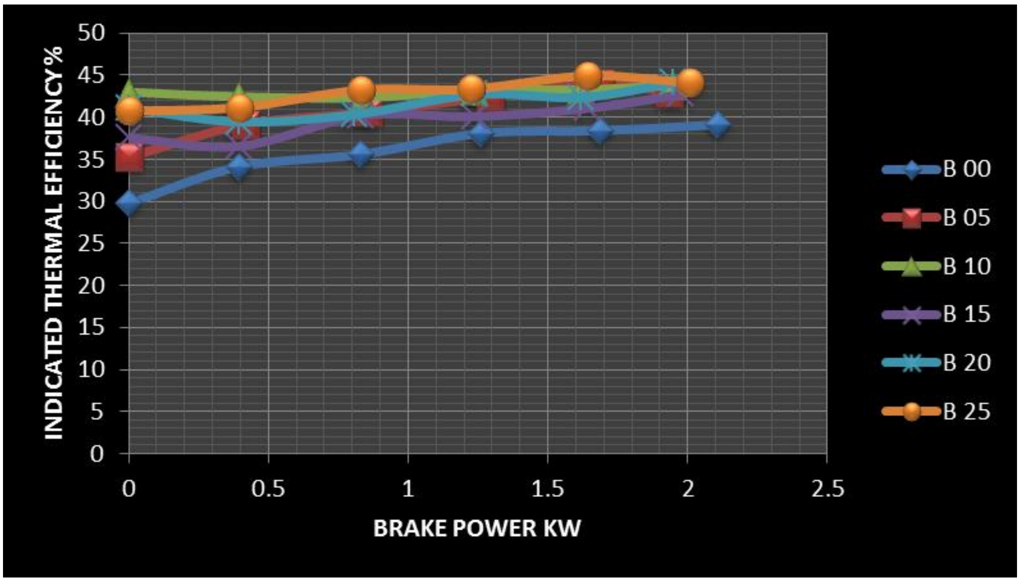

Figure 3. Brake power Vs Indicated thermal efficiency

- Indicated thermal efficiency slightly increases with increase in brake power.
- The value of indicated thermal efficiency is more than that of diesel at a fixed brake power it is because of increase in indicated power and decrease in calorific value.
- B 25 has more indicated thermal efficiency.

EFFECT OF MECHANICAL EFFICIENCY

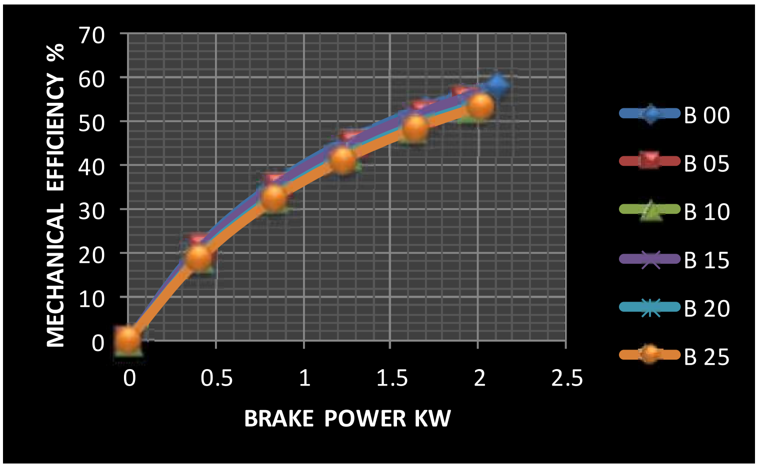

Figure 4. Brake power Vs Mechanical efficiency

- Mechanical efficiency increases with increase in brake power.
- B 15 is comparably equal to the efficiency that of pure diesel.

