Journal of Chemical and Pharmaceutical Sciences ISSN: 0974-2115

EXPERIMENTAL INVESTIGATION ON COMBUSTION CHARATERISTICS OF DIESEL ENGINE WITH MAHUA OIL & DIETHYL ETHER AS ADDITIVE

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ABSTRACT

Mahua oil is considered as one of the promising fuels among the other vegetable oil can be used in diesel engine. But the problem of mahua oil is its high viscosity and density much higher than that of diesel so atomization and vaporization is too difficult. In this work mahua oil blended with diesel, alcohol and Diethyl ether with different proportion to reduce viscosity and density. It can be effectively used to investigate performance and exhaust emission of mahua oil and its blends using in a four stroke diesel engine and compare it with pure diesel fuel. It was observed by them that all mahua oil and its blends with diesel, alcohol and diethyl ether oil (50,10 and 10%) have slightly less thermal efficiency as compare to thermal efficiency of diesel fuel. It should be pointed out that 50% diesel and 50% mahua oil blend is found to be most thermally closer efficient with diesel from their work. The biodiesel was blended with additive in various proportions to prepare a number of test fuels which are tested on a diesel engine to study various parameters like carbon residue, fire point, flash point, viscosity, pour point, cloud point, cetane index etc. and compare those with that of diesel . The result shows biodiesel with 10% additive (Diethyl ether) is best suited for diesel engine.

Keywords: Mahua Oil, Alcohol, Diethyl ether.

INTRODUCTION

In this century, it is observed that crude oil and its products will become very scare and costly. As the numbers of engines are increasing, the consumption of fuel is also increasing. Therefore, enormous increase in number of vehicles hasled to the depletion of crude oil resources at a steep rate. Diesel will become costly in the near future. The various biomass based resources can be used as an extender or a complete substitute to the diesel fuel in agriculture, industrial or transport sector in energy crisis situation. The role of diesel in these sectors has been over emphasised. In fact agriculture and transport sector are almost diesel dependant. So, there is a need to search for an alternative fuel that can substitute diesel. The various edible oils like sunflower, soyabean, peanut, cotton seed etc. have successfully tested in diesel engine. Therefore research in the direction for using non-edible like mahua (MadhucaIndica) oil has been tested as diesel fuel extender. Even though the properties of vegetable oil and non-edible oil are close to diesel fuel, but to run diesel engine without any modification usingthese fuels results in severe engine deposits, dilution of lubricating oil with unburnt fuel, injected choking, piston ring sticking etc.. Most of these problems results due to high viscosity and low volatility of edible and non-edible oils. Hence there is a need for a better fuel which can compensate these problems. In this context bio-diesel can be derived from edible and non-edible oil, which serves the purpose. Bio-diesel can be derived from edible and non-edible oil depending on the availability.

In the context of depletion of these fossil fuels, the search for alternate and renewable fuels has become pertinent. It has been found that the vegetable oil is a promising fuel, because of its properties are similar to those of diesel fuel and it is a renewable and can be easily produced.

Mahua oil is widely available in India and neighboring countries. Furthermore, the use of non-edible vegetable oils such as Mahua oil is of significance because of the great need for replacement of diesel. Compare to other vegetable oil the mahua oil properties like cetane number and calorific values are closer to diesel. So for there are many methods adopted in to use mahua oil in diesel engine. The following methods are widely used Mahua oil converted as biodiesel through transesterification process, Preheating pure vegetable oil about 60-130 degree, Blending mahua oil with diesel in different proportion. In this work investigate were carried out to evaluate performance and exhaust emission of mahua oil and its blends using in a four stroke diesel engine and compare it with pure diesel fuel. It was observed by them that all mahua oil and its blends with diesel, alcohol and diethyl ether oil(50,10 and 10%) have slightly less thermal efficiency as compare to thermal efficiency of diesel fuel. It should be pointed out that 50% diesel and 50% mahua oil blend is found to be most thermally closer efficient with diesel from their work. It was also found that smoke density is higher for mahua oil blends as compared with diesel.The biodiesel was blended with additive in various proportions to prepare a number of test fuels which are tested on a diesel engine to studyvarious parameters like carbon residue, fire point, flash point, viscosity, pour point, cloud point, cetane index etc. and compare those with that of diesel . The result shows biodiesel with 10% additive (Diethyl ether) is best suited for diesel engine.

