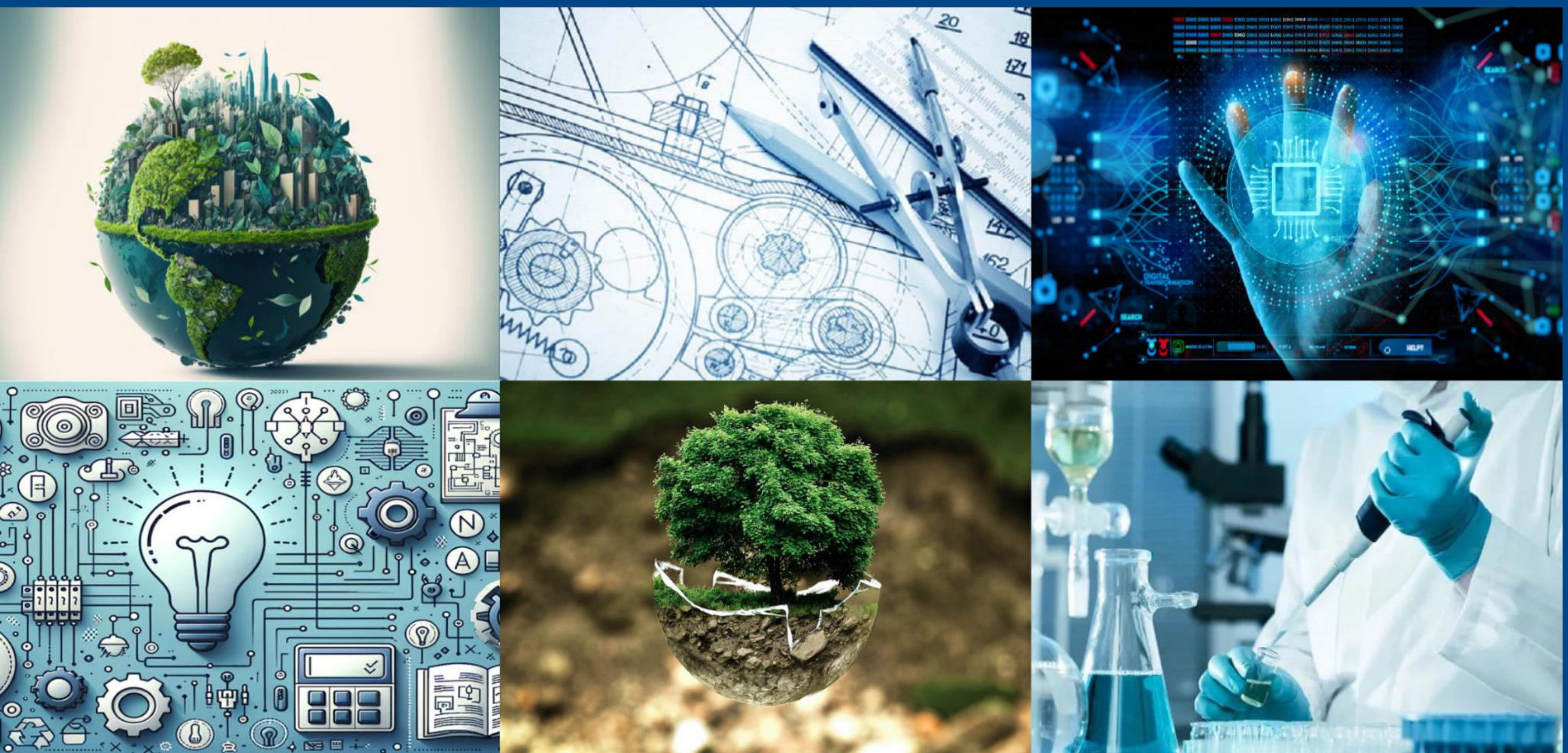
ISSN: 2582-7219

International Journal of Multidisciplinary Research in Science, Engineering and Technology

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)



Impact Factor: 8.206

Volume 9, Issue 4, April 2026

ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 8.206| ESTD Year: 2018|

International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

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Analysis of Di-Ethyl Ether Mixed Thevetia Peruviana Seed Oil in I.C. Engines

