Experimental investigation on performance and emission characteristics of CI engine fuelled with linseed oil and Ethyl-Tert-Butyl-Ether (ETBE) as additive

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Abstract. Increment in vitality exaction, serious outflow gauges, and consumption of the oil resources prompted chase for elective powers for traditional CI Engines. The examination prompts the exhibition and outflow attributes of CI engine fuelled with linseed oil and diesel is blended inside the mixing proportion B20, B40, B60, B80 with 5% ETBE. The Examination was controlled inside the four stroke single chamber diesel by changing the heap from 20% to 80%. The outcomes delineate that expansion of linseed oil increases the Brake thermal efficiency (BTE) with decrease in Brake Specific Fuel consumption (BSFC) and Temperature of Fumes Gas. Higher concentration of linseed oil within the blends also reduces the emission parameter but with an increment in the Hydro Carbon discharge. The expansion of ETBE in mix with diesel fuel has comparative impact thereto of expansion of unadulterated linseed oil in shifting extents, that increases the brake thermal efficiency with decrease in specific fuel utilization and fumes gas temperature, the impact on the emission characteristics by expansion of lamp oil brings about a lower CO, CO$_2$, NOx and Smoke with an increase inside the HC discharge. The powerful blending of linseed oil and diesel yield agreeable outcome on the ignition qualities at lower load which shows signs of improvement on increasing the heap.

1. Introduction
In an era of Electrical mobility the C engines find its place during a dark space. The generation transmission and distribution of the electricity has always been a drag. The diesel engines comes into the mage again but with the higher efficiency and with an approach of other fuels. A considerable reason s provided by the depleting fossil fuels for the utilization of biodiesel and aims to a supply less emission. An attempt was made by Koli et al.[1] illustrated that Performance framework of the mixed oil (mustard and Palm oil mixture) and diesel at the same blending conditions BB 10 blend and BB 20 blend gave better BTE, and lower fuel consumption as compared to other blends with higher mixed oil concentration BB 30, BB 40 and BB 50.

S. Bajpai et al.[2] performed the Karanja SVO tests mixed with diesel and concluded that the so formed Bio-diesel with 10% pure karanja SVO is always accepted as a no-gasoline with a 4% reduction in NOx emissions of KVO10. They further announced that on warming up the viscosity of the karanja SVO at 900C, it was seen as at the edge of Bio-diesel and decreased EGT. Reddy et al[3] indicated that altering
injection time of single cylinder, DI diesel improved performance parameters and emission characteristics using Jatropha Oil. The average emissions were even lower than that of petrolodiesel. Comparable perceptions were made by Devan et al [4], while testing unadulterated raw petroleum (Sterculiafoetida) mixed with diesel that at full burden, 32% decrease in NOx emission from SVO and a 4% decrease in its 20% mix. CO emission from unrefined petroleum and its refining were higher with the exception of the 20% where it diminished by 12%. They watched an expansion in Hydro Carbon discharges by 18% in crude petroleum, while 14% decreases in 20% mix. Montague conducted research on the use of rapeseed biodiesel in conventional diesel engines. The 50% rapeseed oil blend resulted in increase of volumetric efficiency around 0.4%. Investigators used different additives in gasoline and diesel to improve fuel efficiency, the expansion of alcoholic fuel to oil has been progressively appreciative for the specific preferred position of combustion and less emissions. Oxygen compounds such as ethanol, propanol, butanol and i-pentanol improve the performance of the barriers and reduce the emissions. Petrolineethanol mixes with supplements such as cyclooctanol, cycloheptanol incremented brake efficiency compared to petrol and CO, CO\textsubscript{2} and NOx while HC and O2 incremented equally.

2. Methodology
A normally suctioned 4 stroke direct injection diesel (kirloskar) with a eddy current dynamometer is benefited inside the examination with a preset estimation of 1500 rpm. The test was directed for five loads 0 kg, 4.1 kg, 9.1 kg and 18.5 kg consecutively. Refer table 1 for engine specification. The engine is provided with various pressures, temperature, and crank angle sensors for continuous and serial operation. The engines including the dynamometer which is further connected to the panel box. To live the crank angle displacement dynamometer is feed with crank angle sensor (by Kubler-germany) with the range of 360°. Load (by Sensotronics SanmarLtd) and speed sensor are attached to the dynamometer with an upper limit of fifty kg and 100Hz respectively (Refer Table 1). The engine inlet and outlet contains temperature sensor to offer data for exhaust gas temperature, the temperature sensor is the K type thermocouple and assisted with the pressure sensor which is piezo type (by PCB Piezotronics) with the max pressure of 5000 psi. The figure 1 shows the engine layout and therefore, the process layout. Table 1: Engine specifications

![Engine layout](image)

Figure 1. Engine layout.

The emission esteems were gotten utilizing an AVL DiGas 444 analyser which gives the discharge investigation of 5 gases to be specific Carbon Monoxide, Carbon Dioxide, Nitrogen Dioxide, Hydro
Carbon and smoke. The analyser is an in pipe type and uses three sorts of channel which are line channel, tube channel and paper channel. The engine is at first wrenched for 10-15 minutes fuelled with the diesel at that point followed by blends. The mixes so performed are B20, B40, B60, B80, B20 ETBE5%, B40 ETBE5%, B60 ETBE5%, and B80 ETBE5%. With a whole perusing the speedometer the engine was tried with various stacking conditions, i.e. 0 kg, 4.5kg, 9.1kg, 13.6kg and 18.1kg and following properties are being written down like showing mean effective pressure, brake mean effective pressure, brake thermal efficiency, specific fuel consumption, exhaust gas temperature, and total fuel consumption.