Fuel Modification: The procured Mahua oil id filtered with help of fine cotton cloth in order to remove the waste particles. Then it is checked for their physical properties with the aid of suitable instrument. The measured properties is tabulated below

Properties	Mahua oil	Diesel
Kinematic viscosity at 40° c(cst)	38.4	4.1
Flash point(° c)	186	51
Pour point(° c)	11	15
Density at 30° c(kg/m2)	912	840
Net calorific value(kj/kg)	37082	43600
Acidity(mg koh/gm)	28.9	0.2
Carbon residue (%)	0.46	0.3

The above found results were checked with literature papers. And the kinematic viscosity value of Mahua oil and diesel is found to be respectively from the literature survey. Its cetane number found to be for Mahua oil and diesel respectively from the literature review. It is concluded that these mahua oil have some properties near to diesel and hence it has a promising feature to replace diesel in feature. But some of the properties like viscosity, density were found very distinct from the diesel, hence it has to be modified before it is being used as fuel in diesel engine. To made it efficient fuel to use as an alternate fuel to replace diesel, it is concluded to blend the above mentioned pyro oil with various renewable and nonrenewable fuel.

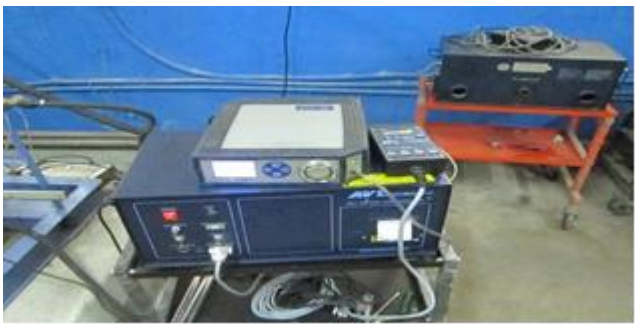
Blending With Diesel: Diesel is a non-renewable fuel which is almost used in many applications to produce energy as well heat. Hence the chosen mahua oil is made blend with base fuel diesel at various proportion by volume. It is found that mahua gets separated when it blends with diesel at minimum proportion by its volume. Diesel is a non-renewable fuel which is almost used in many applications to produce energy as well heat .Hence the chosen mahua oil is made blend with base fuel diesel at various proportion by volume. It is found that mahua gets separated when it blends with diesel at minimum proportion by its volume.

Blending with alcohol oil: Vegetable oil is a renewable source which is mainly used as house hold purposes. Using of this oil will affect the human – nature interface, hence the non-edible oil is chosen for our work which has promising properties which matches with diesel. Mahua oil is one among the one which has heating value very close to diesel. Extracted Mahua oil is made blend with Mahua oil at different proportion by its volume.

Blending of Diethyl ether oil with Mahua oil: Diethyl ether oil is blended fine with Mahua oil with maximum proportion of 10% by its volume.

Engine and experimental setup

Description of the test rig: The setup consists of single cylinder, four strokes, water-cooled diesel engine coupled to eddy current dynamometer with the help of flexible rubber coupling is mounted on a centrally balanced base frame made of ms channels. The set up has stand alone fully powder coated panel box consisting of air box, fuel tank, manometer, fuel measuring unit digital indicators and transmitter for measuring various parameters.



It is also provided with necessary sensors with transmitters for combustion pressure and crank angle measurements. All these signals are interfaced to computer through signal conditioner and signal converter for computerization. The engine is arranged with pre heated setup with thermo stator arrangement, as the process is fully arranged with computerized setup. As the thermo stator is arranged it automatically prefixes the inlet temperature of bio-diesel entering into engine.