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ABSTRACT: The increasing demand for alternative fuels has encouraged the exploration of non-edible oils such as Thevetia peruviana seed oil for diesel engine applications. However, its high viscosity and poor volatility restrict its direct use in compression ignition engines. This study investigates the effect of blending **diethyl ether (DEE)** with Thevetia peruviana seed oil on engine performance, combustion, and emission characteristics. The addition of DEE enhances fuel atomization, reduces ignition delay, and improves brake thermal efficiency. Experimental results indicate a significant reduction in carbon monoxide (CO) and hydrocarbon (HC) emissions, while nitrogen oxides (NOx) emissions show a slight increase. The findings suggest that DEE-blended Thevetia peruviana oil can serve as a viable alternative fuel for conventional diesel engines.Keywords — Di-ethyl ether, Thevetia peruviana, biodiesel, I.C. engine, performance, emissions.

I. INTRODUCTION

Historically, any change in the prime energy source of a society has resulted in a revolution in the life style. Thus domestication of animals and resulting easy availability of draft animal power played a key role in transition from hunter- gatherer society, where human muscle power was the only source of energy to the agricultural society. Before the industrial revolution, which began around 200 years ago, people were essentially dependent on manual and animal labour. Energy requirements were met through food intake. Life was simple and unsophisticated, and the environment was relatively clean and pollution free. Then in 1785, the invention of steam engine by James Watt of Scotland brought industrial revolution. It was the beginning of the mechanical age or the age of machines. The advent of internal combustion engine in the late nineteenth century gave further momentum to the tread. Gradually industrial revolution spread to the whole world and the need for huge quantity of energy realized.

II. RELATED WORK

Deepak Agarwal et., (2006) have made investigation of control of NO_X emissions in biodiesel-fueled compression ignition engine and reported that simultaneous reduction of NOx and Smoke emission can be possible only when engine run with biodiesel along with EGR system.

III. METHODOLOGY

Transesterification

To reduce the viscosity of the vegetable oil, transesterification method is adopted. The procedure involved in this method is as follows: Sodium hydroxide is added to methanol and stirred until properly dissolved. The solution thus prepared is called methoxide which is added to vegetable oil and stirred at a constant rate at 60^0C for one hour. After the reaction is over, the solution is allowed to settle for 20-24 hours in a separating flask. The glycerin settles at the bottom and the methyl ester floats at the top (coarse biodiesel). Coarse biodiesel is separated from the glycerin and it is heated above 100^0C and maintained for 10-15 minutes for removing the untreated methanol.

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ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 8.206| ESTD Year: 2018|
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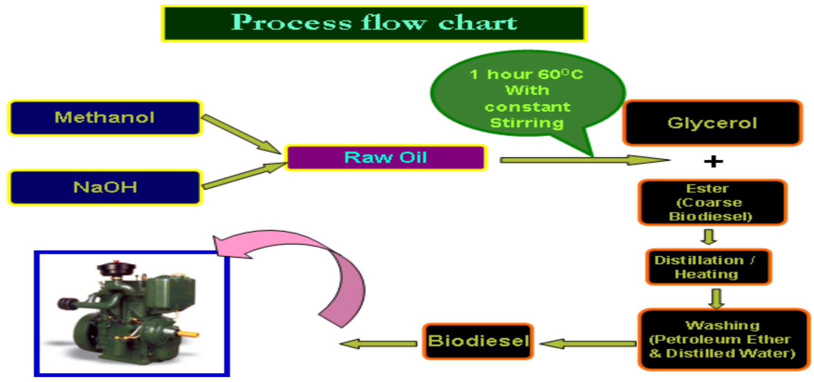

Fig 1 Transesterification

Fuel Preparation
Thevetia peruviana seed oil is typically converted into biodiesel via transesterification. The resulting fuel still exhibits higher viscosity compared to diesel.
Di-Ethyl Ether possesses the following properties:

- High cetane number
- Low viscosity
- High volatility
- Oxygenated nature

Fuel blends are prepared by mixing biodiesel with DEE in varying proportions such as 5%, 10%, 15%, and 20%.