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ISSN 2394 – 3386
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EFFECT OF BRAKE MEAN EFFECTIVE PRESSURE

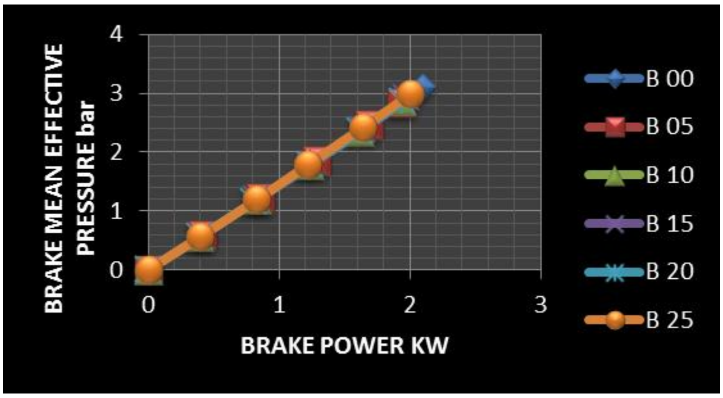

Figure 5. Brake power Vs Brake mean effective pressure

- Brake mean effective pressure increases with increase in B.P.
- It is observed that neem oil blends has no effect on brake mean effective pressure.

EFFECT OF INDICATED MEAN EFFECTIVE PRESSURE

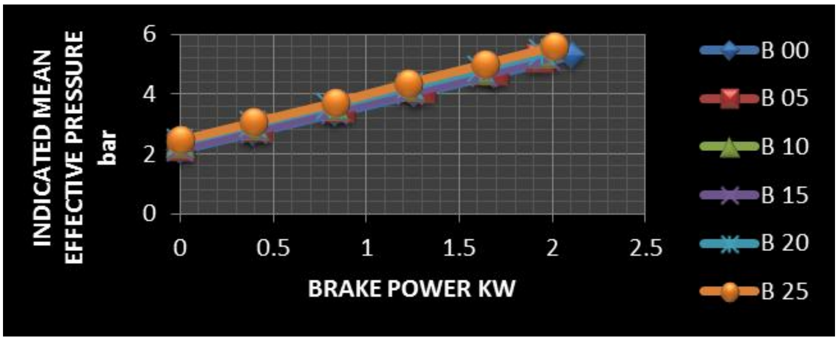

Figure 6. Brake power Vs Indicated thermal efficiency

- Indicated mean effective pressure increases with increase in B.P.
- B 25 has more indicated mean effective pressure at maximum B.P.

VARIATION OF HYDROCARBONS

Figure 7. Brake power Vs Hydrocarbons

- HC emissions with neem oil blends Neem 5 and Neem 15 have less value that of pure diesel.

VARIATION OF CARBON MONOXIDE

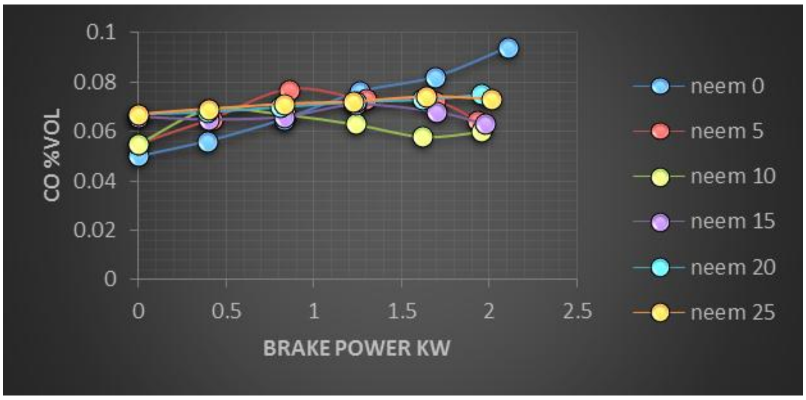

Figure 8. Brake power Vs Carbon monoxide

- CO emissions with neem oil blends have less value than that of pure diesel.
- Neem 10 and Neem 15 greatly reduces the CO emissions than diesel at certain load conditions.