Test rig specification:

- ENGINE: 4 stroke 1 cylinder water cooled diesel engine
- Make: kirloskar
- Rated power: 3.7KW (5HP)
- Bore diameter: 80mm

Journal of Chemical and Pharmaceutical Sciences ISSN: 0974-2115

- Stroke length: 110mm
- Connecting rod length: 234mm
- Swept volume: 562cc\
- Compression ratio:16.5:1
- Rated speed: 1500 rpm
- DYNAMOMETER:eddy current dynamometer
- Make: POWER MAG
- Rated torque:2.4kg-m
- Arm length: 150mm

AVL- Di Gas Analyzer: The AVL Di gas analyzer is used to measure HC, CO, CO2, O2 and NOx. It is based on non-dispersive infrared rays technique to measure the pollutants. The analyzer is allowed to warm up for few hours and then checked for the leak test and HC residue test. Before starting the analyzer ensure the absence of water droplets in the tubes of exhaust probe. Calibrating the analyzer before the measurement will ends up with better results.Figure8.3 shows the AVL Di gas analyzer and Smoke meter set up AVL Di gas analyzer and Smoke meter

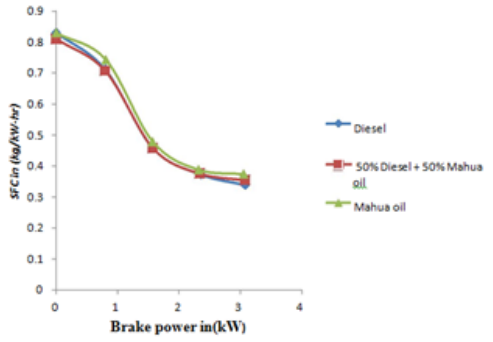
Smoke Meter: The AVL smoke meter helps to measure the smoke intensity of the engine exhaust and it works on light extinction principle. It consists of a flexible sampling hose with appropriate. Exhaust gas probe. The sampling probe is inserted in the exhaust pipe is approximately 200 mm from the engine. a continuous exhaust sample is passed through the tube of about 46cm length, which has a light source at one end the other end fitted with a photocell. The amount of the light passing through the smoke column is sensed as an indication of smoke level. The smoke meter consists of display unit. The smoke density is HSU is displayed

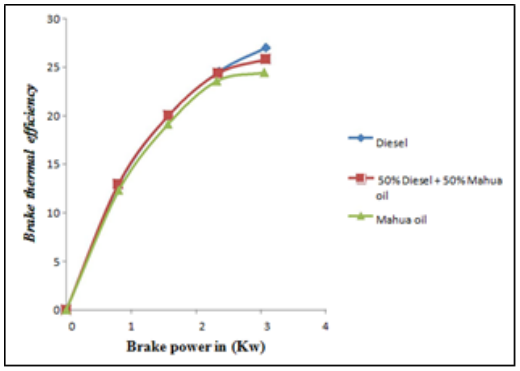
Engine Testing Procedure: Engine was started and allowed to warm up for about 15 minutes and maintained the engine speed as constant at 1500 rpm. The time taken for 10cc fuel consumption was noted down for each load in volume basis flow in the burette. Load was applied by adjusting the knob in the dynamometer load indicator. At each load condition exhaust emission such as HC, CO, CO2, O2, NOx and smoke measured using AVL Di gas analyzer and AVL smoke meter respectively initially base fuel (i.ediesel) is tested for its performance and emission characteristics and then followed by Mahua oil, and blends of and with ignition improvers were tested in the same engine and their results were compared against the base diesel fuel.

RESULTS AND DISCUSSION

Comparative study of Performance And Emission Characteristics of Mahua blend of Diesel and Mahua oil with Diesel fuel.

Comparison of Specific fuel consumption:





Variation of Specific Fuel Consumption with Brake Power for Diesel, Mahua oil, Mahua oil 50% + 50% diesel**.**

1. Brake Specfic fuel consumption decrease for all fuels as there is an increase in Load.
2. The Graph shows that the Mahua Oil - Malcohol Blend has higher Specific Fuel Consumption compared to

