International Journal of Advance Research in Science and Engineering
Volume No.06, Issue No. 11, November 2017
www.ijarse.com
IJARSE
ISSN: 2319-8354

PERFORMANCE AND EMISSION CHARACTERISTICS OF DIESEL ENGINE USING MUSTARD OIL WITH ZIRCONIUM DIOXIDE (ZrO_2) PISTON COATING AT DIFFERENT PRESSURE VARIATIONS

N D Shyam Kiran[1], R Manohar Babu[2]

[1]PG Student, [2]Assistant Professor
Department of mechanical engineering,
G.Pulla Reddy Engineering College (Autonomous), Kurnool, AP, (India)

ABSTRACT

This study concerns with the use of alternate fuels for automobiles. Biodiesels are gaining popularity and becoming more attractive, because of their environmental benefits and the fact that they are made from renewable sources. The currently existing and widely used fuel named gasoline also called as diesel. The cost of this fuel day by day increases and also it will be exhausted in future after some years. To cope up with the load shedding situation we have to go for alternative fuels. In the first step tests were conducted on four stroke single cylinder diesel engine by using diesel. Further in the second step experimental investigations were carried out on the same engine with the same operating parameters by using mustard oil. Studies have revealed that on blending vegetable oils with diesel a remarkable improvement in their physical and chemical properties was observed. Cetane number came to be very close to pure diesel. Engine (C.I.) was run at different loads at a constant speed (1500 rpm) separately on each blend and also on pure diesel. Results have indicated that engine run at 20% blend of oils showed a closer performance to pure diesel. Then by taking blends as 30%, 40%, 50%, 60% of mustard oil with diesel to find out the performance parameters.

The effect of Zirconium dioxide coating on the performance characteristics of biodiesel IC engine and also pressure variation at 180 & 205 bars. The engine used was four stroke single cylinder direct injected diesel engine. The engine was tested with diesel & at different proportionality of diesel and by varying torque without coating. Then the piston head was coated with thermal barrier material. The layer of thermal coating was made of Zirconium dioxide (ZrO_2). Then the coated engine was tested at the same operation conditions as the standard engine.

Key words: *Diesel Engine, Mustard oil, Performance and emissions characteristics, Brake thermal efficiency.*

I. INTRODUCTION

This paper gives an over view of the investigation being done for the preparation of biodiesel from mustard oil. This study concerns with the use of alternate fuels for automobiles. Biodiesel is an alternative fuel that can be used for reducing pollution to the air. It can be derived from vegetable oil like (soybean, rapeseed, canola, neem, mustard, jatropha etc) and animal fat (tallow) sources. Biodiesel is an environmental friendly fuel, which reduces the emission risks to the nature. Biodiesel does not contain any sulphur, aromatic compounds and gives reduced soot. Due to its environmental and economic benefits, production of biodiesel is quickly adopted around the world. Vegetable oil has high viscosity, that it cannot be used directly in conventional engines. Hence, its viscosity is lowered by the trans-esterification process. The molecular structure and the properties of the vegetable oil/animal fat are converted to methyl ester which is popularly known as Bio-diesel.

Air pollution is a major problem which induces the attention of biodiesel. Biodiesel is safer to breathe, nontoxic and biodegradable. This can be used in conventional engines without or few modifications. Internal combustion engine with biodiesel as an alternative fuel which will emit reduced CO, HC and CO_2. NO_X emission is increased for biodiesel due to combustion, oxygen content and some properties of the fuel. It can be reduced by recirculation of the exhaust air of the engine called exhaust gas recirculation (EGR), which creates longer ignition delay and improves fuel air mixing resulting in reduction of NOx and particulate matter (PM) emission. Retarded fuel ignition timing can reduce NOx while maintaining the other emission reductions. Biodiesel blends have the ability to give greater lubricity to the engine which gives greater life span to the engine. Biodiesel on internal combustion engine will give lower emissions like CO, HC and particulate matter when compared to conventional diesel. Biodiesel can be used in pure form in the IC engine without or certain modifications. Vegetable oils have high viscosity when compared to conventional diesel. Recent studies shows that CO, HC and particulate matter emissions improved due to preheating which reduced the viscosity of the vegetable oil, almost to the level of diesel fuel which caused improvement in the combustion.

In the present experimental investigation, mustard oil methyl ester (MOME) was produced by the trans-esterification process, using mustard oil and methanol with Sodium hydroxide as catalyst. Properties of mustard oil were studied. Characterization of mustard biodiesel was done. Internal combustion engine was used for the performance and emission investigation using mustard biodiesel blends (B20, B30, B40, B50 and B60) as fuel. Emission and performance for the biodiesel blends were compared to the fuel.

II. MUSTARD OIL

This oil has a distinctive pungent taste, characteristic of all plants in the mustard (Brassicaceae) family (for example, cabbage, cauliflower, turnip, radish, horseradish or wasabi). It is often used for cooking in North India, Eastern India, Nepal, Bangladesh and Pakistan. In Bengal, Orissa, Assam, Meghalaya, Manipur and Nepal, it is the traditionally preferred oil for cooking. The oil makes up about 30% of the mustard seeds. It can be produced from black mustard (Brassica nigra), brown Indian mustard (B. juncea), and white mustard (B. hirta).

International Journal of Advance Research in Science and Engineering
Volume No.06, Issue No. 11, November 2017
www.ijarse.com
IJARSE
ISSN: 2319-8354

The characteristic pungent flavour of mustard oil is due to allyl isothiocyanate. Mustard oil has about 60% monounsaturated fatty acids (42% erucic acid and 12% oleic acid); it has about 21% polyunsaturated fats (6% the omega-3 alpha-linolenic acid and 15% the omega-6 linoleic acid), and it has about 12% saturated fats.

