IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 16, Issue 6 Ser. IV (Nov. - Dec. 2019), PP 26-33
www.iosrjournals.org

Performance Analysis of Single Cylinder CI Engine Fueled with Diesel, Kerosene and Olive Oil Blends

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Abstract: *Direct utilization of edible consumable cooking oils as fuel in Diesel motors prompts some significant motor operational issues that should be fathomed so as to make their convenience conceivable. Olive Oil was blended with (Diesel 70% + Kerosene 30%) by percentages of (Diesel 70% + Kerosene 30%) 95% + Olive Oil 05%, (Diesel 70% + Kerosene 30%) 90% + Olive Oil 10% and (Diesel 70% + Kerosene 30%) 85% + Olive Oil 15%.These blend fills were from the outset analyzed by strategies for physicochemical fuel properties and connections were made with standard Diesel fuel. Blend fills and standard Diesel fuel were then attempted in a Diesel control generator one chamber so as to examine the burning, execution and outflow qualities of the mix powers and contrast them and the oil-based Diesel fuel. It tends to be inferred that (Diesel + Kerosene) and can be utilized as fuel with improved ignition and performance qualities contrasted with those of unadulterated edible consumable cooking oils.*

Keywords: *Diesel, Kerosene, Olive Oil, Performance.*

Date of Submission: 30-12-2019 Date of Acceptance: 14-01-2020

I. Introduction

Since the start of present century, edible consumable cooking oil-based fills have been perceived to be one of the principle electives energizes for Diesel motors. As elective motor energizes, edible consumable cooking oil mixes have been effectively shown as a powerful substitute in Diesel motors (Nwafor et al., 1996; Labeckas et al., 2006; Rakopoulos et al., 2007). Regardless, since it prompts some motor operational issues, direct utilization of edible consumable cooking oils can't be an answer as of recently. The issues during the motor activity are chiefly because of high thickness, thickness, poor atomization and poor unpredictability of edible consumable cooking oils. Since, surface strain and consistency of edible consumable cooking oil are high it prompts poor atomization because of the augmentation in the mean bead size of infused fuel stream (Lee et al., 2005). In this way, edible consumable cooking oil or their high rates mixes with Diesel fuel have additionally some operational issues in unmodified Diesel motors.

Mixing, emulsification, breaking and pyrolysis, or transesterification are acquainted all together with beat these issues. In addition, mixing of edible consumable cooking oils with fossil Diesel or warming improve unpredictability and diminishes thickness of cooking. Mixing of various rates of edible consumable cooking oils, for example, 10%, 20%, and 30%. With Diesel diminishes thickness radically and the fuel arrangement of motor can work with edible consumable cooking oil Diesel mixes with no issues. Preheating likewise is another route so as to get the consistency tantamount to Diesel fuel and afterward the oil can be brought into the motor after immediate or roundabout infusion framework. The referenced issues can likewise be comprehended by mixing edible consumable cooking oil with another low thickness, consistency and great unpredictability fuel. The issue of utilizing unadulterated or high rates edible consumable cooking oil mixes should be settled by mixing it with another fuel, for example, lamp fuel that has lower thickness, consistency, refining temperature and high unpredictability. It was accounted for somewhere else that edible consumable cooking oil has the upside of miscibility with Diesel or lamp oil and the mixed energizes don't change the nature of answer for quite a while at any blended proportion. Along these lines an answer can be set up by mixing edible consumable cooking oils with either Diesel or lamp oil to diminish the thickness there by making the oils reasonable for motor activity

Utilizing unadulterated lamp oil or too high rates of it with another Diesel-like fuel may cause to mileage in fuel infusion framework or even reason to wear on the moving parts in the start structure (Tay et al., 2016; Anastopoulos et al., 2002; Lee et al., 2012). Along these lines, in the present investigation, low rates of lamp oil with high rates of an unadulterated edible consumable cooking oil were chosen to be tested for perfect paired mixing of two other options. Despite the fact that, the cetane number of lamp fuel is lower which may cause to longer start postpone period in burning chamber, its lower refining temperature abbreviates start delay.

Bergstrand has additionally detailed that the lamp oil has lower cetane number than Diesel, along these lines giving a more extended start delay. The impacts of lamp fuel Diesel mixes in a solitary chamber Diesel motor were tentatively completed and execution qualities were breaking down. Low rates of lamp fuel, 10%, 20% and 30%, were chosen for tests. It was accounted for that brake warm productivity and fumes gas temperature were somewhat expanded with increment of level of lamp oil in the mix while explicit fuel utilization was marginally diminished that it was ascribed to the quicker vaporization and burning of the mix particles.

