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Performance and Emission Characteristics of Diesel Engine Working on Biodiesel with Different Blends

K. Naga Suresh, Ch. Mani Kumar*, K. Daniel*
Department of Mechanical Engineering, Sasi Institute of Technology and Engineering, Tadepalligudem, AP, India

ABSTRACT

Internal combustion engine plays important role in vehicles. These engines are operated by conventional fuels (diesel). Diesel is a one of the nonrenewable energy source for IC engines. Due to usage of diesel, pollutions of engine will be increased and diesel will be exhaust. To avoid the above said problems bio diesel will gives the solution. Biodiesel is one of the alternative fuels in universe. This paper determines the performance and emissions of an engine. In this regard took neem oil methyl esters(NOME) as blend. The test was conducted on four stroke single cylinder water cooled diesel engine at different parameters. The test was carried out at different fuel bends (N10, N15, N20, N25 and N30) and constant speed with varying loads. At the above parameters performance and emissions of the engine was found out. The best results were obtained at N20 blend and in addition to improve the combustion, DEE – diethyl ether added 1% volume ratio to the N20 blend. Again, the test was carried out on the same engine and same parameters with modified blend.

Keywords: diesel engine, neem oil methyl esters as blend

***Corresponding Authors**
E-mail: knsureshme@gmail.com, maniraj06010@gmail.com

INTRODUCTION

Anindita Karmakar et al. [1] assessed and integrated the biological, chemical and generic attributes of the plant and describes about the different tree borne oilseeds in India. Nonedible oils from the sources such as neem mahua, pongamia, karanji, babassu, and jatropha, are easily available in several parts of the world with India and are very cheap compared to edible oils. In india, there are several non-edible oils from different species such as pungam (*Pongamia pinnata*), tatrofa (*Jatrofa curcas*), neem (*Azadirachata indica*), mahua (*Madhuca indica*), and simarouba (*Simarouba indica*), which could be utilized for biodiesel production processes. According to a survey conducted in 2002, 12 spices have been selected for its importance of present industrial usage and abundance in distribution. Atul Dhar et al. [2] investigated performance of C.I. engine using nonedible oil and blend of oil with diesel formed from neem. A wide range of engine loads and volumetric blends of 5% (five) neem bio diesel and 95% (ninety-five) diesel, 10%(ten) neem biodiesel and 90%(ninety) diesel, 20% (twenty) neem biodiesel and 80% (eighty) diesel, 50%(fifty) neem biodiesel and 50% (fifty) diesel are used for performance measurement of vertical, 4 stroke, CI engine of Kirloskar oil engine model no. DM-10.R. Senthilkumar et al. [3] investigated the performance and combustion features of Kirloskar made, single cylinder, naturally aspired, water cooled, direct injection diesel engine running on diesel, volumetric blends of 10%(ten) neem biodiesel and 90%(ninety) diesel, 30%(thirty) neem biodiesel and

70%(seventy) diesel, 40%(forty) neem biodiesel and 60%(sisty) diesel, 50%(fifty) neem biodiesel and 50% diesel.

Nishant Tyagi et al. [4] evaluated the performance and emission characteristics of CI engine using diesel, 10%(ten) neem biodiesel and 90%(ninty) diesel, 20%(twenty) neem biodiesel and 80% diesel, 30%(thirty) neem biodiesel and 70%(seventy) diesel. Carraretto et al. [5] carried out investigation on six cylinders direct injection diesel engine using biodiesel blends. The growth of biodiesel percentage in the blend leads to a slight reduction in both power and torque over the engine speed range. B100 leads to 3% reduction in maximum power and 5% reduction in extreme torque. With B100, maximum torque was delivered at higher engine speed in this study on the contrary. Al-widyan et al. [6] reported slightly increased power and lower bsfc for waste oil biodiesel fuelled engine. Reheman et al. [7] evaluated the performance of biodiesel blends at different comparison ratio and injection timings of the engine. For the same operating situations, performance of the engine reduced with increase in biodiesel percentage in the blend. However, with increase in comparison ratio and advance in injection timing, this difference was decreased and the engine performance became comparable to diesel. This indicated towards the need to calibrate the engine fuel injection system for the new fuel in order to get the best performance. Canacki et al. [8] reported identical brake thermal efficiency for soybean oil biodiesel (B100); diesel and B20. B100 produced significantly lower CO, HC, and smoke compared to diesel. Combustion of earlier injection, shorter ignition delay and longer combustion duration led to higher NOx emissions from biodiesel fueled engine NOx emissions from biodiesel fuelled engines were decreased by retarding the injection timing and low temperature combustion strategies. Neem oil (*Azadirachta indica*) is non- edible oil obtainable in huge surplus quantities in south Asia. Annual production of neem oil India is estimated to be 30,000 tons. Traditionally; it has been utilized as fuel in lamps for lighting purpose in rural areas and is used on an industrial scale for manufacturing of soaps, cosmetics and other non-edible products. ‘Azardiratchi, is the main biochemical component of neem that is used for medical purposes.Regit et al. [9] has stated 83% ester yield of base catalyzed transesterification of neem oil with 6:1 alcohol ratio. Satya Selvabala et al. [10] studied biodiesel production by using phosphoric acid modified mordenite (PMOR) as catalyst. India has shortage of edible oil so its biodiesel program is centered around non-edible vegetables oils like jatropa. For feed stock diversification and utilization of scientifically investigated for efficient biodiesel production and engine utilization. Subramaniam et al. [11] performance emission and combustion characteristic of methyl esters of punnai, neem, waste cooking oil and their diesel blends in a Compression ignition engine was experimentally inspected. By transesterification process punnai oil methyl esters (POME), neem oil methyl ester (NEEM), waste cooking oil methyl ester (WCOME) were prepared for their study. The biodiesel and diesel blends prepared by mixing 10%, 30%, 50% and 70% of biodiesel with diesel. The effect of 3 methyl esters and their diesel blends on engine performance, combustion and exhaust emissions were examined at different engine loads. Experimental results conducted that up to 30% of methyl esters did not affect the performance, combustion, and emission characteristics. On other hand above B30 (30% bio diesel and 70% diesel) a reduction in performance, combustion, and emission characteristics were clear from the study.

Navindgi et al. [12] the diesel engine was altered in to LHR engine by means of partially stabilized zirconia (PSZ) coating. The basic concept of LHR engine is to defeat the heat rejection to the coolant so that the useful power output can be increased, which in turn result in improved thermal efficiency. However previous studies relieved that the thermal efficiency variation of LHR engine not only depends on heat recovery system, but also depends on the engine configuration, operating conditions and physical properties of the insulation material. The various combustion factors such as cylinder pressure, rate of heat release, cumulative heat releases were analyzed. Navindgi et al. [13] here the effect has been made to determine the performance and emission characteristics of CNG and neem blends in CI engine. The maximum achievable neem biodiesel replacement by natural gas was creating to vary with engine loads. The tests are carried out for five different flow rates starting from minimum to maximum flow rate position. The engine showed very similar performance compared to diesel operation near to 90% of rated load up to 54% replacement of diesel by CNG being possible. The maximum flow rate position is one at which the engine begins knocking. Exhaust gas analysis displayed that with higher diesel replacement the level of CO_2 generation decreased and CO emission found to increase. The late burning of the combination with higher diesel replacement levels of CNG had affected more fuel to remain partially unburned increasing formation of CO and decreasing the proportion of CO_2. T. Venkateswara Rao et al. [14] experimental investigation carry out to check the properties, performance and emission of different blends (B10, B20, and B40) of PME, JME and NME in comparison to diesel. Results specified that B20 have nearer performance to diesel and B100 had lower brake thermal efficiency mainly due to its high viscosity compared to diesel. Its diesel blends have efficient properties that showed reasonable efficiencies, lower smoke, CO and HC.K. Anubumani et al. [15] to study the fusibility of using two edible plant oils mustard (*Brassica nigra*, Family: Cruciferae) and neem (*Azadirachta indica*, Family: Meliaceae) as diesel substitute a relative study on their combustion features on a CI engine were made. Butyl eater of mustard oil at 20% blend with diesel gave best performance in terms of low smoke density, emission of HC and NOx, cetane number, total fuel consumption, specific energy consumption, specific fuel consumption, brake thermal efficiency, were almost equal when engine was run on pure diesel. Anindita Karmakara et al. [15] studied bio diesel production from neem towards feedstock diversification: Indian perspective. It was found that CO, NOx, HC and smoke emission were reduced to 18%, 3%, 18% and 12% for NOME when compared to diesel fuel. Prabhu et al. [16] studied combustion, performance and emission characteristics of diesel engine with neem oil methyl ester and its diesel blends. Smoke emission with respect to brake power for diesel and biodiesel blends. The smoke emission with respect to different loads was analyzed for NOME than that of the diesel fuel. 20% blend show low smoke number contributing to the factor that lesser amount of unburnt hydrocarbons is present in the engine exhaust emission. This may be due to the presence of oxygen molecule present in the neem oil the neem oil methyl ester helps for complete combustion (Figure 1–25, Tables 1–26).