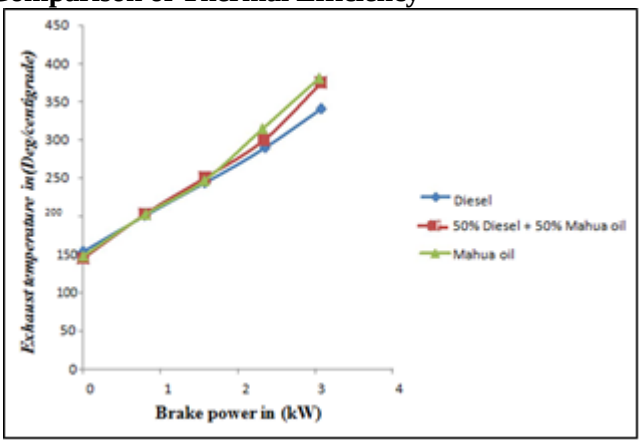
Plain Diesel and Mahua Oil due to lower Calorific Value of the Fuel. Since the Engine is a Constant Speed engine, more fuel is consumed to maintain the Speed.

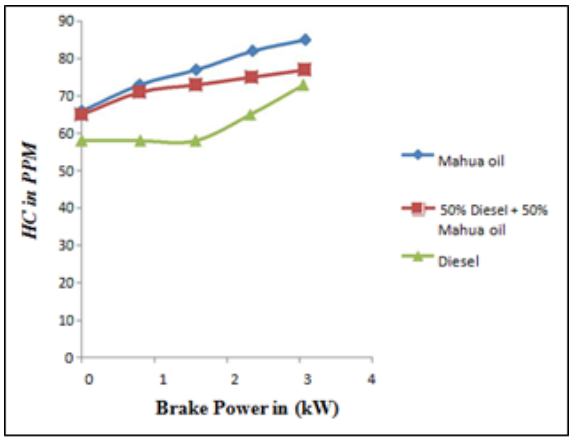
3. The bsfc for Mahua Oil comparatively higher than Diesel, due to Lower CV of the fuel.

Comparison of Thermal Efficiency: Variation of Thermal Efficiency with Brake Power for Diesel, Mahua oil, Mahua oil 50% + 50% diesel

1. Brake thermal efficiency increase for all fuels as there is an increase in Load.
2. It is interference from the Graph that the Mahua Oil - Mahua Oil Blend has lower brake thermal efficiency compared to Plain Diesel and Mahua Oil blend. Due to the addition of Malcohol inMahua Oil the Calorific Value decreases compared to Diesel.
3. Mahua Oil BTE decreases as compared to Diesel this is because of higher viscosity, density and lower calorific value.
4. Mahua oil 50% + 50% diesel give BTE near to diesel due to reduction of viscosity by blending with diesel.

Comparison of Thermal Efficiency





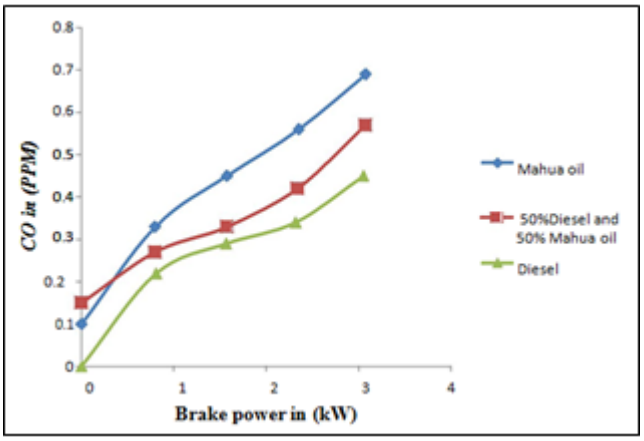
Variation of Exhaust temperature with Brake Power for Diesel, Mahua oil and Blend