Takes a shot at elective fills keep up on various kinds of lamp fuel based energizes to adjust them for Diesel motor and Diesel control generator (Solmaz et al., 2014; Labeckas et al., 2015). In the present investigation, the impacts of specific measures of (Diesel + Kerosene) and Olive Oil mixes on burning, execution and outflow markers in a Diesel motor. The issue that was proposed to be taken care of was to improve the solace of high paces of vegetable oils in unmodified Diesel motors. The issue that was expected to be handled was to improve the comfort of high paces of vegetable oils in unmodified Diesel engines. Along these lines, high rate edible consumable cooking oil lamp oil mixes were tentatively affirmed in the motor so as to discover the plausibility of utilizing edible consumable cooking oils as fills. The lamp oil and Olive Oil were chosen in the investigation since they can be delivered from regular assets and they are inexhaustible. The decided measures of the Diesel and lamp oil added to the edible consumable cooking oil were chosen so as to adjust the blend properties, for example, consistency and thickness and so on with the standard Diesel fuel particulars. Bigger measure of lamp oil was not utilized in light of the fact that it might prompt longer start delay because of the lower cetane number and higher auto-start temperature of lamp fuel. Extensive trials were done to explain the adjustments in the motor test parameters when running it with referenced test fuel (Bayindu et al., 2017).

II. Materials And Test Methods

2.1. Experimental setup and test installations

The reason for mixing (Diesel 70% + Kerosene 30%) with Olive Oil was to inquire about the probability direct utilization of vegetable oils in Diesel motors. Therefore, test fuels were prepared by blending (Diesel 70% + Kerosene 30%) 95% + Olive Oil 05%, (Diesel 70% + Kerosene 30%) 90% + Olive Oil 10% and (Diesel 70% + Kerosene 30%) 85% + Olive Oil 15%. The resulting (Diesel 70% + Kerosene 30%) 95% + Olive Oil 05%, (Diesel 70% + Kerosene 30%) 90% + Olive Oil 10% and (Diesel 70% + Kerosene 30%) 85% + Olive Oil 15%fuels very like traditional Diesel fuel in its fundamental attributes. Some of the properties of the Olive Oil, Kerosene and Diesel were estimated and are introduced in table 1.

Table 1: Properties of fuel

	Olive Oil	**Kerosene**	**Diesel**
Melting Point	-6.0 °C	-51°C	-9°C
Boiling Point	190 °C	150 °C TO 300 °C	140-360°C
Specific Gravity	At 20°C (0.911)	0.820	0.82 to 0.95
Viscosity	At 20°C (5.2 cP)	At 20°C (.64cP)	At 20 °C (6 cP)
Density	0.92 g/mL	0.78-0.81 g/mL	0.832 g/mL
Cetane Number	-	75	45-55
Calorific Value	39560 kJ/kg	43100 kJ/kg	43000 kJ/kg

Calorific value and Density of the (Diesel 70% + Kerosene 30%) 95% + Olive Oil 05%, (Diesel 70% + Kerosene 30%) 90% + Olive Oil 10% and (Diesel 70% + Kerosene 30%) 85% + Olive Oil 15% is show in table 2.

Table 2: Calorific value and density

	Calorific Value	**Density**
(Diesel 70% + Kerosene 30%) 95% + Olive Oil 05%	42905.786 kJ/kg	829.93 kg/m^3
(Diesel 70% + Kerosene 30%) 90% + Olive Oil 10%	42690.700 kJ/kg	834.46 kg/m^3
(Diesel 70% + Kerosene 30%) 85% + Olive Oil 15%	42427.626 kJ/kg	838.99 kg/m^3

Schematic graph of trial arrangement is found in Figure. 1. The arrangement comprises of single chamber, four strokes, VCR (Variable Compression Ratio) Diesel motor associated with vortex current sort dynamometer for stacking. The pressure proportion can be changed ceaselessly the motor and without modifying the ignition chamber geometry by uncommonly structured tilting chamber square course of action. Arrangement is given important instruments for burning weight and wrench edge estimations. This sign is interfaced to PC through motor marker for Pθ-PV outlines. Arrangement is additionally made for interfacing wind current, fuel stream, temperatures and burden estimation. The set-up has remained solitary board box comprising of air box, two fuel tanks for mix test, manometer, fuel estimating unit, transmitters for air and fuel stream estimations, process pointer and motor marker. Rotameters are accommodated cooling water and calorimeter water stream estimation. The arrangement empowers investigation of VCR motor execution with EGR for brake control, demonstrated power, frictional power, BMEP, IMEP, brake warm proficiency, showed warm productivity, Mechanical effectiveness, volumetric productivity, explicit fuel utilization, A/F proportion and warmth balance. Labview based Engine Performance Analysis programming bundle "ICEngineSoft" is accommodated on line execution assessment. A mechanized Diesel infusion pressure estimation is alternatively given. Table 3 show the Specifications of the Diesel engine.