ENGINE SPECIFICATIONS

BHP: 5HP
Speed: 1500 rpm
Bore: 80mm
Stroke: 110mm
Compression ratio: 16.5:1
Orifice diameter: 20mm
Method of start: crank start
Make: kirloskar

Type of ignition: compression Ignition
No. of cylinders: 01

Dynamometer Specifications
Type: Rope brake
Diameter of brake drum: 300mm
Diameter of rope: 12mm
Effective radius of brake drums: 157.5mm

Specifications of Autoexchaust Gas Analyzer
CO: 0 to 9.99% vol. Res. 0.01%
HC: 0 to 20000 ppm. (Propane) Res. 1 ppm
CO_2: 0 to 20.00% vol. Res. 0.10%
O_2: 0 to 25% Res. 0.01%
Lambda: 0.200 to 1.800% Res. 0.001%
Air / Fuel: 0 to 30:1 Res.1

Technical Specifications of Smoke Meter
- Model Name: NPM-SM-111B
- Type of Smoke Meter: Partial Flow
- Display Indication: Light Absorption Co-efficient (K) Percentage Opacity
- Display Range: 0 to 9.90/m^{-1}
- Scale Resolution: 0.01/m^{-1}
- Linearity: 0.1/m^{-1}
- Drift: Zero 0.00//m^{-1}, Span 0.1/m^{-1}
- Repeatability: 0.1/m^{-1}
- Light Source Details: 5 mm diameter green LED
- Response time: 0.3 seconds
- Warm up time: 3 minutes
- Operating Temp. Range: 5 to 50 deg. C
- Power requirement: 230 VAC +/– 10% 50 Hz, 250VA
- Weight: 23 kg. (Approx.)
- Dimensions: W-47.5 cm, D-47.5 cm, H-26 cm
- RPM: 100 RPM to 9999 RPM (for Ripple sensor)
- (Option): 200 RPM to 9999 RPM. (for piezo sensor)
- Oil Temperature: 0 to 150°C
- Remote display: Available
- Computer controlled operation: Available via RS232 interface.

PREPARATION OF BLENDS WITH DIESEL

Table 1. *Blending percentage of fuel.*

Notation	Fuel quantity (l)	Bio-diesel quantity	Diesel quantity
N10	1	100 ml	900 ml
N15	1	150 ml	850 ml
N20	1	200 ml	800 ml
N25	1	250 ml	750 ml
N30	1	300 ml	700 ml
D100	1	0 ml	1000 ml

Fig. 1. *NOME blends (N10, N15, N20, N25 & N30).*

Specific Gravity-Results

Table 2. *Results of specific gravity for NOME and diesel.*

S. no	Oil		Specific gravity
1.	Diesel	D100	0.835
2	Neem oil methyl ester blends with biodiesel (NOME)	N10	0.820
		N15	0.827
		N20	0.835
		N25	0.840
		N30	0.846

Viscosity Result

Table 3. *Results of viscosity for NOME and diesel at 40°C.*

S. no	Oil		Kinematic viscosity (stokes)	Dynamic viscosity (Poise)
1	Diesel	D100	0.364	0.652
2.	Neem oil methyl ester blends with biodiesel (NOME)	N10	0.423	0.321
		N15	0.444	0.355
		N20	0.457	0.389
		N25	0.490	0.400
		N30	0.523	0.412

Flash and Fire Points-Results

Table 4. *Results of flash point and fire of NOME and diesel.*

S. no	Oil		Flash point °C	Fire point °C
1.	Diesel	D100	58	62
2.	Neem oil methyl ester blends with biodiesel (NOME)	N10	45	50
		N15	46	52
		N20	48	53
		N25	50	56
		N30	54	59.5

Calorific Value-Results

Table 5. *Results of calorific value in kJ/kg for NOME and diesel.*

Oil	N10	N15	N20	N25	N30	N100
Neem oil	42200	42050	41900	41750	41600	39501
Diesel	42500	42500	42500	42500	42500	42500

RESULTS AND DISCUSSIONS

The experiments are conducted on the four strokes single cylinder water cooled compression ignition diesel engine at constant speed (1500 rpm) with varying 0 to 100% loads with diesel and different blends of neem like N10, N15, N20, N25, N30, and N20D79DEE1%. The performance parameters such as brake thermal efficiency and brake specific fuel consumption were calculated from the observed parameters and shown in the graph chart. The new emissions parameters such as exhaust gas emissions such as Carbon monoxide, hydrocarbons, and oxides of nitrogen, carbon dioxide, unused oxygen and smoke were denoted in the form of graph chart from the measured values. The difference in performance parameters and emissions are discussed with respect to the brake power for diesel fuel, diesel-biodiesel blends and obtained optimum blend with adding ignition improver are discussed in below.

Performance Analyses Using Pure Diesel and Its Blends of (NOME)

Table 6. *Experimental observations for diesel (D100).*

S. no	Load				Speed (N) (rpm)	Time taken for 20cc fuel consumption (sec)	Manometer reading		
	%	W (kg)	S (kg)	W-S (kg)			h_1 (cm)	h_2 (cm)	h_w (m)
1	0	0	0	0	1500	145	4	2	0.06
2	25	4	0	4	1500	120	3.8	1.8	0.056
3	50	8	0	8	1500	92	3.6	1.6	0.052
4	75	12	0	12	1500	74	3.3	1.5	0.048
5	100	16	0	16	1500	60	3.3	1.3	0.046

Table 7. *Experimental results using diesel D100.*

S. no	Load %	Va m^3/sec	BP (kW)	FP (kW)	IP (kW)	η_{mec} (%)	ηbte (%)	ηite (%)	ηvol (%)	A/F	ISFC (kg/kW-h)	BSFC (kg/kW-h)
1	0	0.0062	0	2.25	2.25	0	0	46.27	89.74	62.8	0.18	∞
2	25	0.0059	0.96	2.25	3.25	30.41	16.33	54.44	86.52	50.18	0.155	0.52
3	50	0.0057	1.92	2.25	4.17	46.02	25.04	54.88	83.48	37.12	0.156	0.34
4	75	0.0055	2.88	2.25	5.05	55.44	29.37	52.97	80.22	28.68	0.159	0.28
5	100	0.0054	3.84	2.25	6.10	63.11	32.82	52.00	78.42	22.71	0.163	0.26

Table 8. *Experimental observations of exhaust emissions D100.*

S. no	Load (%)	Weight (kgf)	Net load (kgf)	Speed (rpm)	HC (ppm)	CO (%)	CO_2 (%)	NO_x	O_2 (%)	Absorption co-efficient (K)	Smoke density (H.S.U.)
1	0	0	0	1500	54	0.09	2.20	53	21.91	0.92	32.67
2	25	4	4	1500	56	0.09	3.20	129	21.58	1.06	36.60
3	50	8	8	1500	52	0.07	4.50	342	21.37	1.45	46.39
4	75	12	12	1500	55	0.05	6.20	745	20.91	2.25	61.99
5	100	16	16	1500	58	0.07	8.50	1236	18.62	3.7	79.6

Experimental Observations for Blend N10

Table 9. *Experimental observations using blend N10.*

S. no	Load				Speed (N) (rpm)	Time taken for 20 CC fuel consumption (sec)	Manometer reading		
	%	W (kg)	S (kg)	W-S (kg)			h_1 (cm)	h_2 (cm)	h_w (m)
1	0	0	0	0	1500	168	3.3	1.3	0.046
2	25	4	0	4	1500	124	3.3	1.3	0.046
3	50	8	0	8	1500	96	3.2	1.4	0.046
4	75	12	0	12	1500	76	3.2	1.3	0.045
5	100	16	0	16	1500	60	3.1	1.2	0.043

Table 10. *Experimental results using blend N10.*

S. no	Load %	Va m^3/sec	vs m^3/sec	BP (kW)	FP (kW)	IP (kW)	η_{mec} (%)	ηbte (%)	ηite (%)	mf (kg/sec)	ηvol (%)	A/F	ISFC Kg/kW-hr	BSFC Kg/kW-hr
1	0	0.00543	0.00617	0	1.5	1.50	0	0	39.49	0.00097	88.00	63.54	0.232	∞
2	25	0.00543	0.00617	0.96	1.5	2.46	39.02	17.49	44.84	0.000135	88.00	47.41	0.190	0.487
3	50	0.00543	0.00617	1.92	1.5	3.42	56.14	26.76	47.67	0.000171	88.00	36.25	0.178	0.318
4	75	0.00537	0.00617	2.88	1.5	4.38	65.75	32.49	49.42	0.000214	87.03	29.05	0.172	0.265
5	100	0.00525	0.00617	3.84	1.5	5.34	71.91	33.70	46.86	0.000271	85.08	22.07	0.182	0.253

Table 11. *Experimental observations of exhaust emissions using N10.*

S. no	Load (%)	Weight (kgf)	Net load (kgf)	Speed (rpm)	HC (ppm)	CO (%)	CO_2 (%)	NO_X	O_2 (%)	Absorption co-efficient (K)	Smoke density (H.S.U.)
1	0	0	0	1500	29	0.16	3.5	19	32.64	1.28	11.34
2	25	4	4	1500	26	0.16	5.1	80	30.9	0.44	17.23
3	50	8	8	1500	20	0.15	7.1	225	28.73	0.68	25.35
4	75	12	12	1500	19	0.11	9.1	542	26.00	1.15	39.01
5	100	16	16	1500	18	0.10	11.1	956	23.49	1.93	56.39

Experimental Observations for Blend N15

Table 12. *Experimental observations for using N15.*

S. no	Load				Speed (N) (rpm)	Time taken for 20 cc fuel consumption (sec)	Manometer reading		
	%	W (kg)	S (kg)	W-S (kg)			h (cm)	h_2 (cm)	h_w (m)
1	0	0	0	0	1500	164	3.15	1.35	0.046
2	25	4	0	4	1500	126	3.15	1.35	0.046
3	50	8	0	8	1500	95	3.2	1.30	0.043
4	75	12	0	12	1500	73	3.15	1.3	0.0445
5	100	16	0	16	1500	61	3.1	1.25	0.037

Table 13. *Experimental results using blend N15.*

S. no	Load (%)	Va (m^3/sec)	Vs (m^3/sec)	BP (kW)	FP (kW)	IP (kW)	η_{mec} (%)	ηbte (%)	ηite (%)	mf (kg/sec)	ηvol (%)	A/F	ISFC (kg/kW-h)	BSFC (kg/kW-h)
1	0	0.00543	0.00617	0	1.55	1.55	0	0	38.83	0.000535	88	62.53	0.228	∞
2	25	0.00543	0.00617	0.96	1.55	2.51	38.5	17.55	45.91	0.000135	88	47.41	0.186	0.487
3	50	0.00542	0.00617	1.92	1.55	3.47	55.34	26.85	48.54	0.000144	87.51	36.05	0.175	0.318
4	75	0.00534	0.00617	2.88	1.55	4.43	65.16	31.18	47.95	0.000225	86.54	27.62	0.178	0.276
5	100	0.00528	0.00617	3.84	1.55	5.39	71.24	34.47	48.39	0.000267	85.57	22.62	0.177	0.253