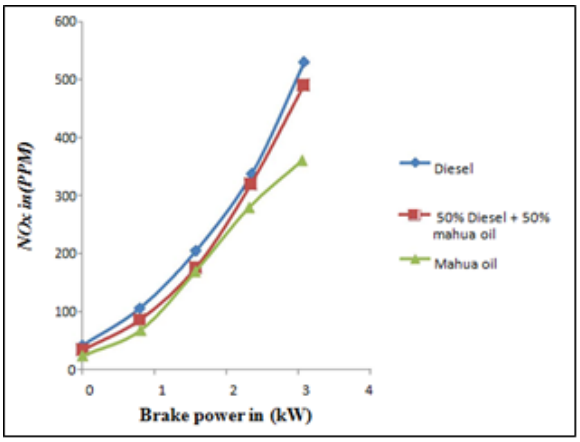
1. Exhaust Temperature increase for all fuels as there is an increase in Load.
2. It is interference from the Graph that the Mahua Oil - Malcohol Blend has higher temperature compared to Plain diesel and Mahua Oil. This can be interrelated as, the addition of Malcohol, an Oxygenated Fuel increase combustion rate., which oblivious increase the exhaust temperature and NOx formation with HC and CO emission reduced. There may be a chance of Malcohol reacts with delayed vapourisatedMahua Oil, which increases the exhaust temperature. The Exhaust temperature of Mahua Oil comparatively lower than Diesel in most cases, due to slightly higher rate of heat of vaporization.

Comparison of Hydro Carbon Emission: Variation of HC Emission Brake Power for Diesel, Mahua oil, Mahua oil 50% + 50% diesel. The variation of hydrocarbon emission of diesel, Mahua oil and Mahua oil 50% + 50% diesel blend. It is inferred that Mahua oil has more hydrocarbon emission as compared to Diesel and Mahua oil 50% + 50% diesel blend, the viscosity of the Mahua oil is quite high when compared to other two fuels which will results in poor atomization increasing the HC emission. On the other hand, Mahua oil 50% + 50% diesel blend inferred lesser hydrocarbon emission as compared to with Mahua oil due to relatively lesser viscosity but higher than diesel.

Comparison of Carbon Monoxide Emission: Variation of CO Emission Brake Power for Diesel, Mahua oil, Mahua oil 50% + 50% diesel. The variation of CO emission of diesel, Mahua oil, Mahua oil 50% + 50%diesel. Being an oxygenated fuel, Mahua oil produces lesser CO emission as compared to diesel. In order to reduce CO emission further diesel is made blended with oxygenated fuel Mahua oil which results in further reduction in CO level as compared with diesel.

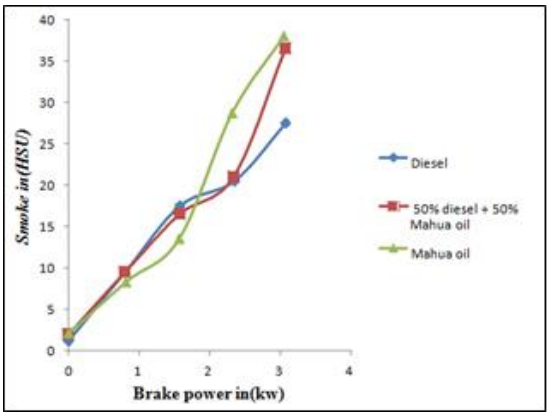
Journal of Chemical and Pharmaceutical Sciences ISSN: 0974-2115

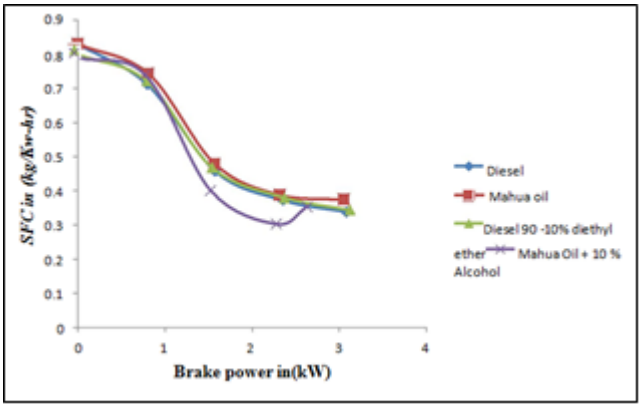




Comparison of NOx Emission: Variation of NOx Emission Brake Power for Diesel, Mahua oil, Mahua oil 50% + 50% diesel**.** The variation of NOx emission of diesel, Mahua oil, Mahua oil 50% + 50% diesel. It is inferred that Diesel producing higher oxides of nitrogen emission as compared to other two fuels. This is due to the high peak cycle temperature of diesel which has relatively higher heating and higher cetane number as compared with Mahua oil and diesel blend, which results in prolonged delay period. However when diesel blend of Mahua oil give off lesser NOx emission due to lesser cycle temperature as compared to other two fuels.