Figure 1: Schematic outline of trial arrangement

Table 3: Specifications of the Diesel engine

Engine Manufacturer	**Apex Innovation**
Product	Research motor arrangement single chamber, 4-stroke, multi fuel, Electronic
Engine cylinder size	Stroke 110mm, Bore 87.5mm, limit 661 cc
Diesel mode	Power 5.2 kW, speed 1500 rpm, CR go 12:1-18:1, infusion variety 0-25° BTDC
Petrol mode	Power 4.5 KW at 1800 rpm, speed go 1200-1800 rpm, CR extend 6:1-10:1, flash variety 0-700 BTDC
Dynamometer	Whirlpool ebb and flow, water cooled with stacking unit
Temperature sensor	RTD type, PT 100 and thermocouple
Load indicator	Computerized, run 0-50 kg
Load sensor	Strain check, 0-50 kg
Software	Enginesoft, engine performance and analysis

2.2. CALCULATED PARAMETERS

Brake Power

$$\mathrm{BP} = \frac{2\times\pi\times \mathrm{N}\times \mathrm{T}}{60\times 1000}\, kw$$

Density

$$\frac{vd}{bvd} = \frac{\rho bd - \rho blend}{\rho blend - \rho d}\,\mathrm{kg/m^3}$$

calorific value

$$cv = \frac{Md \times cvd + Mb\ \times cvb}{Mblend}\, kJ/kg$$

Fuel Consumption

$$FC = \frac{fc\times 60\times density}{1000000}\,\mathrm{kg/hr}$$

Specific fuel Consumption

$$SFC = \frac{FC}{BP}$$

Indicated power

$$IP = \frac{IMEP \times L \times A \times N}{60000} kw$$

$$FP = IP - BP$$

Heat equivalent to BP

$$H_{BP} = BP \times 36000 \text{ kJ/hr}$$

Brake Thermal Efficiency

$$\eta_{bthe} = \frac{HBP}{mf \times cv} \times 100$$

Mechanical Efficiency

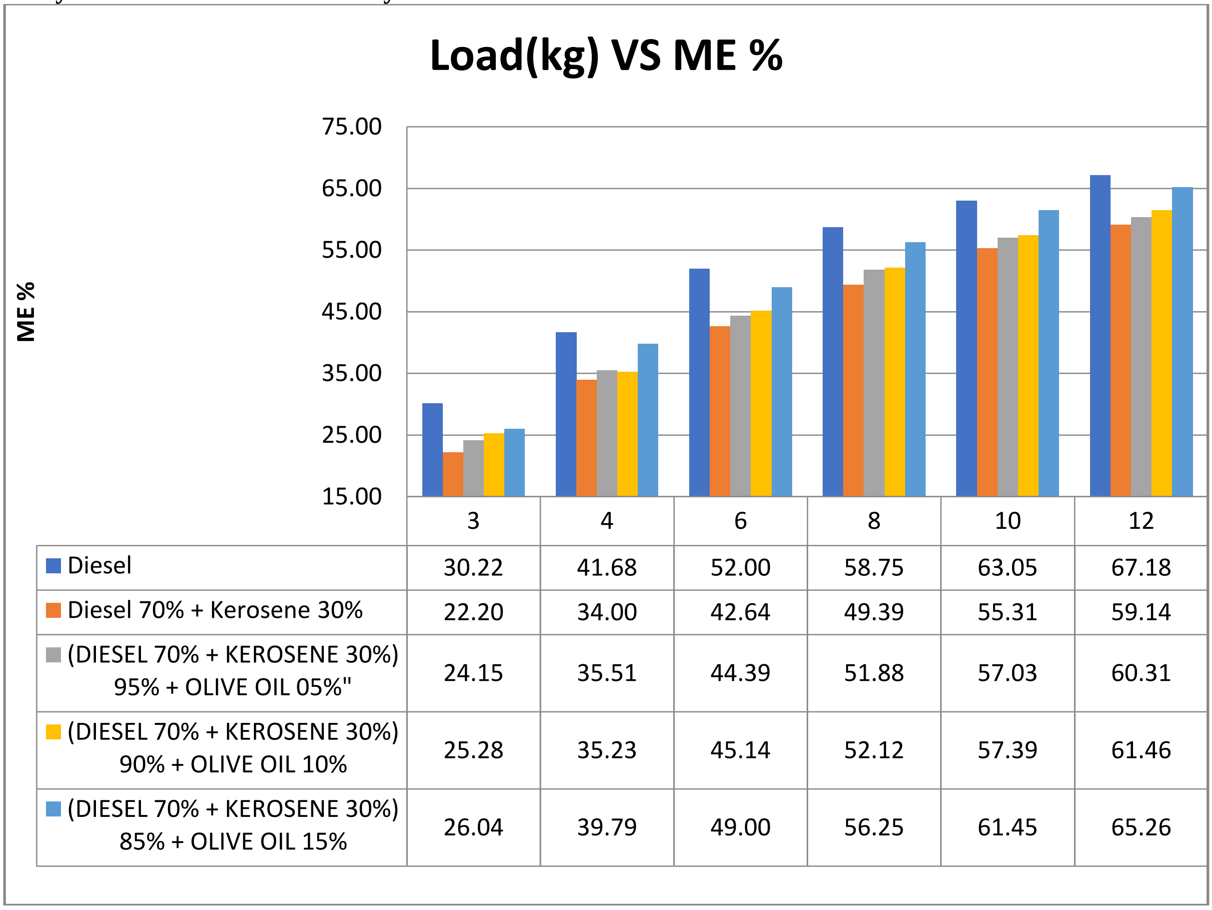
$$\eta_{mech} = \frac{BP}{IP} \times 100$$