Table 14. *Experimental observations of exhaust emissions using N15.*

S. no	Load (%)	Weight (kgf)	Net load (kgf)	Speed (rpm)	HC (ppm)	CO (%)	CO_2 (%)	NO_X	O_2 (%)	Absorption co-efficient (K)	Smoke density (H.S.U.)
1	0	0	0	1500	41	0.125	2.7	33	25.57	0.79	11.72
2	25	4	4	1500	39	0.125	4	95	24.2	0.41	16.15
3	50	8	8	1500	30	0.079	5.75	253	22.4	0.67	25.19
4	75	12	12	1500	33	0.058	7.65	584	20.4	1.17	39.65
5	100	16	16	1500	31.5	0.0525	9.65	1012	18.2	2.01	58.1

Experimental Observations for Blend N20

Table 15. *Experimental observations for using N20.*

S. no	Load				Speed (N) (rpm)	Time taken for 20 cc fuel consumption (sec)	Manometer reading		
	%	W (kg)	S (kg)	W-S (kg)			h_1 (cm)	h_2 (cm)	h_w (m)
1	0	0	0	0	1500	160	3.2	1.4	0.046
2	25	4	0	4	1500	128	3.2	1.4	0.046
3	50	8	0	8	1500	94	3.2	1.3	0.045
4	75	12	0	12	1500	70	3.1	1.3	0.044
5	100	16	0	16	1500	62	3.1	1.3	0.044

Table 16. *Experimental results using blend N20.*

S. no	Load %	Va m^3/sec	vs m^3/sec	BP kW	FP kW	IP kW	η_{mec} %	ηbte (%)	ηite (%)	mf (kg/sec)	ηvol (%)	A/F	ISFC (kg/kW-h)	BSFC (kg/kW-h)
1	0	0.00543	0.00617	0	1.6	1.6	0	0	38.18	0.000100	88.00	61.64	0.225	∞
2	25	0.00543	0.00617	0.96	1.6	2.56	37.50	17.62	46.99	0.000135	88.00	47.41	0.182	0.487
3	50	0.00537	0.00617	1.92	1.6	3.52	54.54	26.95	49.41	0.000171	87.03	35.85	0.173	0.318
4	75	0.00531	0.00617	2.88	1.6	4.48	64.28	29.88	46.48	0.000236	86.06	26.20	0.184	0.287
5	100	0.00531	0.00617	3.84	1.6	5.44	70.58	35.24	49.93	0.000263	86.06	23.18	0.172	0.243

Table 17. *Experimental observations of exhaust emissions using N20.*

S. no	Load (%)	Weight (kgf)	Net load (kgf)	Speed (rpm)	HC (ppm	CO (%)	CO_2 (%)	NO_X	O_2 (%)	Absorption co-efficient (K)	Smoke density (H.S.U.)
1	0	0	0	1500	53	0.09	1.9	47	18.51	0.30	12.10
2	25	4	4	1500	52	0.09	2.9	111	17.51	0.38	15.07
3	50	8	8	1500	40	0.08	4.4	282	16.21	0.67	25.03
4	75	12	12	1500	47	0.06	6.2	626	14.80	1.20	40.30
5	100	16	16	1500	45	0.05	8.2	1069	12.96	2.10	59.81

Experimental Observations for Blend N25

Table 18. *Experimental observations using blend N25.*

S. no	Load				Speed (N) (rpm)	Time taken for 20cc fuel consumption (sec)	Manometer reading		
	%	W (kg)	S (kg)	W-S (kg)			h_1 (cm)	h_2 (cm)	h_w (m)
1	0	0	0	0	1500	170	3.2	1.4	0.046
2	25	4	0	4	1500	127	3.2	1.4	0.046
3	50	8	0	8	1500	95	3.2	1.35	0.045
4	75	12	0	12	1500	72	3.1	1.3	0.044
5	100	16	0	16	1500	61	3.1	1.25	0.043

Table 19. *Experimental results using blend N25.*

S. no	Load (%)	Va (m^3/sec)	Vs (m^3/sec)	BP (kW)	FP (Kw)	IP (Kw)	η_{mec} (%)	ηbte (%)	ηite (%)	mf (kg/sec)	ηvol (%)	A/F	ISFC (kg/kW-h)	BSFC (kg/kW-h)
1	0	0.00543	0.00617	0	1.65	1.70	0	0	41.79	0.000097	88	65.06	0.207	∞
2	25	0.00543	0.00617	0.96	1.65	2.66	36.79	17.61	48.08	0.000269	88	47.41	0.178	0.487
3	50	0.00542	0.00617	1.92	1.65	3.62	53.76	26.95	50.29	0.000172	87.5	36.05	0.171	0.318
4	75	0.00531	0.00617	2.88	1.65	4.58	63.58	30.56	48.26	0.000259	86.06	26.79	0.178	0.281
5	100	0.00528	0.00617	3.84	1.65	5.54	69.94	33.98	48.74	0.000275	85.57	22.29	0.176	0.252

Table 20. *Experimental observations of exhaust omissions using N25.*

S. no	Load (%)	Weight (kgf)	Net load (kgf)	Speed (rpm)	HC (ppm)	CO (%)	CO_2 (%)	NO_X	O_2 (%)	Absorption co-efficient (K)	Smoke density (H.S.U.)
1	0	0	0	1500	54.5	0.085	1.85	52	18.35	0.29	11.72
2	25	4	4	1500	52.5	0.085	2.85	120	17.35	0.38	15.25
3	50	8	8	1500	44.5	0.08	4.31	295	15.95	0.65	24.54
4	75	12	12	1500	44.5	0.06	6.07	621	14.68	1.24	41.31
5	100	16	16	1500	41	0.055	7.95	1010	12.98	2.23	61.78

Experimental Observations for Blend N30

Table 21. *Experimental observations using blend N30.*

S. no	Load				Speed (N) (rpm)	Time taken for 20cc fuel consumption (sec)	Manometer reading		
	%	W (kg)	S (kg)	W-S (kg)			h_1 (cm)	h_2 (cm)	h_w (m)
1	0	0	0	0	1500	180	3.2	1.4	0.046
2	25	4	0	4	1500	126	3.2	1.4	0.046
3	50	8	0	8	1500	96	3.2	1.4	0.046
4	75	12	0	12	1500	74	3.1	1.3	0.044
5	100	16	0	16	1500	60	3.1	1.2	0.043

Table 22. *Experimental results using blend N30.*

S. no	Load (%)	Va (m^3/sec)	Vs (m^3/sec)	BP (kW)	FP (kW)	IP (kW)	η_{mec} (%)	ηbte (%)	ηite (%)	mf (kg/sec)	ηvol (%)	A/F	ISFC (kg/kW-h)	BSFC (kg/kW-h)
1	0	0.00543	0.00617	0	1.7	1.70	0	0	45.40	0.000094	88.00	68.49	0.190	∞
2	25	0.00543	0.00617	0.96	1.7	2.66	36.09	17.62	49.18	0.000134	88.00	47.41	0.175	0.487
3	50	0.00543	0.00617	1.92	1.7	3.62	53.03	26.95	51.18	0.000173	88.00	36.25	0.169	0.318
4	75	0.00531	0.00617	2.88	1.7	4.58	62.88	31.24	50.04	0.000228	86.06	27.39	0.172	0.275
5	100	0.00525	0.00617	3.84	1.7	5.54	69.31	32.73	47.56	0.000288	85.08	21.28	0.181	0.262

Table 23. *Experimental observations of exhaust omissions using N30.*

S. no	Load (%)	Weight (kgf)	Net load (kgf)	Speed (rpm)	HC (ppm)	CO (%)	CO_2 (%)	NO_X	O_2 (%)	Absorption co-efficient (K)	Smoke density (H.S.U.)
1	0	0	0	1500	56	0.08	1.8	57	18.20	0.28	11.34
2	25	4	4	1500	53	0.08	2.80	129	17.20	0.39	15.43
3	50	8	8	1500	49	0.08	4.23	309	15.70	0.64	24.05
4	75	12	12	1500	42	0.06	5.94	617	14.57	1.28	42.32
5	100	16	16	1500	37	0.06	7.70	952	13.01	2.36	63.75

Performance Analyses Using Pure Diesel and Its Blends of (NOME)

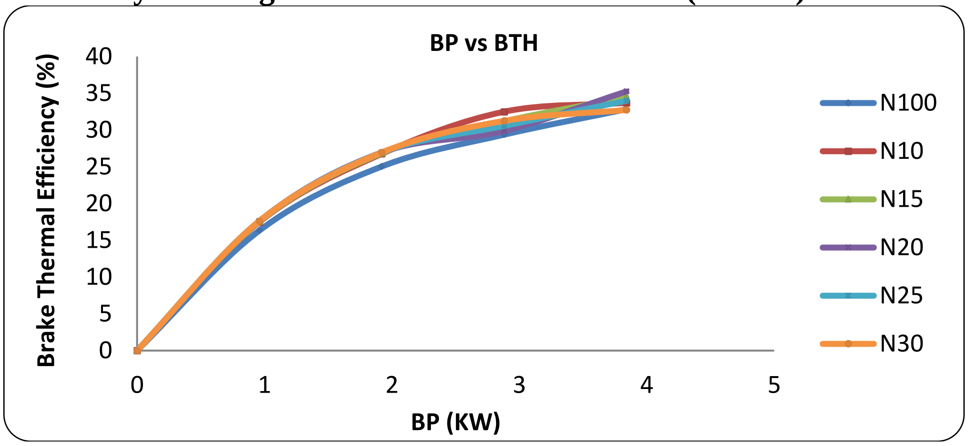

Fig. 2. *Variation of brake thermal efficiency with brake power using NOME blends.*