IV. EXPERIMENTAL SETUP

A 3.5 kW, 1500 rpm, Kirloskar diesel engine is used in this investigation as shown in Figure 1. The detailed specification is given in Table 1. Two separate fuel tanks with a fuel switching system are used, one for diesel (D100) and the other for biodiesel (B100).

Fuel consumption is measured using optical sensor. A differential pressure transducer is used to measure airflow rate. Engine is coupled with an eddy current dynamometer to control engine torque through computer. Engine speed and load are controlled by varying excitation current to eddy current dynamometer using dynamometer controller.

A piezoelectric pressure transducer is installed in engine cylinder head to measure combustion pressure. Signals from pressure transducer are fed to charge amplifier. A high precision crank angle encoder is used to give signals for top dead centre and crank angle. The signals from charge amplifier and crank angle encoder are supplied to data acquisition system.An AVL exhaust gas analyzer and AVL smoke meter are used to measure emission parameters and smoke intensity respectively. Thermocouples (chrommel alumel) are used to measure exhaust temperature, coolant temperature, and inlet air temperature.

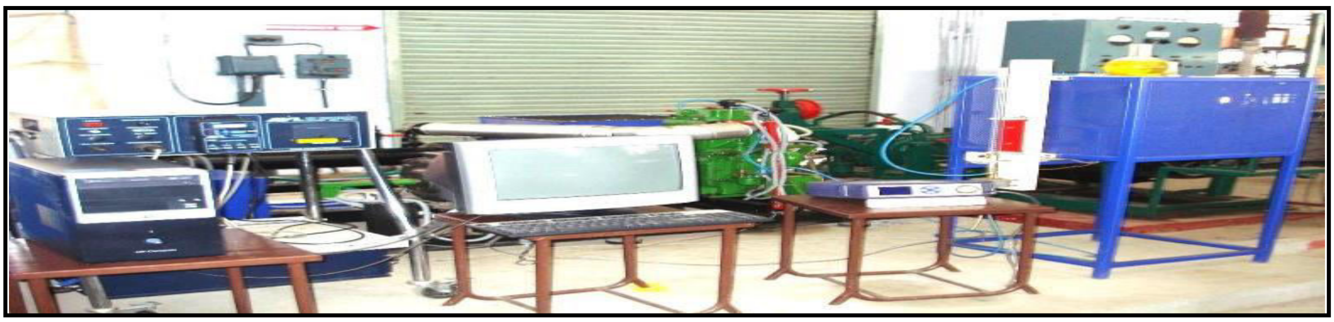

Fig.2 Photographic view of the experimental setup

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V. RESULTS

Performance and combustion characteristics were investigated on a CI engine fuelled with blends of di-ethyl ether TPSO and diesel. An effort has been put to study the effect of combustion characteristics of the CI engine fuelled with 20% TPSO blended with diesel.

Performance and combustion characteristics of compression ignition engine using bio diesel as fuel at different blending rates analysed. To control the emission rates such as NOx and smoke bio diesel is oxygenated using Di-Ethyl Ether or peroxide.The CI engine is tested using the following bio diesel blends and diesel

- D100 – Pure diesel (Petro diesel)
- B20 – 20% bio diesel
- B40 - 40% bio diesel
- B60 - 60% bio diesel
- B80 - 80% bio diesel
- B100 --- 100% bio diesel

The following observations were taken while testing the CI Engine using Bio diesel with different blending rates.

1. Brake Thermal Efficiency Vs Brake Power

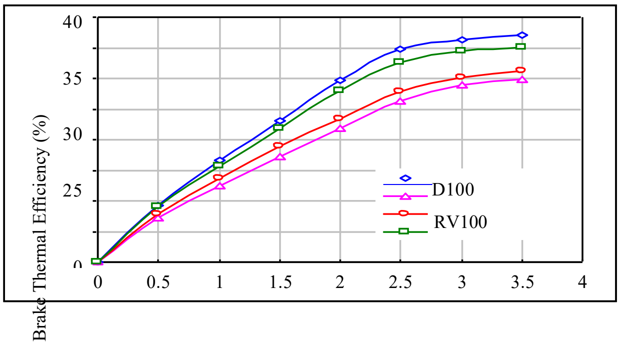

Fig.3 Variation of Brake Thermal Efficiency with Brake Power

When DEE is mixed with B100, it evaporates quickly, mixes easily with air and forms a homogeneous mixture, and results in combustion, creating a hotter environment to assist the combustion of TPSO, which leads to higher thermal efficiency.