VARIATION OF CARBON DIOXIDE

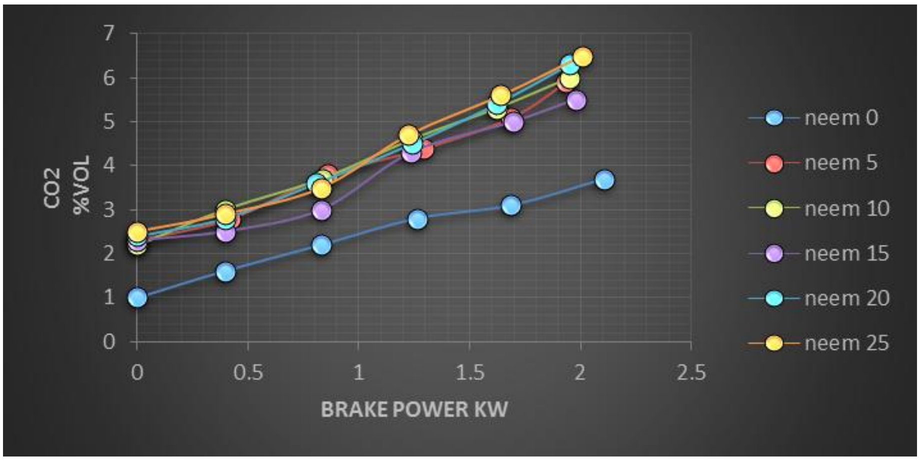

Figure 9. Brake power Vs Carbon dioxide

- CO_2 % with pure diesel has lesser value than that of neem oil blends due to repeated use of engine.
- Comparing to all other blends Neem 15 has lesser value of emissions.

VARIATION OF NITROGEN OXIDES

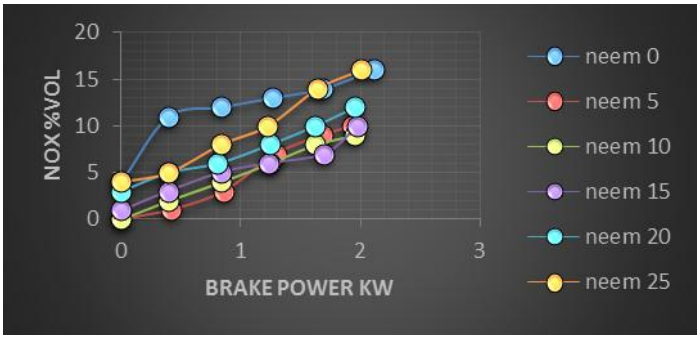

Figure 10. Brake power Vs Nitrogen oxides

- NO_2 emissions with neem oil blends have less value than that of pure diesel.
- Neem 10 and Neem 15 reduces NO_2 emissions than diesel.

CONCLUSIONS

A single cylinder high speed diesel engine was operated successfully with neem oil and its blends with diesel. The following conclusions are made based on experimental results.

- Engine works smoothly on neem oil with performance comparable to diesel operation.
- Neem oil results in increased brake thermal efficiency as compared that of diesel engine.
- B 15 has comparably equal to the mechanical efficiency to that of pure diesel.
- Neem oil blends has no effect on brake mean effective pressure.
- CO emissions of blends of neem oil are low as compared to pure diesel.
- NO_X emissions of pure diesel and blends of neem oil are almost same i.e, slightly varied with pure diesel NO_X emissions.
- Comparing to all other blends Neem 15 has lesser value of emissions of CO_2.
- Neem 10 and Neem 15 greatly reduces the CO emissions than diesel at certain load conditions.
- HC emissions with neem oil blends Neem 5 and Neem 15 have less value that of pure diesel.
- Neem 10 and Neem 15 reduces NO_2 emissions than diesel.

On whole it is concluded that the blends of neem oil especially (15% neem – 85%diesel) will be a best alternative fuel for automotive applications and agricultural applications and it will save much of our foreign currency exchange

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