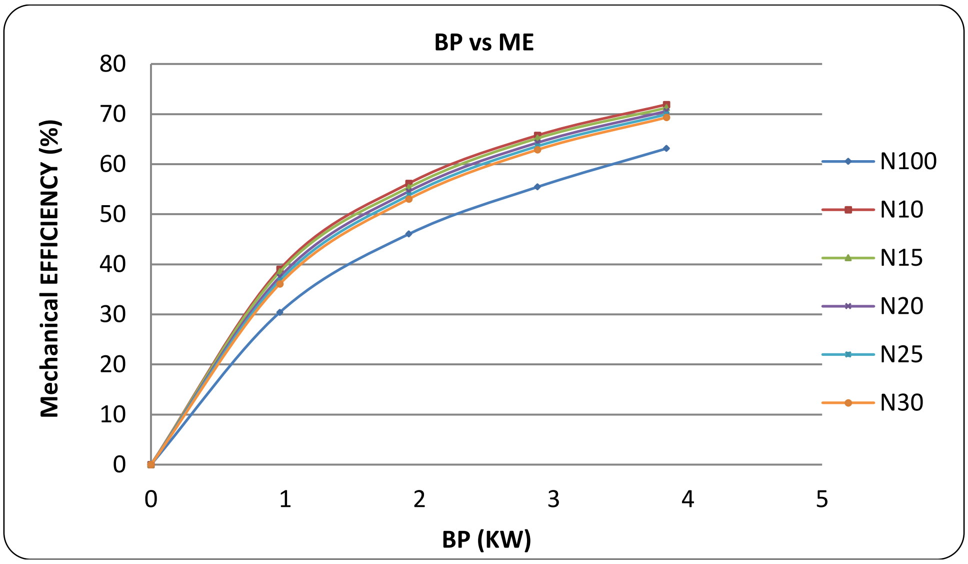

Fig. 3. *Variation of mechanical efficiency with brake power using NOME blends.*

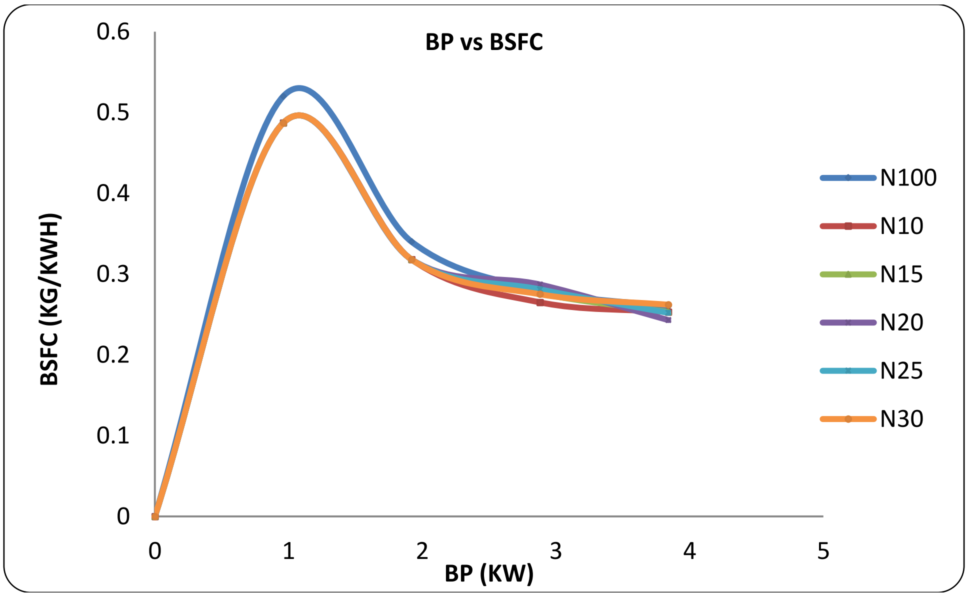

Fig. 4. *Variation of brake specific fuel consumption with brake power using NOME blends.*

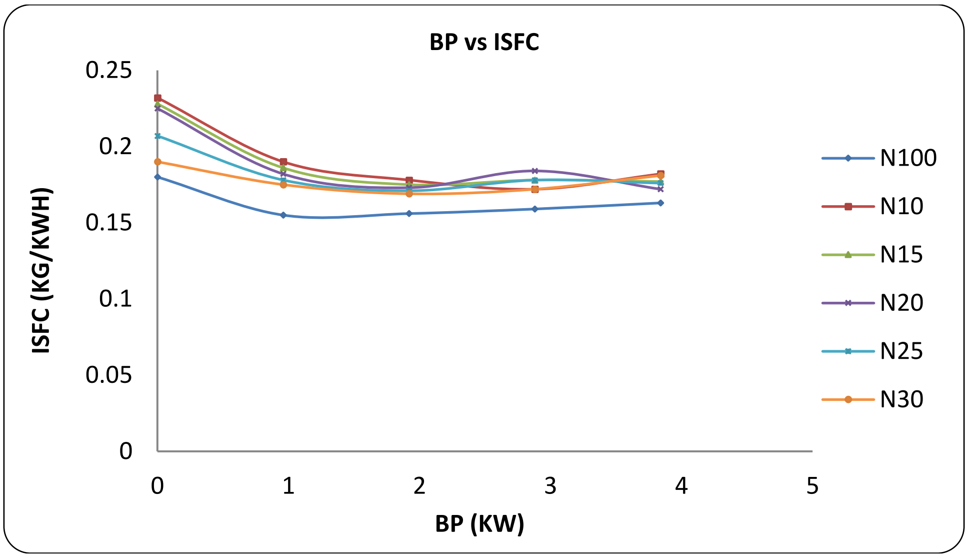

Fig. 5. *Variation of indicated specific fuel consumption with brake power using NOME blends.*

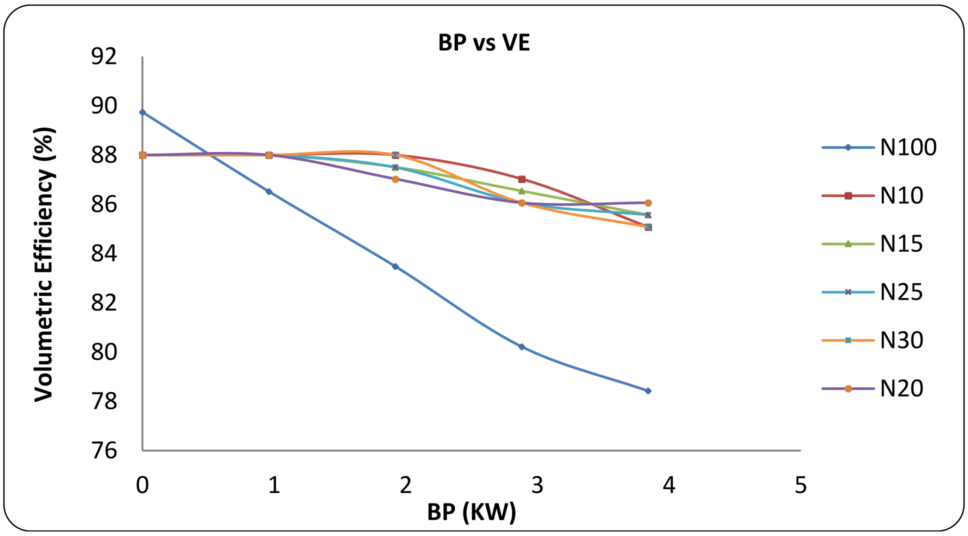

Fig. 6. *Variation of volumetric efficiency with Brake power using NOME blends.*

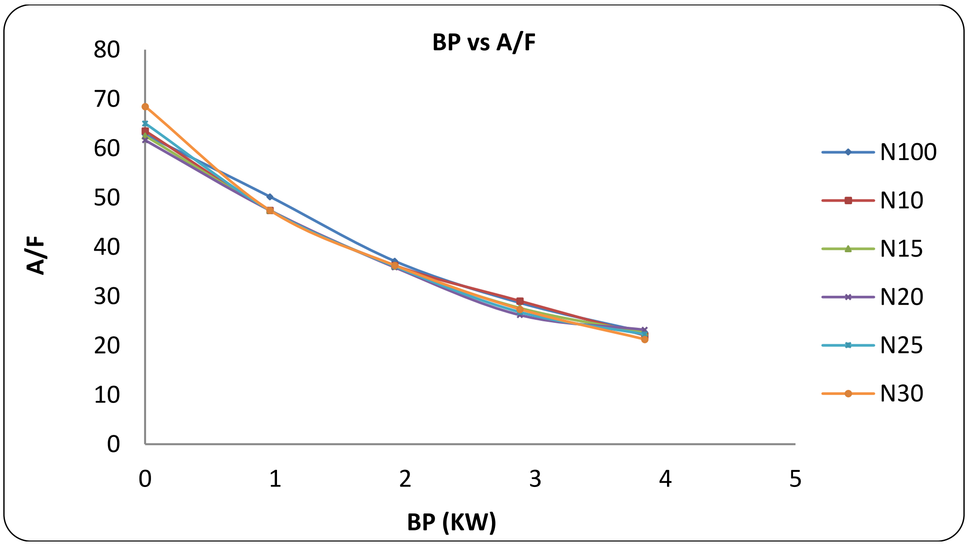

Fig. 7. *Variation of air-fuel ratio with Brake power using NOME blends.*

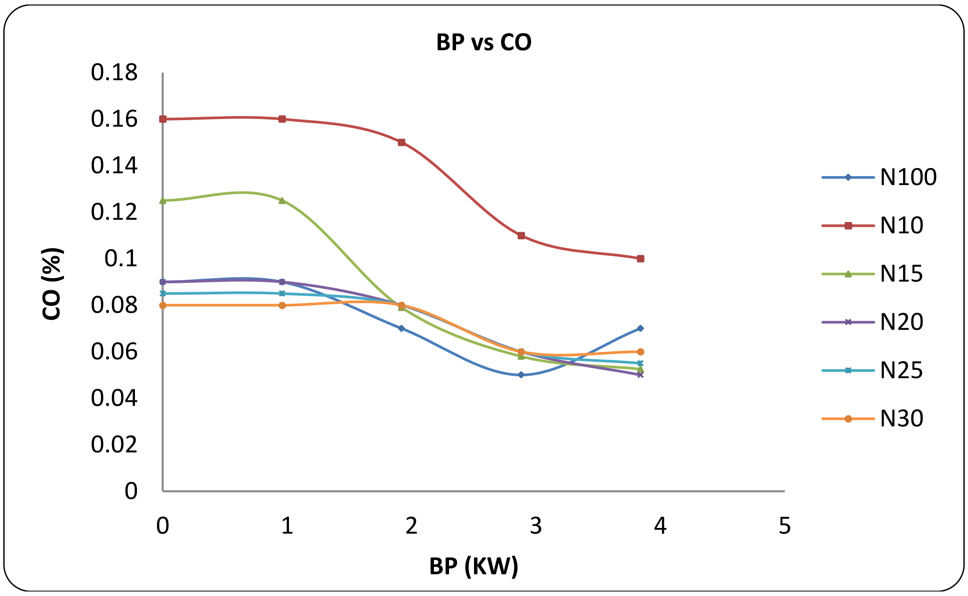

Fig. 8. *Variation of carbon monoxide emissions with Brake power using NOME blends.*