III. Experimental Result And Discussion

Performance results

Specific Fuel Consumption (SFC), Fuel Consumption (FC), Exhaust Gas Temperature, Mechanical Efficiency (ME%), Brake Thermal Efficiency (BTHE%) and Volumetric Efficiency effective efficiency of the engine according to the operation load, for all the test fuels are presented and analyzed in this section, as the performance parameters.

Analysis for Mechanical Efficiency

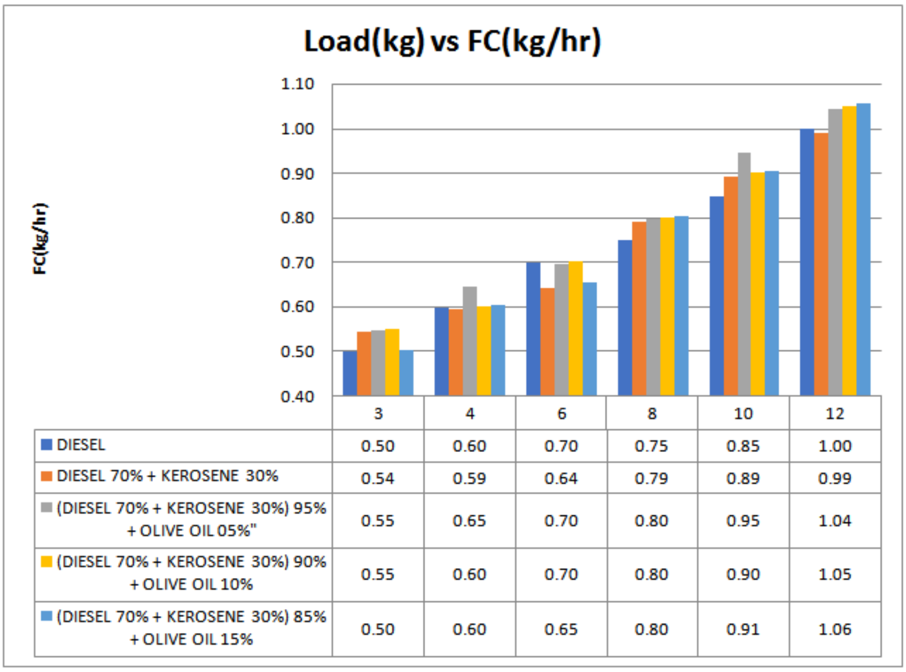


	3	4	6	8	10	12
🟦 Diesel	30.22	41.68	52.00	58.75	63.05	67.18
🟧 Diesel 70% + Kerosene 30%	22.20	34.00	42.64	49.39	55.31	59.14
⬜ (DIESEL 70% + KEROSENE 30%) 95% + OLIVE OIL 05%"	24.15	35.51	44.39	51.88	57.03	60.31
🟨 (DIESEL 70% + KEROSENE 30%) 90% + OLIVE OIL 10%	25.28	35.23	45.14	52.12	57.39	61.46
🟦 (DIESEL 70% + KEROSENE 30%) 85% + OLIVE OIL 15%	26.04	39.79	49.00	56.25	61.45	65.26

Figure 2: Load (kg) Vs ME %

- Mechanical efficiency vs Load graph for various blends is shown in figure 2.
- For all load conditions DK85O15 blend gives better result for Mechanical efficiency, which is less than Mechanical Efficiency when fueled with D100 but greater than rest of the blends.