2. Brake specific fuel consumption Vs BSFC

The variation of the bsfc with the brake power is shown in Figure 7.2. The bsfc of TPSO is higher than those of TPSO with DEE and diesel. The bsfc at full load in TPSO is 1.25 Kg/ (kW h), compared to that of TPSO with DEE of 1.01 Kg/ (kWh) and that of diesel of 0.91 Kg/ (kW h).

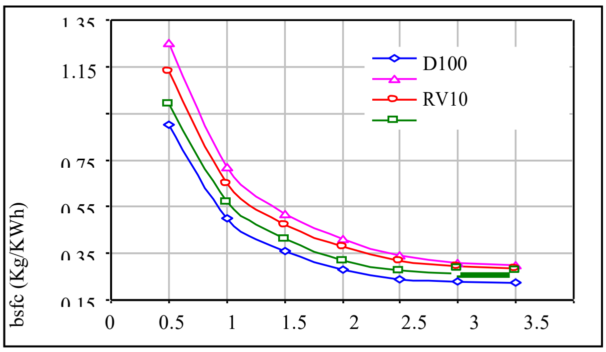

Fig.4 Brake Power Vs BSFC

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3. Brake Power Vs Volumetric efficiency

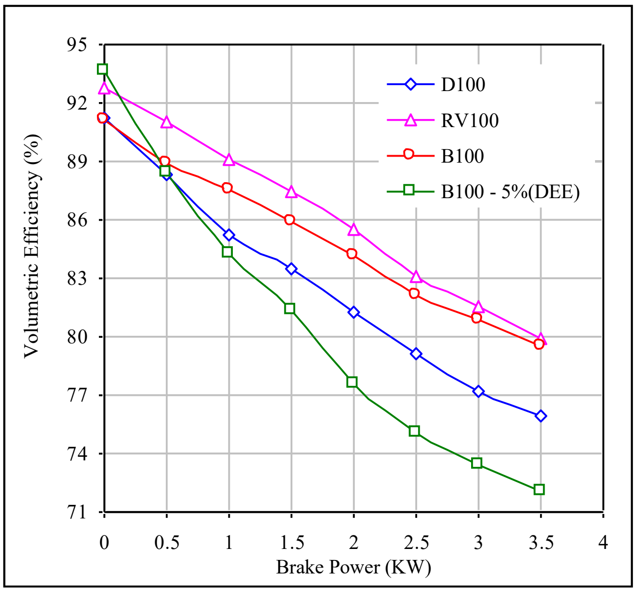

Fig.5 Brake Power Vs Volumetric efficiency

4. Brake Power Vs Exhaust Gas Temperature

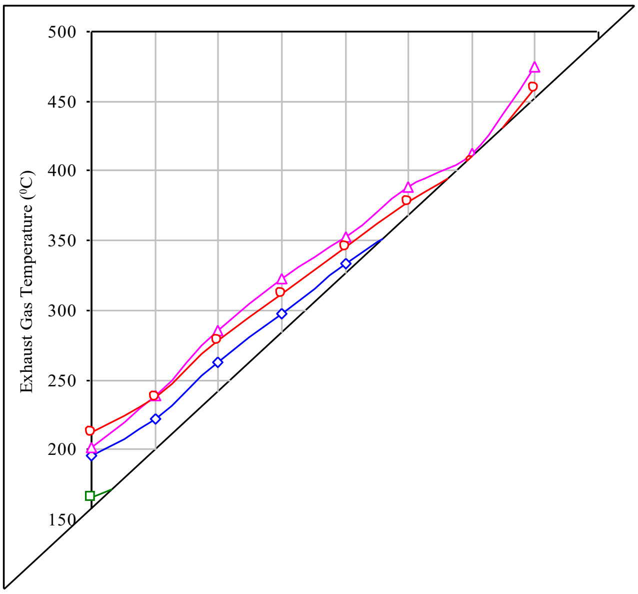

Fig 6. Brake Power Vs Exhaust Gas Temperature

5. Brake Power Vs Smoke Intensity

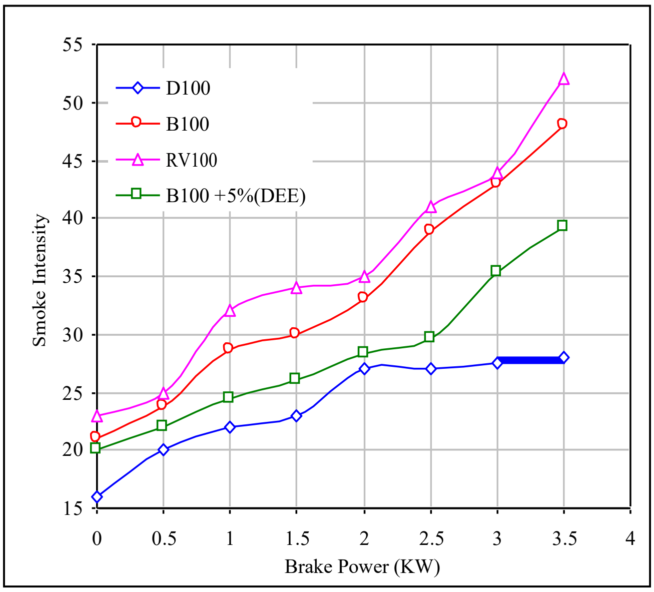

Fig.7 Brake Power Vs Smoke Intensity

The variation of the smoke density with the brake power. The maximum smoke emission is 52.5 BSU (Bosch smoke units) with neat TPSO and 47.2 BSU with diesel at the maximum power output