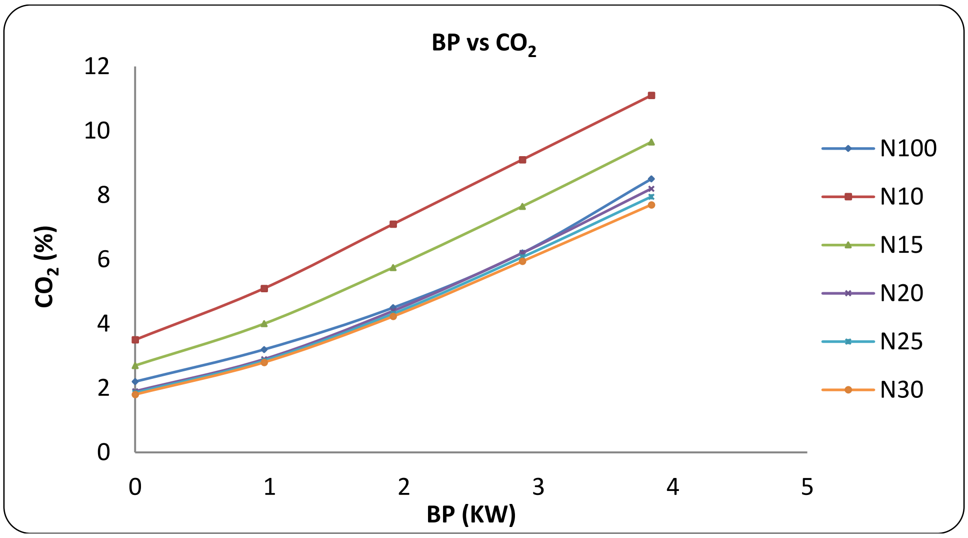

Fig. 9. *Variation of carbon dioxide with Brake power using NOME Blends.*

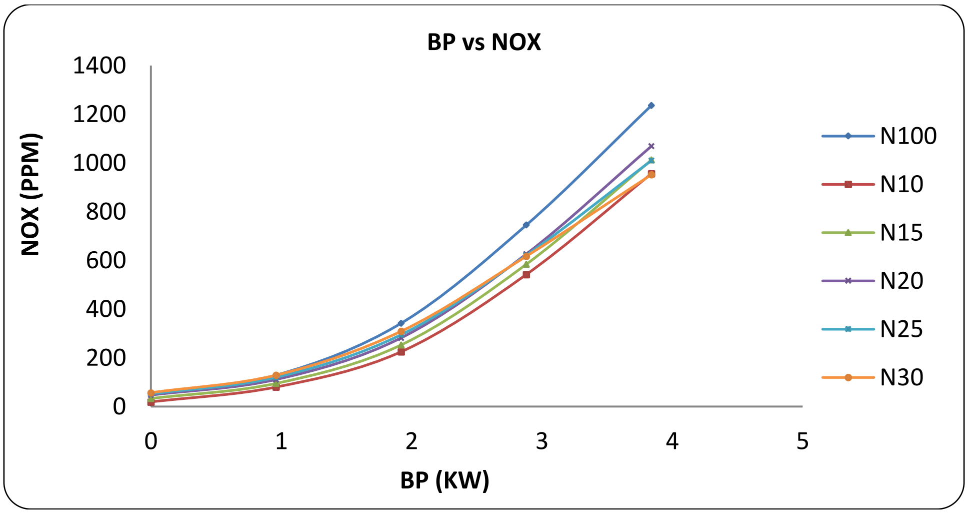

Fig. 10. *Variation of oxides of nitrogen emissions with Brake power using NOME blends.*

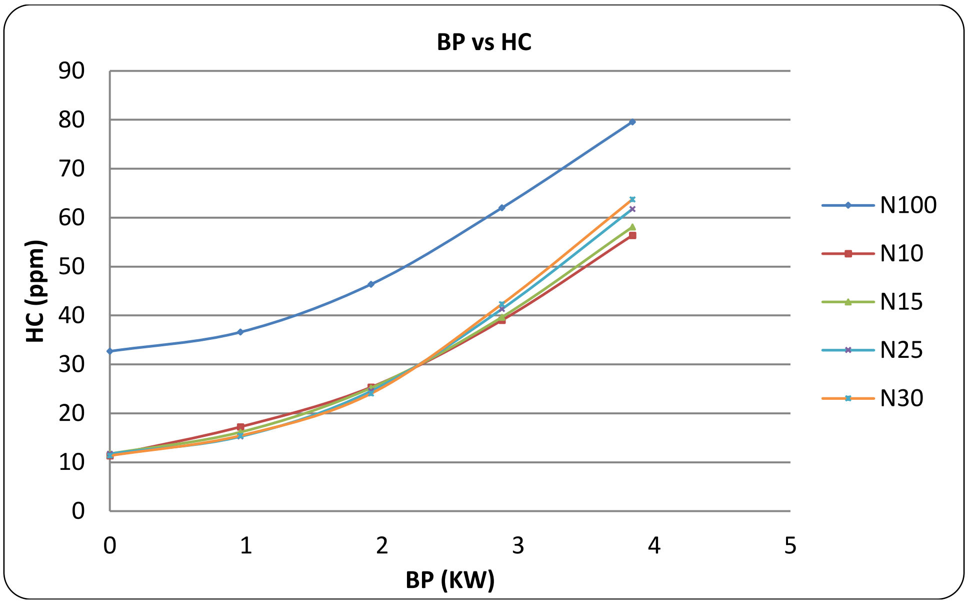

Fig. 11. *Variation unburned hydrocarbons emissions with Brake power using NOME blends.*

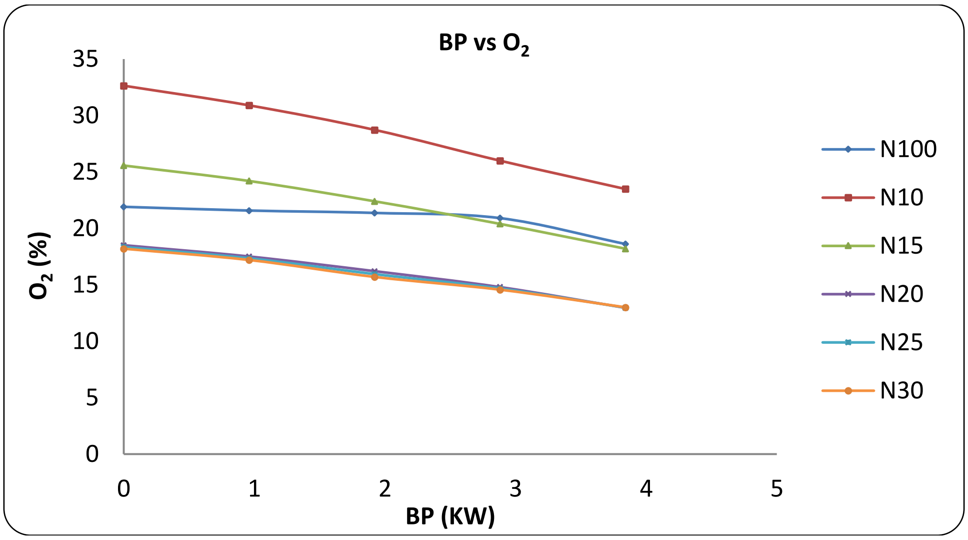

Fig. 12. *Variation unburned oxygen emissions with Brake power using NOME blends.*