Comparison of Smoke Emission: Variation of Smoke Emission Brake Power for Diesel, Mahua oil, Mahua oil 50% + 50% diesel. The variation of Smoke emission of diesel, Mahua oil, Mahua oil bled with Mahua oil. Both Mahua oil, Mahua oil bled with diesel experience higher smokes emission as compared to diesel, due to its viscous nature which results in poor atomization and thus pay ways for reduced premixed combustion and prolonged diffusion combustion. Comparative study of Performance and Emission Characteristics of Mahua blend of Alcohol exculpates oil, diesel and Mahua oil.

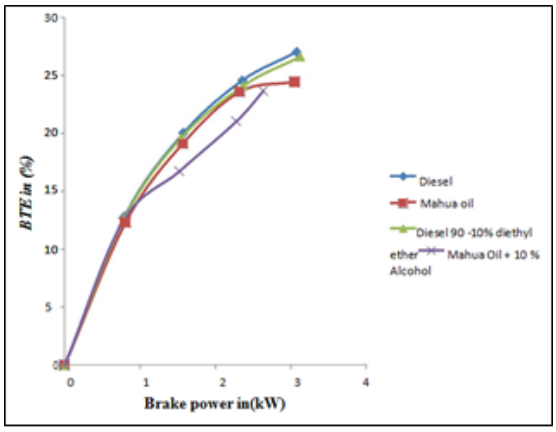


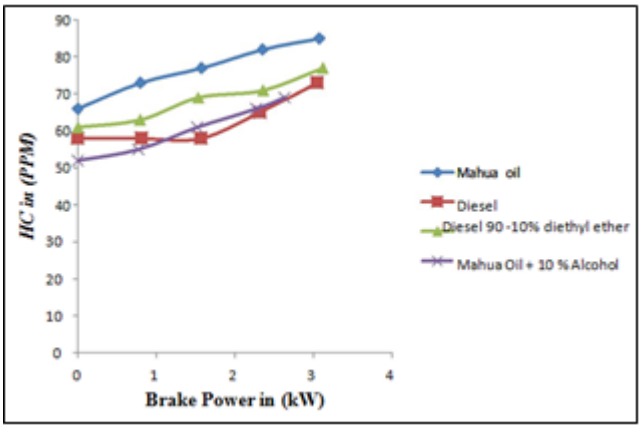


Comparison of Specific fuel consumption: Variation of Specific Fuel Consumption Mahua oil blend of Alcohol ,diethyl ether oil, diesel and Mahua oil. The variation of specific fuel consumption of Mahua blend of Alcohol , exculpates oil, diesel and Mahua oil. It is clear from the graph Mahua oil blend with alcohol experiencing least specific fuel consumption. Specific fuel consumption of mahua is quite high as compared to all other the fuel. The bsfc for Mahua Oil comparatively higher than other three fuel, due to Lower CV of the fuel.

Comparison of Brake Thermal Efficiency: Variation of brake Thermal Efficiency of Mahua oil blend of Alcohol diethyl ether oil, diesel and Mahua oil. The variation of Thermal Efficiency of Mahua oil blend of Alcohol ,diethyl ether oil, diesel and Mahua oil. Brake thermal efficiency increase for all fuels as there is an increase in Load. It is interference from the Graph that the Mahua Oil - Malcohol Blend has lower brake thermal efficiency compared to Plain Diesel and Mahua Oil. Due to the addition of alcohol in Mahua Oil the Calorific Value decreases compared to Diesel. Diesel and diethyl ether oil blend give better BTE near to diesel this is due to reduced viscosity further.