6. Brake Power Vs Carbon monoxide

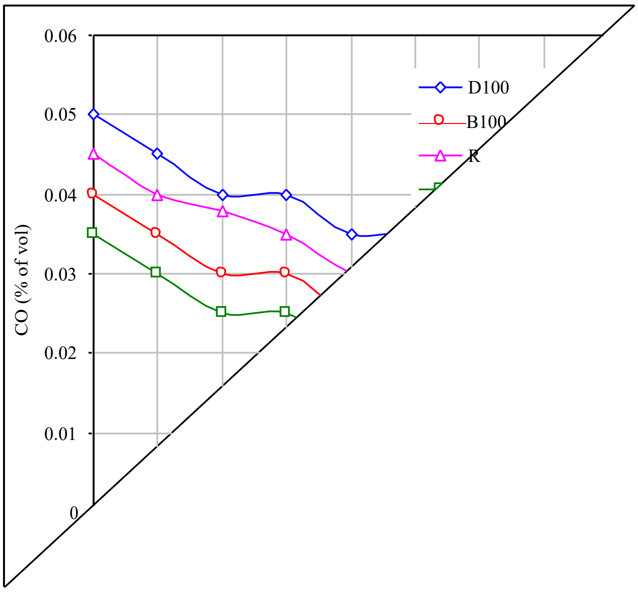

Fig 8.Brake Power Vs Carbon monoxide

7. Brake Power Vs Hydrocarbon

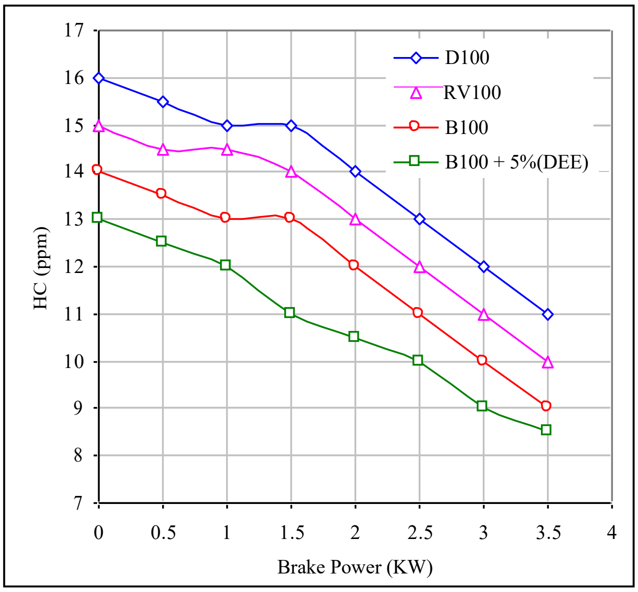

Fig.9.Brake Power Vs Hydrocarbon

The HC emission at full load for TPSO, TPSO with DEE and diesel is 15, 13, and 16 ppm, respectively. The reduction in HC emission is due to the early injection of DEE that makes the mixture (air and DEE) homogeneous before the injection of TPSO. The ignition improver (DEE) forms a number of ignition centers in the combustion chamber, which results in complete combustion.