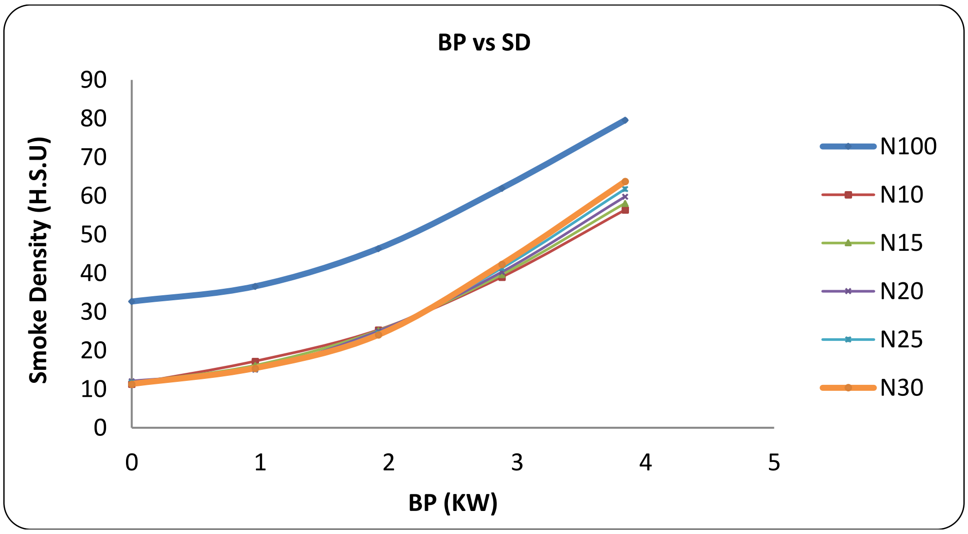

Fig. 13. *Variation smoke density with Brake power using NOME blends.*

Observations for N20 With Ignition Improver 10ml

Table 24. *Experimental observations using N20 with 10 ml DEE.*

S. no	Load				Speed (N) (rpm)	Time taken for 20 cc fuel consumption (sec)	Manometer reading		
	%	W (kg)	S (kg)	W-S (kg)			h_1 (cm)	h_2 (cm)	h_w (m)
1	0	0	0	0	1500	158	3.5	1.9	0.054
2	25	4	0	4	1500	118	3.5	1.9	0.054
3	50	8	0	8	1500	92	3.4	1.7	0.051
4	75	12	0	12	1500	70	3.4	1.7	0.051
5	100	16	0	16	1500	62	3.3	1.6	0.049

Table 25. *Experimental results using N20 with 10 ml DEE.*

S. no	Load (%)	Va (m^3/sec)	Vs (m^3/sec)	BP (kW)	FP (kW)	IP (kW)	η_{mec} (%)	ηbte (%)	ηite (%)	mf (kg/sec)	ηvol (%)	A/F	ISFC (kg/kW-h)	BSFC (kg/kW-h)
1	0	0.00594	0.00617	0	1.6	1.6	0	0	36.36	0.000105	96.27	64.19	0.236	∞
2	25	0.00594	0.00617	0.96	1.6	2.56	37.5	19.24	43.33	0.000141	96.27	47.80	0.198	0.528
3	50	0.00577	0.00617	1.92	1.6	3.52	54.54	29.76	45.41	0.000185	93.51	35.40	0.189	0.346
4	75	0.00577	0.00617	2.88	1.6	4.48	64.28	34.88	44.92	0.000238	93.51	27.52	0.191	0.297
5	100	0.00566	0.00617	3.84	1.6	5.44	70.58	37.12	46.70	0.000278	91.73	23.09	0.183	0.249

Table 26. *Experimental observations of exhaust emissions using N20 with 10ml DEE.*

S. no	Load (%)	Weight (kgf)	Net load (kgf)	Speed (rpm)	HC (ppm)	CO (%)	CO_2 (%)	NO_X	O_2 (%)	Absorption co-efficient (K)	Smoke density (H.S.U.)
1	0	0	0	1500	63	0.10	2.2	59	19.20	0.60	22.74
2	25	4	4	1500	60	0.10	3.3	158	18.33	0.85	30.61
3	50	8	8	1500	58	0.10	4.8	348	17.17	1.71	52.06
4	75	12	12	1500	58	0.09	6.8	612	16.09	2.95	71.87
5	100	16	16	1500	57	0.07	7.6	643	15.95	5.07	88.69

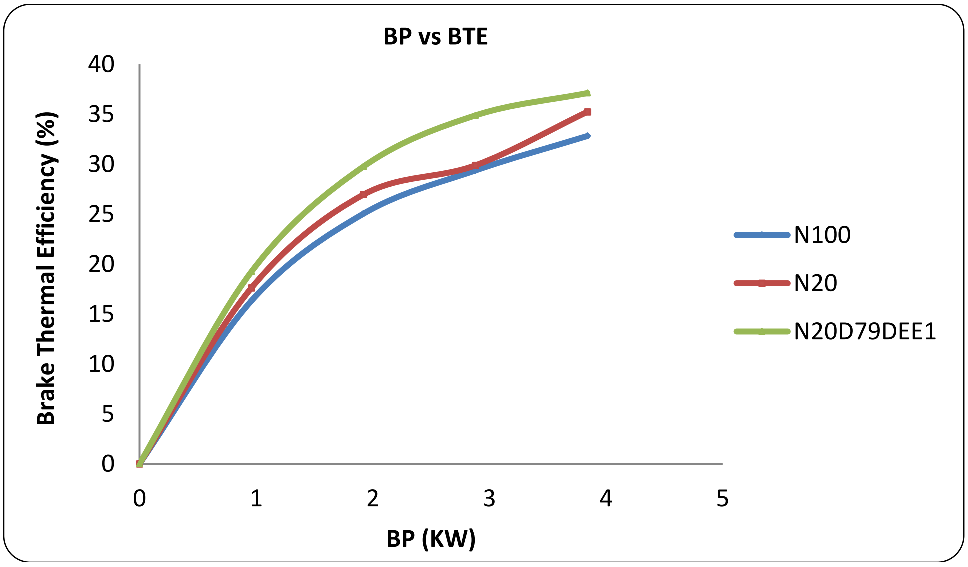

Fig. 14. *Variation of Brake thermal efficiency with Brake power using Ignition Iprover.*

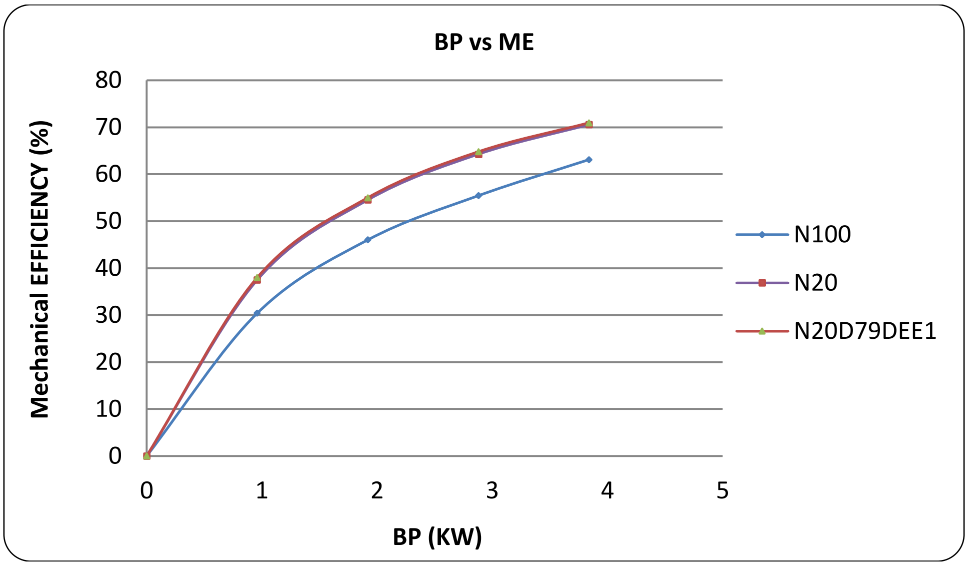

Fig. 15. *Variation of mechanical efficiency with Brake power using Ignition Iprover.*

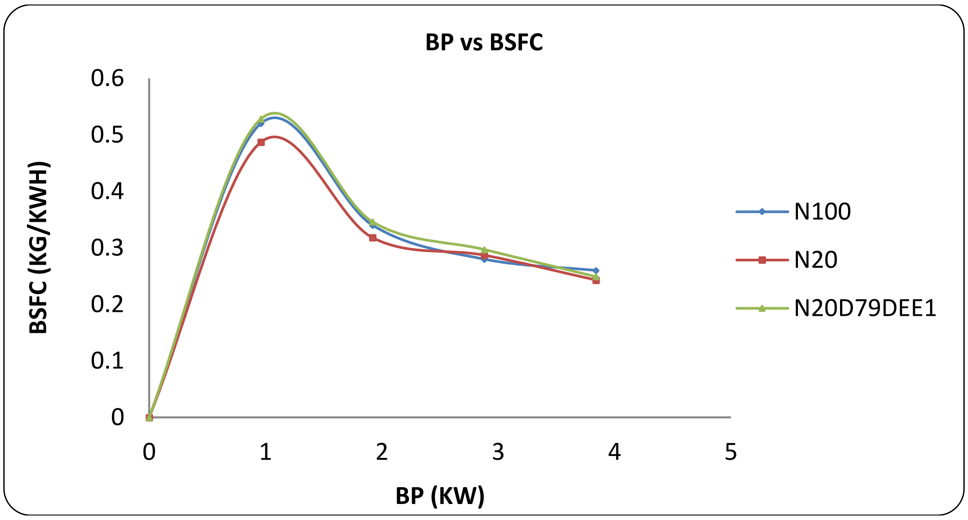

Fig. 16. *Variation of Brake specific fuel consumption with Brake power using Ignition Iprover.*

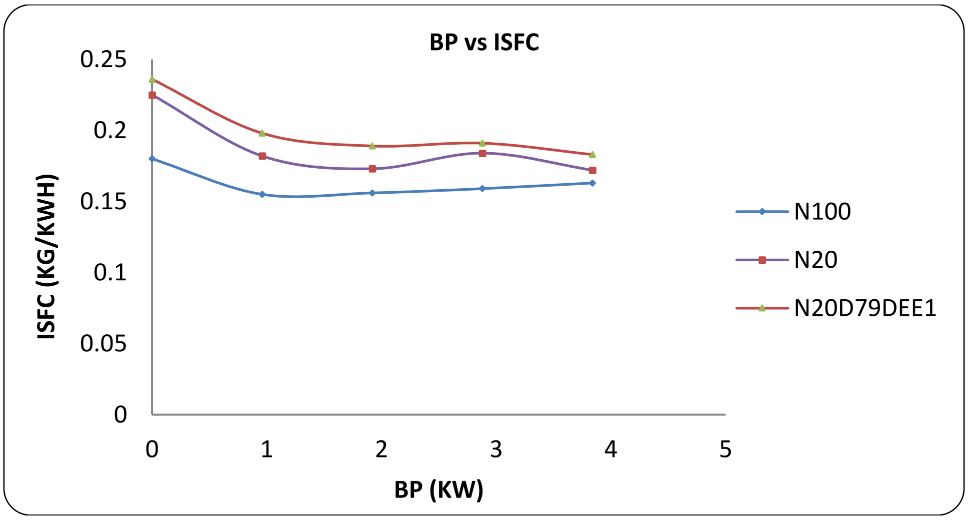

Fig. 17. *Variation of indicated specific fuel consumption with Brake power using Ignition Iprover.*