Analysis for Fuel Consumption

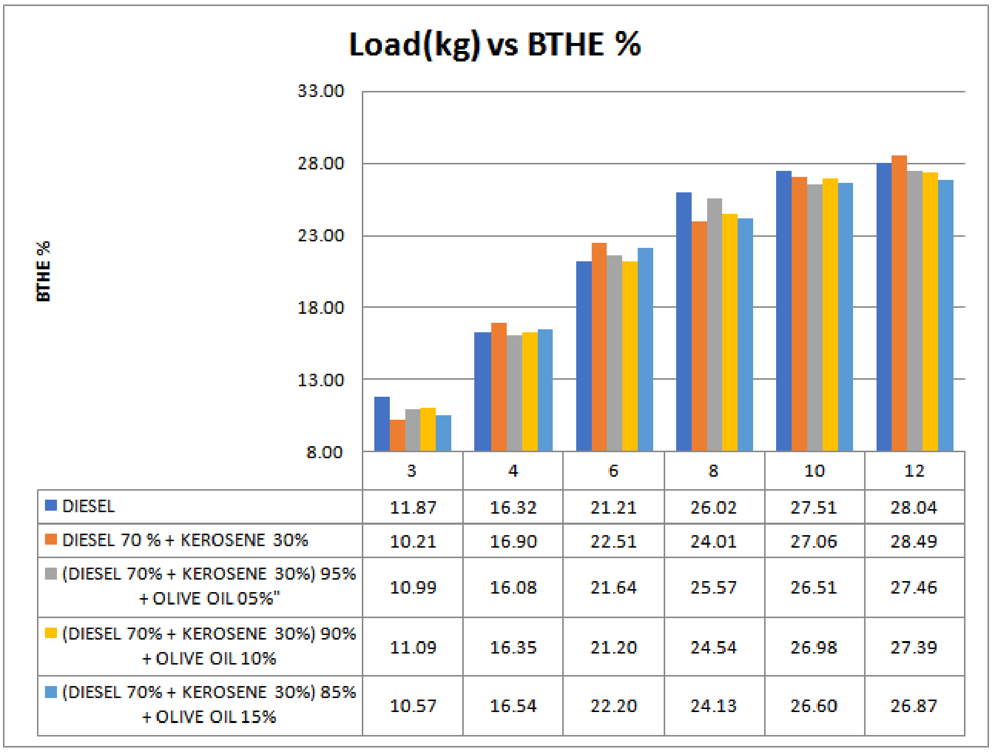


	3	4	6	8	10	12
■ DIESEL	0.50	0.60	0.70	0.75	0.85	1.00
■ DIESEL 70% + KEROSENE 30%	0.54	0.59	0.64	0.79	0.89	0.99
■ (DIESEL 70% + KEROSENE 30%) 95% + OLIVE OIL 05%"	0.55	0.65	0.70	0.80	0.95	1.04
■ (DIESEL 70% + KEROSENE 30%) 90% + OLIVE OIL 10%	0.55	0.60	0.70	0.80	0.90	1.05
■ (DIESEL 70% + KEROSENE 30%) 85% + OLIVE OIL 15%	0.50	0.60	0.65	0.80	0.91	1.06

Figure 3: Load (kg) Vs FC (kg/hr)

- ➢ Fuel consumption vs Load graph for various blends is shown in figure 3.
- ➢ For 2kg load conditions D100 and DK85O15 blends gives good result for Fuel Consumption. It is less than Fuel Consumption when fueled with DK, DK95O5 and DK90O10 blends.
- ➢ For 6kg load conditions DK and DK85O15 blends gives good result for Fuel Consumption. It is less than Fuel Consumption when fueled with D100, DK95O5 and DK90O10 blends.
- ➢ For 12kg load conditions DK blend gives good result for Fuel Consumption. It is less than Fuel Consumption when fueled with D100, DK95O5, DK90O10 and DK85O15 blends.