8. Brake Power Vs Nitrous Oxides

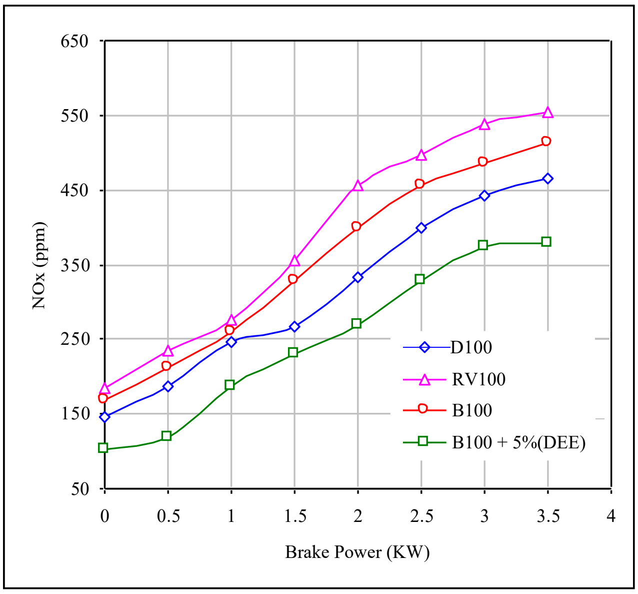

Fig.10 Brake Power Vs Nitrous Oxides

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9. Variation of Maximum Cylinder Pressure with Brake Power

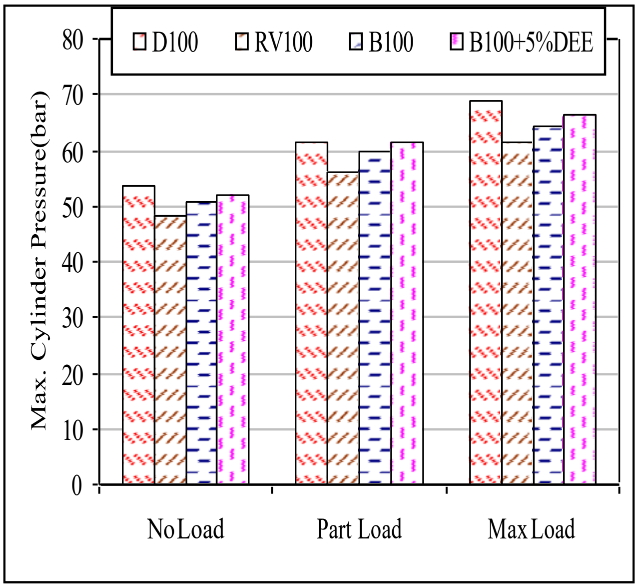

Fig.11 Variation of Maximum Cylinder Pressure with Brake Power

Fig.10 shows the comparison of maximum pressure for RV100, B100, B100+5%DEE and D100 with different loading conditions.