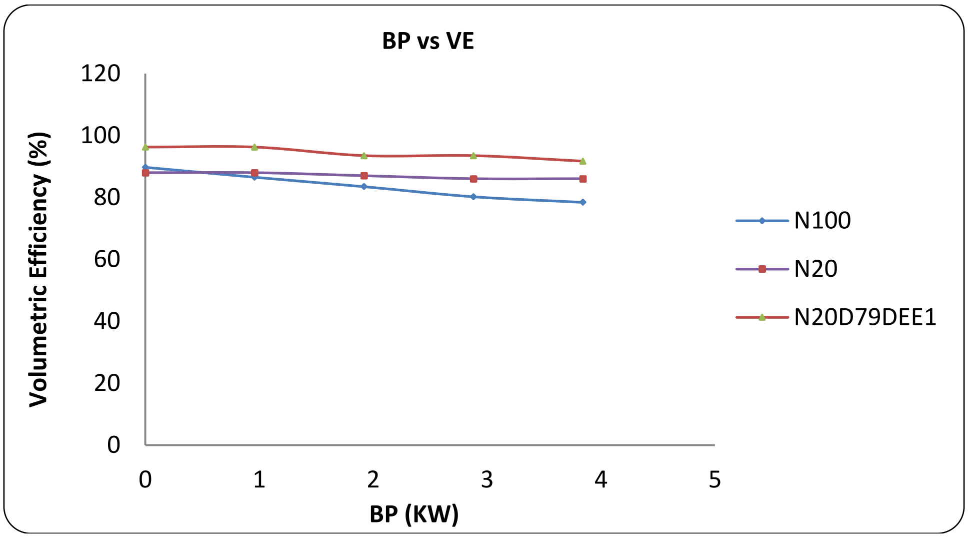

Fig. 18. *Variation of volumetric efficiency with Brake power using Ignition Iprover.*

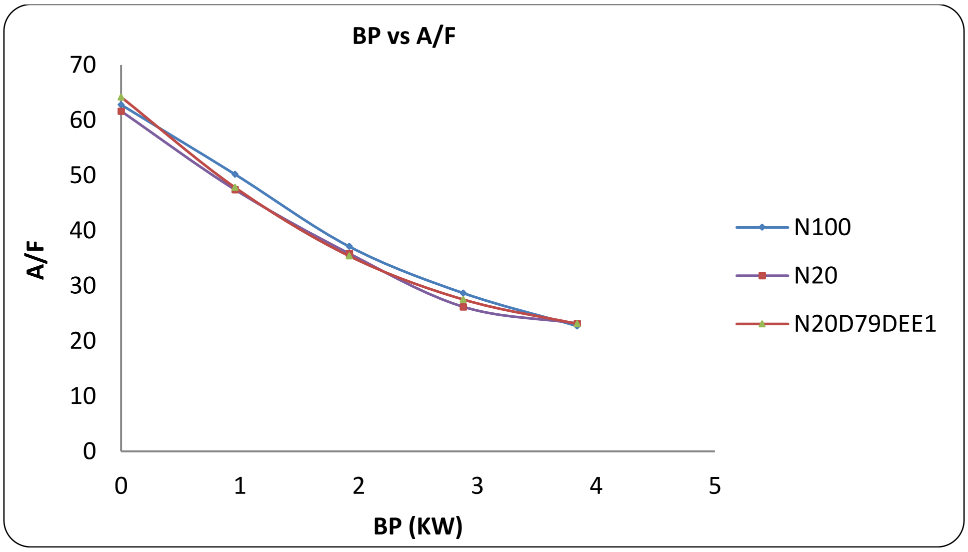

Fig. 19. *Variation of air-fuel ratio with Brake power using Ignition Iprover.*

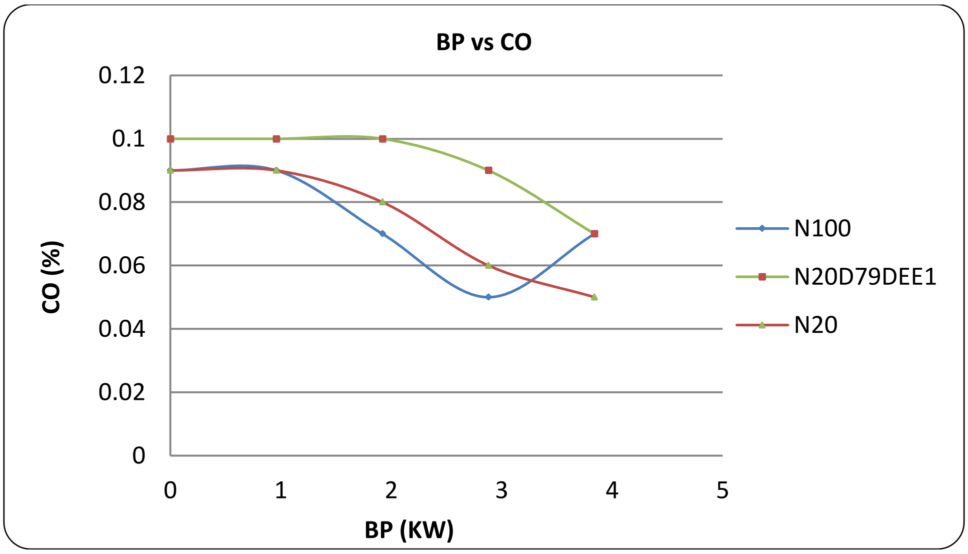

Fig. 20. *Variation of carbon monoxide emissions with Brake power using Ignition Iprover.*

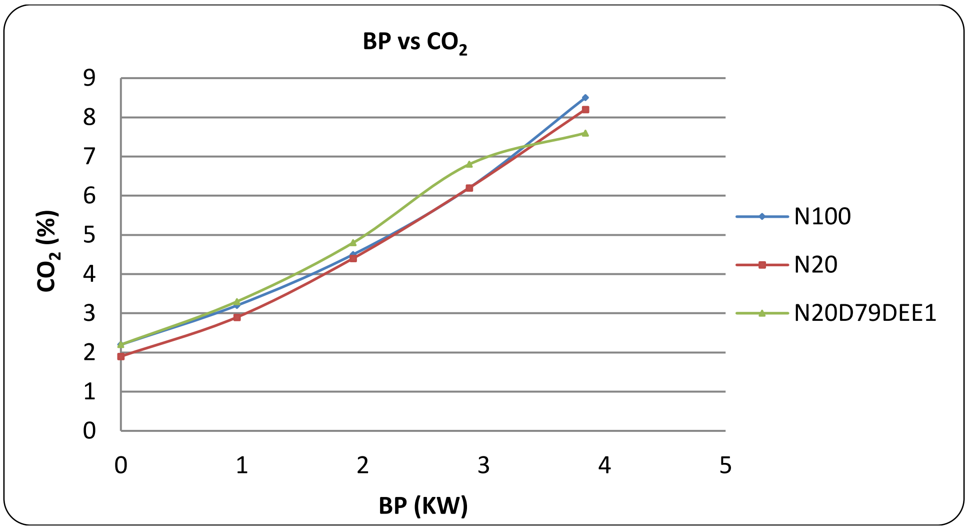

Fig. 21. *Variation of carbon dioxide with Brake power using Ignition Iprover.*

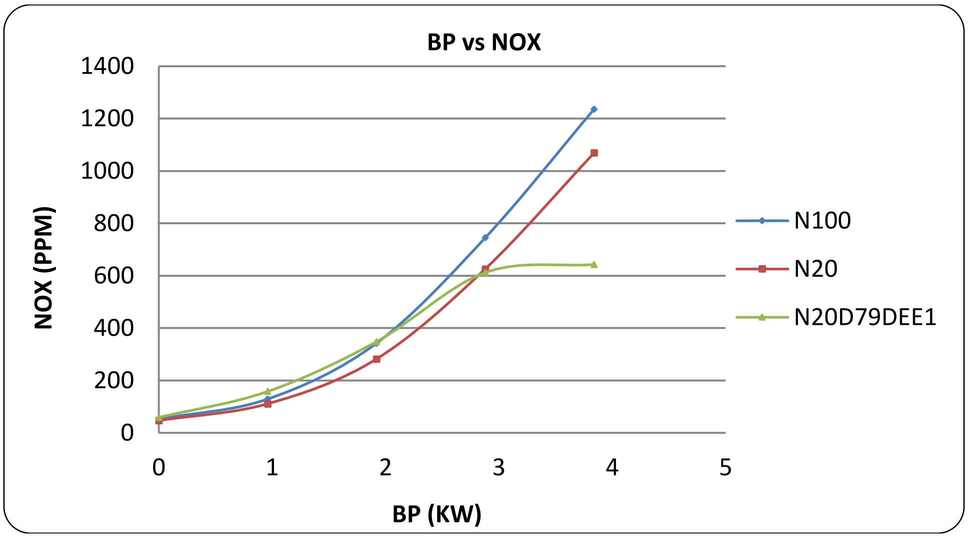

Fig. 22. *Variation of oxides of nitrogen emissions with Brake power using Ignition Iprover.*