Table 1. Engine specifications.

| ENGINE Specifications          |   |
|-------------------------------|---|
| Engine power                  | 5.2 kW at the rate of 1500 rpm |
| Cylinder bore - Stroke length - Connecting rod length | 87.5 mm x 110 mm x 234 mm |
| Type of compression ratio and cooling type | FCR7& water cooled |
| Dynamometer                   | Eddy current dynamometer |
| Engine Capacity               | 661 CC |

Table 2. Properties of oil and its blends.

| Fuel Properties | Diesel | Lin-Seed Oil | ETBE |
|-----------------|--------|--------------|------|
| Density (kg/m³) | 850    | 931          | 730  |
| Calorific Value (MJ/kg) | 42.5 | 39.3 | 36.2 |
| Kinematic Viscosity (mm²/s) | 2.6 | 26-30 | 5.24 |
| Flash Point (°C) | 65     | 204          | -27  |
| Fire Point (°C)  | 75     | 264          | 30   |

3. Results and Discussion

3.1. Performance Characteristics

3.1.1. Brake Thermal Efficiency. The chart is against the brake thermal efficiency and load for a steady speed. BTE is inversely proportional to C, Hence with increase in CV BTE decreases. It was seen that the
BTE of the blend B20 is most minimal then B60. Likewise on higher convergence of the Linseed oil, the BTE esteems are low.

![BTE vs Load](image)

**Figure 2.** BTE vs Load.

A similar pattern is seen on expansion of added substance (here ETBE) which lessens the BTE estimation of the blend when contrasted with non ETBE blends. It is a direct result of the lessened calorific estimation of the mixes.

3.1.2. Brake Specific Fuel Consumption. The plot is among SFC and load. The utilization of fuel was determined by estimating the volume flow rate and density, which is only same engine power, relies on the mass flow rate. Additionally it very well may be obviously delineated that as the load increment the estimation of BSFC diminishes which show reverse pattern of the BTE v/s load diagram and reasoned that BTE is contrarily relative to BSFC.

![SFC vs Load](image)

**Figure 3.** SFC vs Load.

3.2. Emission Characteristics

3.2.1. Carbon Dioxide. The above diagram has a decent trademark bend which tops at 8-12kg load and jotted that B40 + 5%,B80 + 5% has consistently been at the highest point of the bend and B60+ 5% at the base. The figure shows the impact of expansion of the ETBE at various loads.
Figure 4. CO₂ vs Load.

The chart clarifies and finishes up the impacts based on average values which show that the measure of CO₂ lessens as the measure of Linseed oil increments in the blend which is additionally responding on account of option of ETBE, along these lines decreasing the measure of CO₂ in the fumes. B80, B40+5%ETBE and B80+5%ETBE shows significant level of carbon dioxide discharge in 8kg and 12kg loads. CO₂ level is less in low and high loads.

3.2.2. Carbon Monoxide. It is reviewed that CO emission increments as the centralization of ETBE increments in the blends that adds up to higher oxygen content in the blends with ETBE which moves in the CO emission and formation. Carbon monoxide level is more in low load as shown in the plot.

Figure 5. CO vs Load.

Carbon monoxide level is high in 4kg at all blending. The figure shows that carbon monoxide level is more than other emission gases particularly in B20+5%ETBE. As per the plot carbon monoxide level is high in B20+5%ETBE at all load (4 to 16kg). Further carbon monoxide level is low in B60+5%ISO at all load (4 to 16kg).

3.2.3. Hydro Carbon. The graph is of Hydro Carbon against the load. The bends in this diagram are arbitrary and don't depict a particular pattern as for the expansion of ETBE. Here the values of HC are lower for B20 blend which shows that the HC have been burnt and converted to CO. The fundamental purpose behind the higher estimations of Hydro Carbon in the fumes is the lofty visidity of the mixes.
Hydro carbon level is more in all loads except high as per figure the hydro carbon level is low in 16kg at all blending. Particularly hydro carbon level is low in B20+5%ETBE at all load (4 to 16kg).

![HC vs Load](image)

**Figure 6. HC vs Load.**

3.2.4. Oxides of Nitrogen. The chart shows the attributes of the run of the mill NOx bend which is expanding with load and in this manner the temp in the chamber builds, this make extra NOx. In any case, the estimation of NOx decreases at higher loads.

![NOx vs Load](image)

**Figure 7. NOx vs Load.**

It is observed that nitrogen oxide level is more than the other emission gases particularly in B40, B80 and B60+5%ETBE at 8kg and at 12kg it shows that nitrogen oxide level is more than the other emission gases particularly in B40, B20 and B20+5%ETBE.

4. Conclusion

The BTE was found higher for the blended fuel because of the higher calorific value and higher fuel oxygen content with commenting in the increment in the exhaust gas temperature with result of higher BSFC. Addition of the ETBE in the blended fuel produces more CO emissions and lower Nox and Hc emissions.
5. References

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