Analysis for Brake Thermal Efficiency

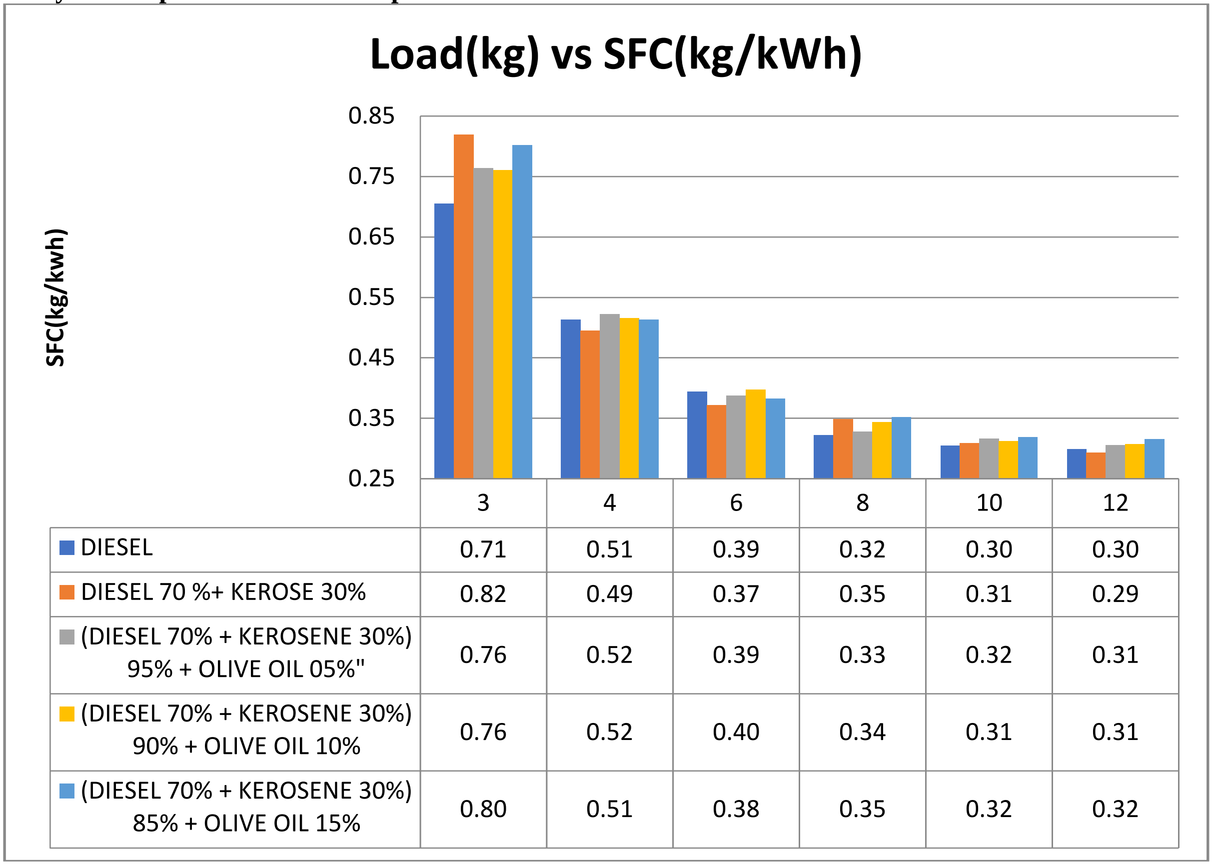


	3	4	6	8	10	12
■ DIESEL	11.87	16.32	21.21	26.02	27.51	28.04
■ DIESEL 70 % + KEROSENE 30%	10.21	16.90	22.51	24.01	27.06	28.49
■ (DIESEL 70% + KEROSENE 30%) 95% + OLIVE OIL 05%"	10.99	16.08	21.64	25.57	26.51	27.46
■ (DIESEL 70% + KEROSENE 30%) 90% + OLIVE OIL 10%	11.09	16.35	21.20	24.54	26.98	27.39
■ (DIESEL 70% + KEROSENE 30%) 85% + OLIVE OIL 15%	10.57	16.54	22.20	24.13	26.60	26.87

Figure 4: Load (kg) Vs BTHE %

- Brake thermal efficiency vs Load graph for various blends is shown in figure 4.
- For 3kg load conditions DK blend gives better result for Brake Thermal Efficiency. It is less than Brake Thermal Efficiency when fueled with D100, DK95O5, DK90O10 and DK85O15 blends.
- For 6kg load conditions DK blend gives good result for Brake Thermal Efficiency. It is less than Brake Thermal Efficiency when fueled with D100, DK95O5, DK90O10 and DK85O15 blends.
- For 12kg load conditions DK85015 blend gives better result for Brake Thermal Efficiency. It is less than Brake Thermal Efficiency when fueled with D100, DK, DK95O5 and DK90O10 blends.