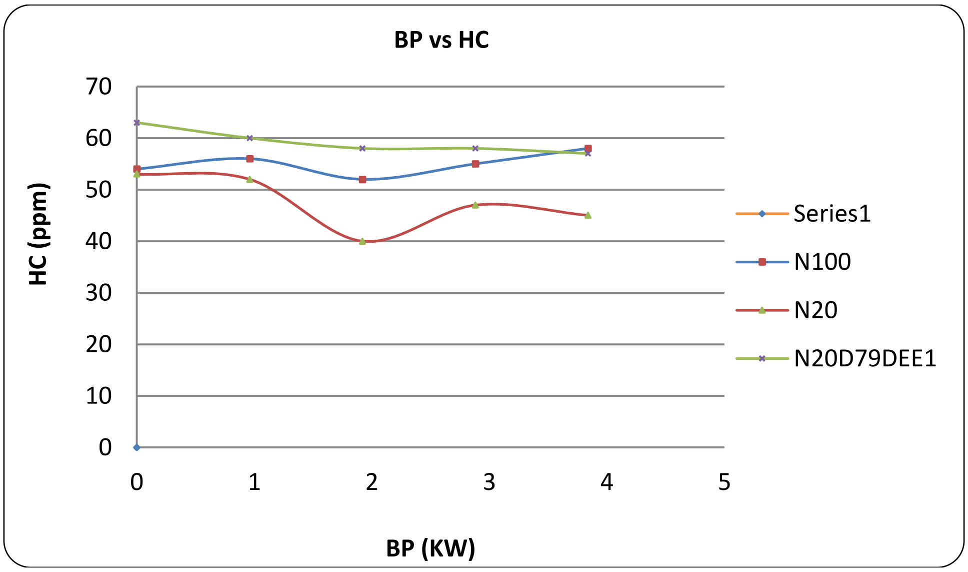

Fig. 23. *Variation unburned hydrocarbons emissions with Brake power using Ignition Iprover.*

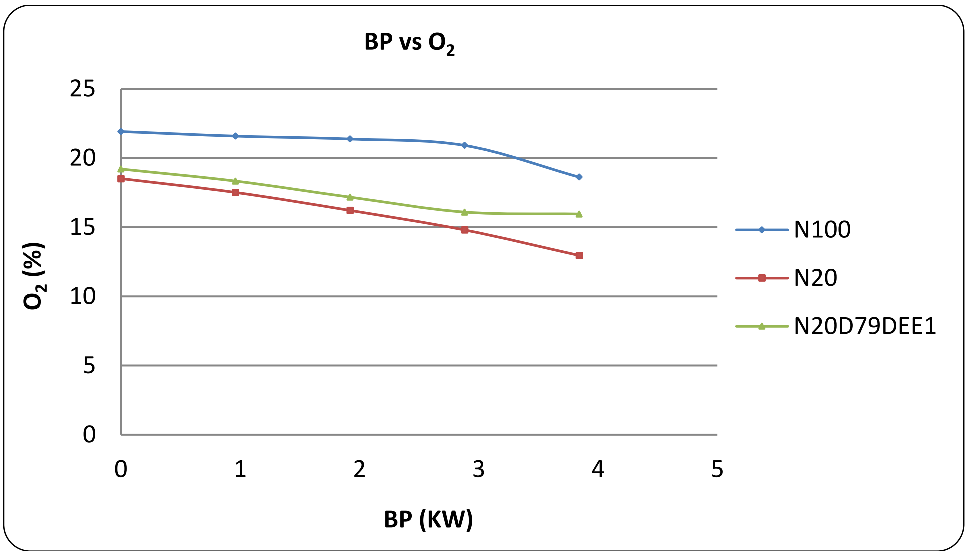

Fig. 24. *Variation unburned oxygen emissions with Brake power using Ignition Iprover.*

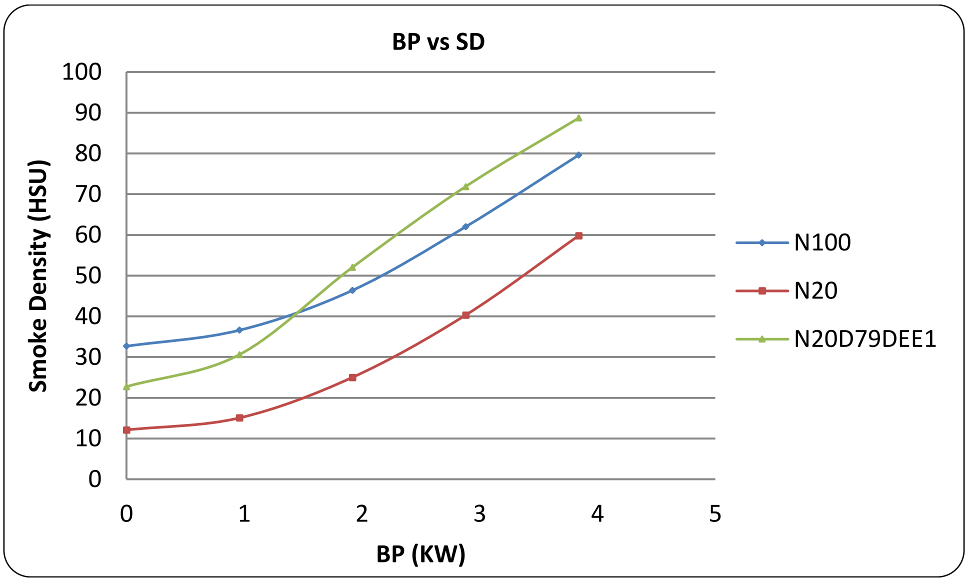

Fig. 25. *Variation smoke density with Brake power using Ignition Iprover.*

CONCLUSION

The experiments were conducted on four stroke single cylinder water cooled diesel engine at constant speed using NOME blends. The performance of the engine was increased and emissions of engine decreased at blend N20.

Performance and Emissions Analysis Using Diesel and NOME Blends

In this experimental study, the effect of neem oil methyl ester blends and diesel fuel on engine performance and exhaust emissions were investigated on single cylinder, water cooled and direct injection at constant speed of 1500 rpm. Out of all blends of neem oil methyl esters N20 shows best results in performance and emissions parameters.

The conclusions of this investigation are comparing with diesel base line information at full load as follows:

- The maximum brake thermal efficiency for N20 (35.24%) was higher than that of diesel.
- The brake thermal efficiency increased in 7.76% compared with diesel.

- Brake specific fuel consumption is decreases in blended fuels. In N20 fuel the BSFC is lower than the diesel in 2.8%.
- Significant reductions were obtained in smoke level, CO emissions with N20 blend. Smoke level was decreased by 24.86% with N20 compared to diesel at maximum load of the engine.
- The highest decrease in CO emissions was obtained with N20 as 28.57% compared to diesel fuel.
- Significant reductions were obtained in unused oxygen emissions with N20 was decreased by 30.39% compared to diesel at maximum load of the engine.
- On the other hand, NOx emissions were decreased with N20 compared to diesel fuel. NOx emissions were decreased by 13.57% with N20 compared diesel.
- The marginal increases in carbon dioxide emissions were 6.66% compared to diesel.
- Reductions in unburned hydrocarbon emissions were 22.41% compared to diesel.

Performance and Emissions Analysis Using Diesel and (NOME) Blend with Ignition Improver

In further stage the investigations were carried out on the same engine with addition of DEE (ignition improver) 1% volume ratios to optimum blend N20, N20D79DEE1 find out performance and emissions parameters and compared with optimum blend and diesel base line data. Out of this 1% volume addition of ignition improver (N20D79DEE1) shows best results in performance and emissions parameters. The conclusions of this investigation are compared with optimum blend N20 and diesel base line data at full load as follows:

- The maximum brake thermal efficiency for was (37.12%) was higher than that of N20 and diesel. The brake thermal efficiency increased in 5.33%, 15.3% compared with N20 and diesel.
- Brake specific fuel consumption is decreases in blended fuels with added ignition improver. In N20D79DEE1 fuel the BSFC is lower than the diesel the decreased in BSFC in 4.23%.
- Significant reductions were obtained in unburned hydrocarbons emissions with N20D79DEE1blend compared with N20 diesel. Unburned hydrocarbons were decreased by 1.724% compared to diesel at maximum load of the engine. But increases 16.32% in N20 compared with N20D79DEE1.
- Significant reductions were obtained in unused oxygen emissions with N20D79DEE1 was decreased by 14.33% compared to diesel at maximum load of the engine, but it was increased 23.07% compared with N20.
- The interesting things were obtained NOx emissions were decreased with N20D79DEE1 compared to optimum blend N20 and diesel. NOx emissions were decreased by 39.85%, 47.9%compared with N20 and diesel.
- The significant increase in CO_2 emissions were obtained with N20D79DEE1 as compared to N20 is 7.89%, it was decreased11.8% compared with diesel at and diesel.
- The marginal increases in smoke densities compared with N20 and diesel. The increment was in the order of 48.2% and 11.4%, respectively.

All these tests for characterization of biodiesel demonstrated that almost all the important properties of bio diesel are very close agreement with the diesel making it a competent candidate for the application in CI engines. An attempt made to use neem oil methyl esters as a fuel in the C.I engine is very effective and can be used as an alternative fuel. From all these discussions it can be concluded that diesel engine can perform satisfactorily on bio-diesel blends

N20 with addition of improver with 10ml without any engine design modification. It is observed that having 20% neem oil CI engine gives energetic results for as performance and emissions parameters. Finally I conclude we can save 20% diesel importing from other countries and increases country economy. Based on this investigation, it is observed that a time will be reached in the future scope when demand for non-polluting and capable energy sources will be met by other sources than fossil fuel globally. It is concluded that in order to overcome the energy crisis in future, mega cultivation of this species may be carried out for biodiesel production at large-scale.

SCOPE OF FUTURE WORK

In the present investigation the performance and emission are evaluated with constant operating parameters such as injection pressure, injection timing, compression ratio, speed and crank angle.

In the future work the investigation will be carried out by varying the operating parameters like injection pressure, injection timing and compression ratios by using neem oil methyl esters blends. With varying these parameters to be finding inside cylinder pressure, combustion analysis and heat release rate. Major modification in engine design will be changed to evaluate performance and emissions up to blends N40, N50 also possible.

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