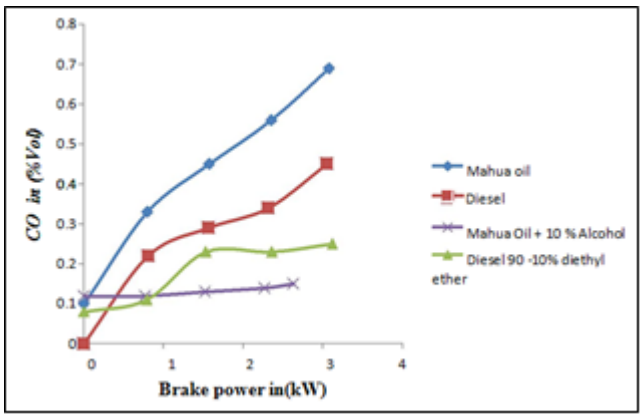
Journal of Chemical and Pharmaceutical Sciences ISSN: 0974-2115

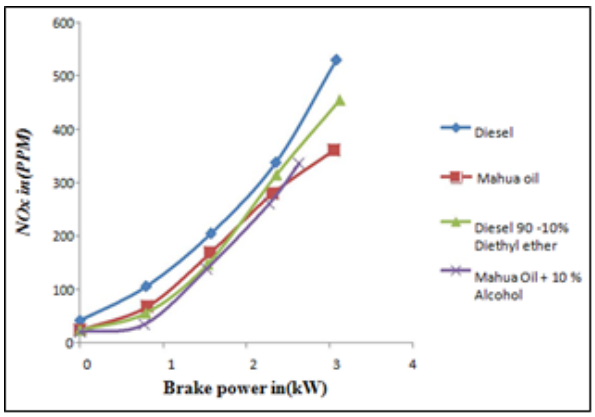




Comparison of Hydro Carbon Emission: Variation of HC Emission of Mahua oil blend of Alcohol diethyl ether oil, diesel and Mahua oil. The variation of hydrocarbon emission of Mahua oil blend of Alcohol exculpates oil, diesel and Mahua oil. It is inferred that Mahua oil has more hydrocarbon emission as compared to Diesel and Mahua oil other blend, the viscosity of the Mahua oil is quite high when compared to other fuels which will results in poor atomization increasing the HC emission. On the other hand, Mahua oil10% alcohol blend inferred lesser hydrocarbon emission as compared to with Mahua oil due to relatively lesser viscosity but higher than diesel.

Comparison of Carbon Monoxide Emission: Variation of CO Emission with Brake Power of Mahua oil blends of Alcohol diethyl ether oil, diesel and Mahua oil. The variation of CO emission of diesel, Mahua oil, Mahua oil blends of Alcohol diethyl ether oil, diesel and Mahua oil. Being an oxygenated fuel, Mahua oil produces lesser CO emission as compared to diesel. In order to reduce CO emission further diesel is made blended with oxygenated fuel alcohol and diethyl ether which results in further reduction in CO level as compared with diesel.

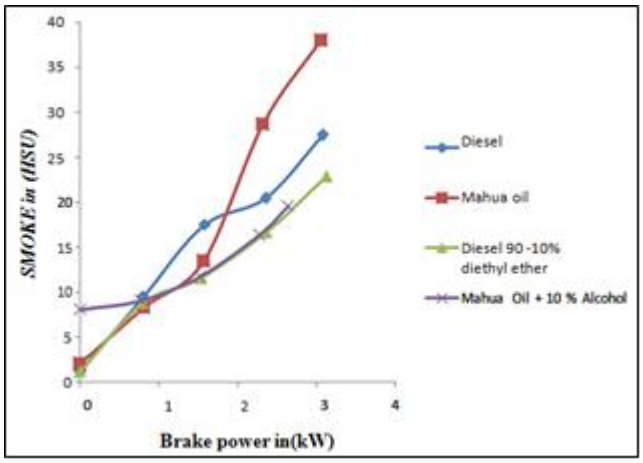




Comparison of NOx Emission: Variation of NOx Emission with Brake Power for Mahua oil blend of Alcohol diethyl ether oil, diesel and Mahua oil**.** The variation NOx emission of diesel, for Mahua oil blend of Alcohol diethyl ether oil, diesel and Mahua oil. It is clear from the graph, that formation of blend of the fuel will certainly reduce the NOx emission by reducing the cycle temperature. And at lower load adding of diethyl ether and alcohol results in reduced oxide of nitrogen emission, it is because of reduced delay period.