Analysis for Specific Fuel Consumption

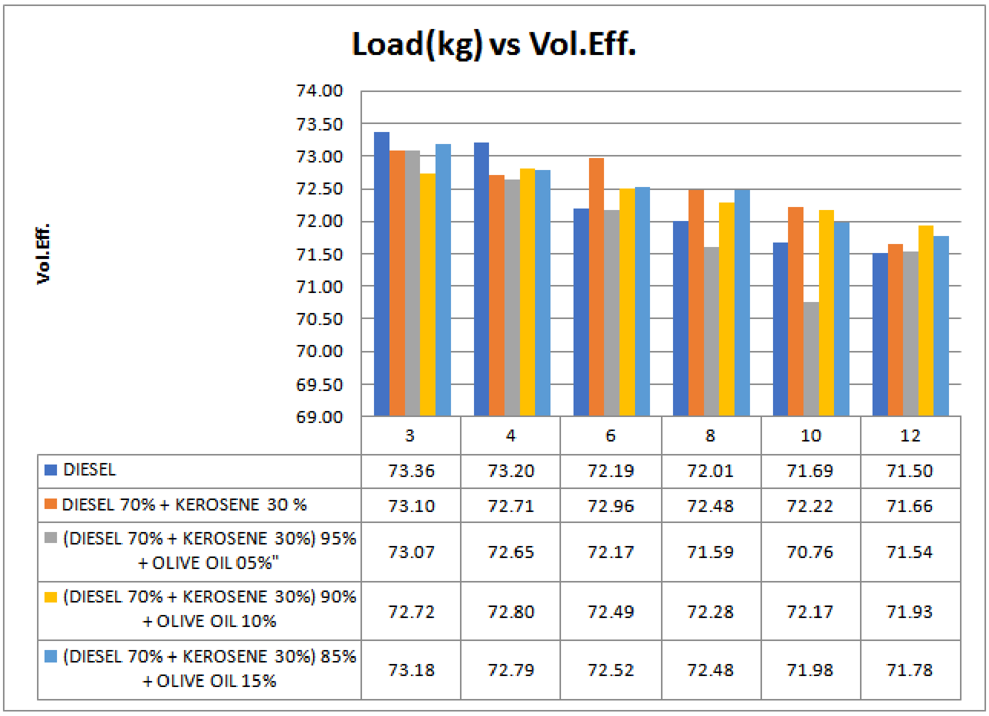


	3	4	6	8	10	12
🟦 DIESEL	0.71	0.51	0.39	0.32	0.30	0.30
🟧 DIESEL 70 %+ KEROSE 30%	0.82	0.49	0.37	0.35	0.31	0.29
⬜ (DIESEL 70% + KEROSENE 30%) 95% + OLIVE OIL 05%"	0.76	0.52	0.39	0.33	0.32	0.31
🟨 (DIESEL 70% + KEROSENE 30%) 90% + OLIVE OIL 10%	0.76	0.52	0.40	0.34	0.31	0.31
🟦 (DIESEL 70% + KEROSENE 30%) 85% + OLIVE OIL 15%	0.80	0.51	0.38	0.35	0.32	0.32

Figure 5: Load (kg) Vs SFC (kg/kWh)

- Specific fuel consumption vs Load graph for various blends is shown in figure 5.
- For 2kg load conditions D100 blend gives better result for Specific Fuel Consumption. It is less than Specific Fuel Consumption when fueled with DK, DK95O5, DK90O10 and DK90O10 blends.
- For 6kg load conditions DK blend gives better result for Specific Fuel Consumption. It is less than Specific Fuel Consumption when fueled with D100, DK95O5, DK90O10 and DK90O10 blends.
- For 6kg load conditions DK blend gives good result for Specific Fuel Consumption. It is less than Specific Fuel Consumption when fueled with D100, DK95O5, DK90O10 and DK90O10 blends.