10 Variation of Maximum Cylinder Pressure with Crank Angle at Full Load

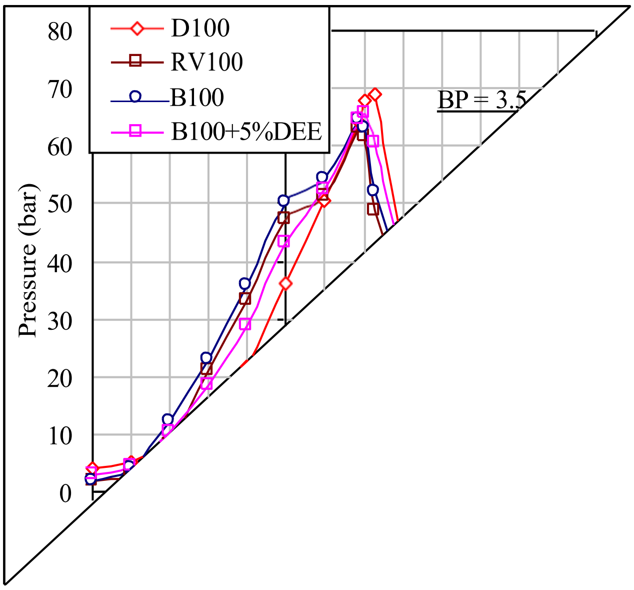

Fig.12 Variation of Maximum Cylinder Pressure with Crank Angle at Full Load

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11. Variation of Instantaneous Heat Release with Crank Angle at Full Load

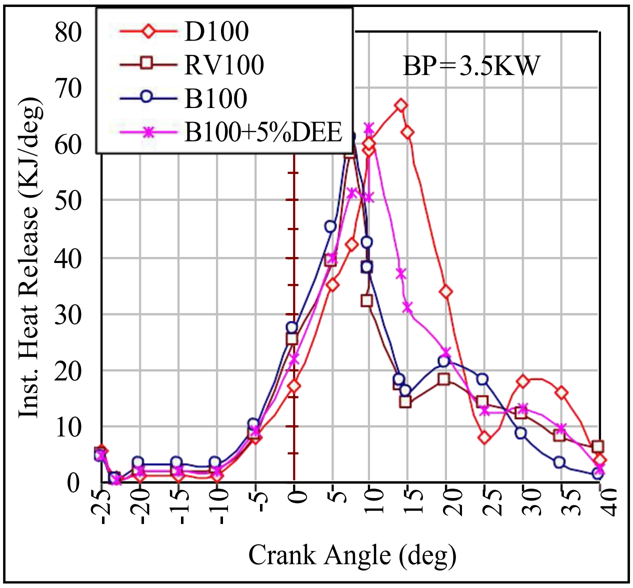

Fig.13 Variation of Instantaneous Heat Release with Crank Angle at Full Load

Good atomization and evaporation of DEE promotes rapid mixing of DEE with the surrounding air, and excessive oxygen in the combustion chamber during the combustion period increases the rate of combustion

VI. CONCLUSION

A single-cylinder compression ignition engine was operated successfully on neat TPSO and TPSO with DEE injection. The following conclusions are drawn on the basis of the experimental results at 3.5 kW load:

- Mixing of 5%DEE with TPSO increases the brake thermal efficiency. The brake thermal efficiency is 34.9% with 5% of DEE, with neat TPSO it is 28.2%, and with diesel it is 37.5%.
- A significant reduction in the smoke emission of an engine fueled with TPSO-DEE from 52.5 BSU with neat TPSOto 39.7 BSU with DEE was noticed. The reduction in smoke emission is due to better combustion of injected fuel in the hotter combustion chamber by the early-burning DEE.
- With DEE mixing, the HC reduction is 13.3% compared to that of neat TPSO. Also the CO level for DEE operation is 0.019% with the optimum quantity of DEE, which is 13.6% lower than that of neat TPSO.
- NO_X emission increased from 450 ppm with TPSO to 360 ppm in the case of DEE. This is mainly due to the high premixed heat release with DEE.
- Maximum pressure of B100+5%DEE is higher which just 3.4% is lower than that of D100.
- B100+5%DEE fuel exhibits higher heat release among the other biofuels.
- Maximum values of rate of pressure rise are 4.13, 4.28 and 4.415 bar/deg for RV100, B100 and B100+5%DEE; but incase of diesel the value is 4.55 bar/deg.
- With B100+5%DEE, a shorter ignition delay is observed as compared to that of B100 operation.
- All biofuels had highest value of combustion duration compared to that of diesel.

On the whole, it is concluded that DEE mixed TPSO can be used as a fuel in diesel engines because combustion characteristics on the engine was significantly

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