Comparison of Smoke Emission: Variation of Smoke Emission with Brake Power for Diesel, Mahua oil blend of Alcohol diethyl ether oil, diesel and Mahua oil. The variation of Smoke emission of diesel, Mahua oil blend of Alcohol diethyl ether oil, diesel and Mahua oil. It is inference from the With neat mahua oil there is increased smoke emission at all power output this is mainly due to high viscosity and density which result poor atomization and vaporization. Diesel blend with diethyl ether oil and alcohol there is reduced smoke emission at all power output this is mainly due to reduced viscosity and density which result optimal atomization and vaporization.

Journal of Chemical and Pharmaceutical Sciences ISSN: 0974-2115



CONCLUSION

The experiments were conducted in the CI engine at constant speed of 1500 rpm under varying load and proportion of Diesel-Mahua oil blend with diethyl ether. The performance and emission characteristics were compared. From the experiments following conclusion were made.

1. The maximum thermal efficiency as around 27% with diesel at about70% of load condition, this is due to higher cetane number and calorific value of the diesel. It is found that at same load condition, mahua oil producing relatively lower thermal efficiency as compared to diesel and its different blend energy content and high viscosity and density of mahua is quite higher than diesel.
2. The HC emission of mahua is very higher compared to diesel and other blends. This is due to improper combustion .On comparing with all the blends alcohol, diethyl ether oil and alcohol blend slightly lower HC emission than diesel.
3. The CO emission of mahua oil is higher than as compared to all blends which is taken for the test. Since all the blends were oxygenated fuels resulting in reduced CO emission. At lower load condition diesel oil exhibits lower CO emission, since alcohol as a ignition improvers which will enhance the rate of combustion thereby increasing the CO2 emission and reducing the CO emission.
4. The NOx emission of diesel is higher as compared to others. Higher calorific value of diesel will results in increased peak cycle temperature, thus increasing the oxides of nitrogen emission, however by making it to an blend with alcohol NOx emission is reduced to some extent than the diesel fuel.
5. The Smoke emission of mahua is higher as compared to other tested blends. Since both the fuels are which will results in increased smoke emission .Usually mahua oil fuel will experiences higher smoke emission ,thus blends is required for effective usage of them in diesel engine.
6. It is found that there is a significant improvement in both the performance and emission characteristics of diesel blend with alcohol, diethyl ether oil as compared to neat mahua oil. It is mainly due to reduction of viscosity and density and improved calorific values of mahua oil blend with diesel. Blend of alcohol will further reduce oxides of nitrogen emission by reducing the peak cycle temperature. And intensity of smoke is also get reduced due to the blend of alcohol.

REFERENCES

B. Baiju, M.K. Naik, L.M. Das comparative evaluation of compression ignition engine characteristics using methyl and ethyl esters of Karanja oil Renewable Energy 34 (2009)

M.Senthil Kumar, M. Jaikumar A comprehensive study on performance, emission and combustion behavior of a compression ignition engine fuelled with WCO (waste cooking oil) emulsion as fuel Journal of the Energy Institute (2014) 1–9

N. Kapilan R. P. Reddy Evaluation of Methyl Esters of Mahua Oil (MadhucaIndica)as Diesel Fuel J Am Oil ChemSoc (2008) 85:185–188

N. Saravanana,, Sukumar Puhanb, G. Nagarajanc, N. Vedaraman, Production and comparison of fuel properties, An experimental comparison of transesterification process with different alcohol s using acid catalysts.Bio mass bio energy 34 -2010.

Shashikant Vilas Ghadge, HifjurRaheman, Biodiesel production from mahua (Madhucaindica) oil having high free fatty acids Biomass and Bioenergy 28 (2005) 601–605.

Soo-Young No Inedible vegetable oils and their derivatives for alternative diesel fuels in CI engines Renewable and Sustainable Energy Reviews 15 (2011) 131–149

Sukumar Puhana, N. Vedaramana,_, Boppana V.B. Rama,G. Sankarnarayananb, K. JeychandranMahua oil (MadhucaIndica seed oil) methyl ester as biodiesel-preparation and emission characterstics Biomass and Bioenergy