Analysis for Volumetric Efficiency

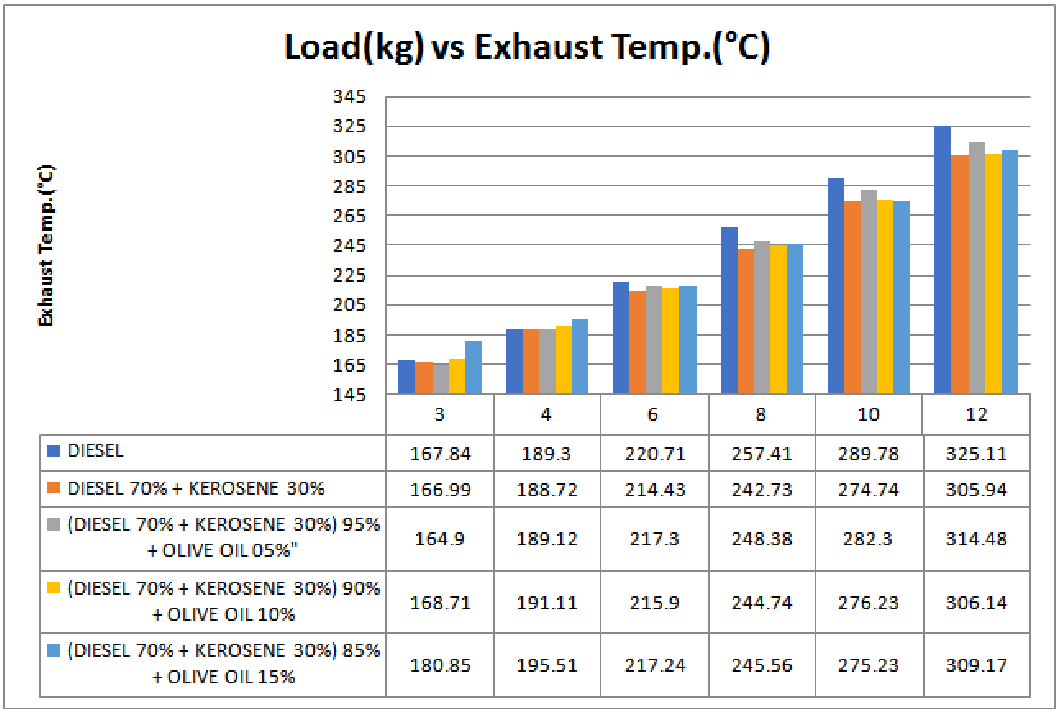


	3	4	6	8	10	12
DIESEL	73.36	73.20	72.19	72.01	71.69	71.50
DIESEL 70% + KEROSENE 30 %	73.10	72.71	72.96	72.48	72.22	71.66
(DIESEL 70% + KEROSENE 30%) 95% + OLIVE OIL 05%"	73.07	72.65	72.17	71.59	70.76	71.54
(DIESEL 70% + KEROSENE 30%) 90% + OLIVE OIL 10%	72.72	72.80	72.49	72.28	72.17	71.93
(DIESEL 70% + KEROSENE 30%) 85% + OLIVE OIL 15%	73.18	72.79	72.52	72.48	71.98	71.78

Figure 6: Load (kg) Vs Vol.Eff.

- Volumetric efficiency vs Load graph for various blends is shown in figure 6.
- For 3kg load conditions D100 blend gives good result for Volumetric Efficiency. It is greater than Specific Fuel Consumption when fueled with DK, DK95O5, DK90O10 and DK90O10 blends.
- For 6kg load conditions DK blend gives good result for Volumetric Efficiency. It is greater than Specific Fuel Consumption when fueled with D100, DK95O5, DK90O10 and DK90O10 blends.
- For 12kg load conditions DK90O10 blend gives good result for Volumetric Efficiency. It is greater than Specific Fuel Consumption when fueled with D100, DK, DK95O5 and DK90O15 blends.

Analysis for Exhaust Gas Temperature



	3	4	6	8	10	12
DIESEL	167.84	189.3	220.71	257.41	289.78	325.11
DIESEL 70% + KEROSENE 30%	166.99	188.72	214.43	242.73	274.74	305.94
(DIESEL 70% + KEROSENE 30%) 95% + OLIVE OIL 05%"	164.9	189.12	217.3	248.38	282.3	314.48
(DIESEL 70% + KEROSENE 30%) 90% + OLIVE OIL 10%	168.71	191.11	215.9	244.74	276.23	306.14
(DIESEL 70% + KEROSENE 30%) 85% + OLIVE OIL 15%	180.85	195.51	217.24	245.56	275.23	309.17

Figure 7: Load (kg) Vs Exhaust Temp.(°C)

- Exhaust gas temperature vs Load graph for various blends is shown in figure 7.
- For 2kg load conditions DK90O5 blend gives better result for Exhaust Gas Temperature. It is less than Exhaust Gas Temperature when fueled with D100, DK, DK90O10 and DK90O10 blends.
- For 6kg load conditions DK blend gives better result for Exhaust Gas Temperature. It is less than Exhaust Gas Temperature when fueled with D100, DK95O5, DK90O10 and DK90O10 blends.
- For 12kg load conditions DK blend gives better result for Exhaust Gas Temperature. It is less than Exhaust Gas Temperature when fueled with D100, DK95O5, DK90O10 and DK90O10 blends.

IV. Conclusions

In the present study, Olive Oil was blended with Diesel 70% +Kerosene 30% by percentages of (Diesel 70% + Kerosene 30%) 95% + Olive Oil 05%, (Diesel 70% + Kerosene 30%) 90% + Olive Oil 10% and (Diesel 70% + Kerosene 30%) 85% + Olive Oil 15%. The effects these blends on performance indicators in a Diesel engine. Lamp oil expansion to edible consumable cooking oil can be considered as a decent answer for decreasing thickness, consistency and in this manner improved convenience of edible consumable cooking oil energizes its activity in Diesel motors. In the long run, while considering its improved performance results.

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Masi Mohmad Jilani. “Performance Analysis of Single Cylinder CI Engine Fueled with Diesel, Kerosene and Olive Oil Blends.” IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), vol. 16, no. 6, 2019, pp. 26-33.