Optimization of esters of nerium biodiesel in a diesel engine

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Abstract
The methyl and ethyl esters of vegetable oils, known as biodiesel are becoming increasingly popular because of their low environmental impact and potential as a green alternative fuel for diesel engine. In the present work, methyl and ethyl esters of nerium oil were prepared by transesterification using both methanol and ethanol. However, viscosity of ethyl esters of nerium oil (EEON) was slightly higher than that of methyl esters of nerium oil (MEON). A single cylinder stationary kirloskar engine is used to compare the Performance and Emission and Combustion characteristics between pure diesel and nerium blends. The nerium oil blends are in percentage of 20%, 40%, 60%, 80%, and 100% of nerium oil to 80%, 60%, 40%, 20% and 0% of diesel. Results show that methyl esters of nerium oil (MEON) produced slightly higher efficiency than ethyl esters of nerium oil (EEON). Exhaust emissions and Combustion characteristics of methyl esters of nerium oil (MEON) were also higher than ethyl esters of nerium oil (EEON). Hence methyl and ethyl esters of nerium blend can be used in existing diesel engines without compromising the engine performance.

Keywords: Transesterification, methyl esters, ethyl esters, nerium oil.

Introduction
Rapid depletion of conventional energy sources, along with increasing demand for energy is a matter of serious concern. To solve both the energy concern and environmental concern, the renewable energies with lower environmental pollution impact should be necessary. Biodiesel is renewable and environmental friendly alternative diesel fuel for diesel engine.

It can be produced by transesterification process. Transesterification is a chemical reaction in which vegetable oils and animal fats are reacted with alcohol in the presence of a catalyst. The products of reaction are fatty acid alkyl ester and glycerin, and were the fatty acid alkyl esters known as biodiesel.

Materials and methods
Transesterification of nerium oil: To reduce the viscosity of the Nerium oil, trans-esterification method is adopted for the preparation of biodiesel.

Methyl ester of nerium oil: The procedure involved in this method is as follows: 1000 ml of nerium oil is taken in a three way flask. 12 grams of sodium hydroxide (NaOH) and 200 ml of methanol (CH3OH) are taken in a beaker. The sodium hydroxide (NaOH) and the alcohol are thoroughly mixed until it is properly dissolved. The solution obtained is mixed with Nerium oil in three way flask and it is stirred properly. The methoxide solution with nerium oil is heated to 60°C and it is continuously stirred at constant rate for 1 hour by stirrer. The solution is poured down to the separating beaker and is allowed to settle for 4 hours. The glycerin settles at the bottom and the methyl ester floats at the top (coarse biodiesel). Methyl ester is separated from the glycerin. This coarse biodiesel is heated above 100°C and maintained for 10-15 minutes to remove the untreated methanol. Certain impurities like sodium hydroxide (NaOH) etc are still dissolved in the obtained coarse biodiesel. These impurities are cleaned up by washing with 350 ml of water for 1000 ml of coarse biodiesel. This cleaned biodiesel is the methyl ester of nerium oil.

Ethyl ester of nerium oil: The procedure involved in this method is as follows: 1000 ml of nerium oil is taken in a three way flask. 12 grams of sodium hydroxide (NaOH) and 200 ml of Ethanol (C2H5OH) are taken in a beaker. The sodium hydroxide (NaOH) and the alcohol are thoroughly mixed until it is properly dissolved. The solution obtained is mixed with Nerium oil in three way flask and it is stirred properly. The ethoxide solution with nerium oil is heated to 60°C and it is continuously stirred at constant rate for 1 hour by stirrer. The solution is poured down to the separating beaker and is allowed to settle for 4 hours. The glycerin settles at the bottom and the ethyl ester floats at the top (coarse biodiesel). Ethyl ester is separated from the glycerin. This coarse biodiesel is heated above 100°C and maintained for 10-15 minutes to remove the untreated ethanol. Certain impurities like sodium hydroxide (NaOH) etc are still dissolved in the obtained coarse biodiesel. These impurities are cleaned up by washing with 350 ml of water for 1000 ml of coarse biodiesel. This cleaned biodiesel is the Ethyl ester of nerium oil.

This bio-diesel of methyl ester of nerium oil and ethyl ester of nerium oil was then blended with mineral diesel in various concentrations for preparing biodiesel blends to be used in CI engine for conducting various engine tests.

Experimental setup
The engine used for the investigation is kirloskar SV1, single cylinder, four stroke, constant speed, vertical, water cooled, high speed compression ignition
**Fig. 1. The experimental setup.**

1. Engine
2. Fuel injection pump
3. Fuel injection nozzle
4. Intake manifold
5. Intake air surge tank
6. Air cleaner
7. U-Tube Manometer
8. Fuel tank
9. Crank angle detector
10. Electric dynamometer
11. Exhaust manifold
12. Compression pressure transducer
13. Injector needle lift sensor
14. Dynamometer control panel
15. Exhaust gas analyzer
16. Smoke meter
17. Digital scope recorder
18. Exhaust gas temp sensor
19. EGR system
20. Exhaust pipe

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**Fig. 2.1. Variation of BTE VS BP for MEON.**

**Fig. 2.2. Variation of BTE VS BP for EEON.**

**Fig. 4.1. Variation of UBHC with BP for MEON.**

**Fig. 4.2. Variation of UBHC with BP for EEON.**

**Fig. 6.1. Variation of NOx with BP for MEON.**

**Fig. 6.2. Variation of NOx with BP for EEON.**

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diesel engine. The kirloskar engine is mounted on the
ground. The test engine was directly coupled to an eddy current dynamometer with suitable switching and control facility for loading the engine. The liquid fuel flow rate was measured on the volumetric basis using a burette and a stopwatch. AVL smoke meter was used to measure the CO and HC emissions from the engine. The NOX emission from the test engine was measured by chemical luminescent detector type NOX analyser. A SES combustion analyser was used to measure the peak pressure rise and Cumulative heat release rate. The sound from the engine was measured by Rion sound level meter. The experimental setup is shown in Fig.1.

Performance analysis

Brake thermal efficiency: methyl and ethyl esters of nerium oil (biodiesel) were used separately as the fuel for compression ignition engine without any engine modifications. The performance and emissions of the engine with diesel, blends of biodiesel and diesel, and neat biodiesel are presented and discussed below. Fig. 2.1 shows the variation of Variation of BTE vs BP for MEON blends. Fig. 2.2 shows the variation of Variation of BTE vs BP for EEON blends. The brake thermal efficiency is highest with diesel in all loads. The maximum efficiency was obtained for MEON blends. This may be due to availability of O2, which helps in complete combustion compared with EEON blends. The following conclusions are made based on the results obtained from both experimental and characteristics analysis of nerium oil are listed below.

- Nerium oil, being non-edible oil proves to be a very effective alternate fuel.
- After trans-esterification of Nerium oil, the kinematic viscosity and density is reduced while the calorific value is increased for both MEON blends and for EEON blends.
- Engine performance with biodiesel does not differ greatly from that of diesel fuel. A little power loss, combined with an increase in fuel consumption, is often encountered due to the lower calorific value of the biodiesel.
- Among the blends, methyl esters of nerium oil blends (meon) shows better performance, emission and combustion characteristics than ethyl esters of nerium oil blends (eeon).
- From the above discussions it is concluded that methyl and ethyl esters of nerium blends can be used in existing diesel engines without compromising the engine performance.

References