Fig.1: Pure Mustard oil

Table: 1 Properties of Mustard oil

Properties	Unit	Mustard biodiesel	Diesel
Specific gravity	-	0.672	0.83
Cetane number	-	53	48
Aniline point	^0C	54	42
Acid value	mg NaOHg	1.5	0
Flash point	^0C	156	60 to 80
Viscosity (40 °C)	cSt	4.10	1.3-4.1
Pour point	^0C	-4	18
Density	Kg/m^3	0.88	0.84

III. ZIRCONIUM DIOXIDE

Zirconium dioxide (ZrO_2), sometimes known as zirconia (not to be confused with zircon), is a white crystalline oxide of zirconium. Its most naturally occurring form, with a monoclinic crystalline structure, is the mineral baddeleyite. A dopant stabilized cubic structured zirconia, cubic zirconia, is synthesized in various colours for use as a gemstone and a diamond stimulant.

Zirconium dioxide is one of the most studied ceramic materials. ZrO_2 adopts a monoclinic crystal at room temperature and transitions to tetragonal and cubic at higher temperatures. The change of volume caused by the structure transitions from tetragonal to monoclinic to cubic induces large stresses, causing it to crack upon cooling from high temperatures. When the zirconia is blended with some other oxides, the tetragonal and/or cubic phases are stabilized. Effective dopants include magnesium oxide (MgO), yttrium oxide (Y_2O_3, yttria), calcium oxide (CaO), and cerium (III) oxide (Ce_2O_3)

Zirconia is often more useful in its phase 'stabilized' state. Upon heating, zirconia undergoes disruptive phase changes. By adding small percentages of yttria, these phase changes are eliminated, and the resulting material has superior thermal, mechanical, and electrical properties. In some cases, the tetragonal phase can be metastable. If sufficient quantities of the metastable tetragonal phase is present, then an applied stress, magnified by the stress concentrationat a crack tip, can cause the tetragonal phase to convert to monoclinic, with the associated volume expansion. This phase transformation can then put the crack into compression, retarding its growth, and enhancing the fracture toughness

IV. ENVIRONMENTAL DAMAGE

It is defined as the change or disturbance to the environment, which is not desirable. The emissions coming from vehicles are damaging the environment and causing air pollution. Several major environmental problems are caused by the use of fossil fuels.

4.1 Global Warming

Global warming, also called as the "Greenhouse Effect", is caused by an accumulation of carbon dioxide (CO_2) emissions that do not leave the Earth's lower atmosphere. We are already at risk because the level of greenhouse gas already high. CO_2 is the gas responsible for keeping the earth's climate warm to a higher temperature by reducing outward radiations. However, an excess amount of CO_2 in the Earth's atmosphere is building up due to fossil fuel emissions that contain large quantities of CO_2. The UV rays travelling from the Sun are able to penetrate the CO_2 blanket. The trapped UV rays are remaining near the earth's surface and this is reflected in the increased incidence of cancer among the world's population. The additional heat that is now being trapped near the earth's surface is also causing a general rise in global temperatures and a melting of million year old glaciers. As a result, weather patterns are being affected. A shifting of weather patterns will cause storms, heat waves and droughts that will lead to possible crop failures and famines. Tropical diseases will increase due to the increase in temperature. Rising ocean and lake levels will lead to coastal flooding.

V. EXPERIMENTAL STUDIES

Mustard oil ratio are to be done with proper mixtures of diesel quantity, B1 (20%MO + 80%Diesel) B2 (30%MO + 70%Diesel), B3 (40%MO + 60%Diesel), B4 (50%MO + 50%Diesel), B5(60%MO + 40%Diesel).Initially the engine is running with diesel fuel for the duration of 10 to 15 minutes before using Mustard oil blends in order to attain stable working environment. After that diesel fuel is completely drained out from the fuel tank and then the sample of (500 ml) Mustard oil-diesel blends are poured into the fuel tank.

It is important to note that whether the engine has attained its optimum (warm) temperature conditions. At constant speed of 1500 rpm, engine is loaded with 0%, 5%,25%,50%, 75%, 100% load by using an eddy current dynamometer. The B15 & B20 proportions of Mustard oil blends are tested at all load conditions running at constant speed, where the experimental procedure is same for every proportion to be tested.

5.1 EXPERIMENTAL SETUP

Fig.2: 4 Stroke single cylinder diesel engine set up with generator loading

This experimental setup consists of four stroke diesel engine connected with electrical loading. By Using this experimental setup estimating the performance and emission analysis at different loading conditions and different diesel blends and with piston coating and without piston coating.

The engine specifications are:

Bore : 80 mm

Dia of brake drum: 360 mm

Stroke : 110 mm

Thickness of the belt (t): 5mm

RPM : 1500

Coefficient of discharge: 0.6

BHP : 5

Dia of the orifice (d): 20mm

CR : 16:1

Maximum current : 13 Amp

Generator efficiency: 80 %

Exhaust emissions were determined using Exhaust emission analyzer, AVL DIGAS 444. Smoke emission was analyzed by AVL smoke meter 437C. Exhaust emission specifications were given in (Table-5). Fuel was filled in the measuring burette attached to the fuel tank, which provides the measurement of the fuel consumption. Pressure variations were determined by the U-tube manometer. Engine was allowed to run for sufficient time with the remaining fuel, before starting with a new biodiesel blend. Internal combustion engine was performed using five different blends respectively.

VI. GRAPHS

6.1 Pressure at 180bar without piston coating

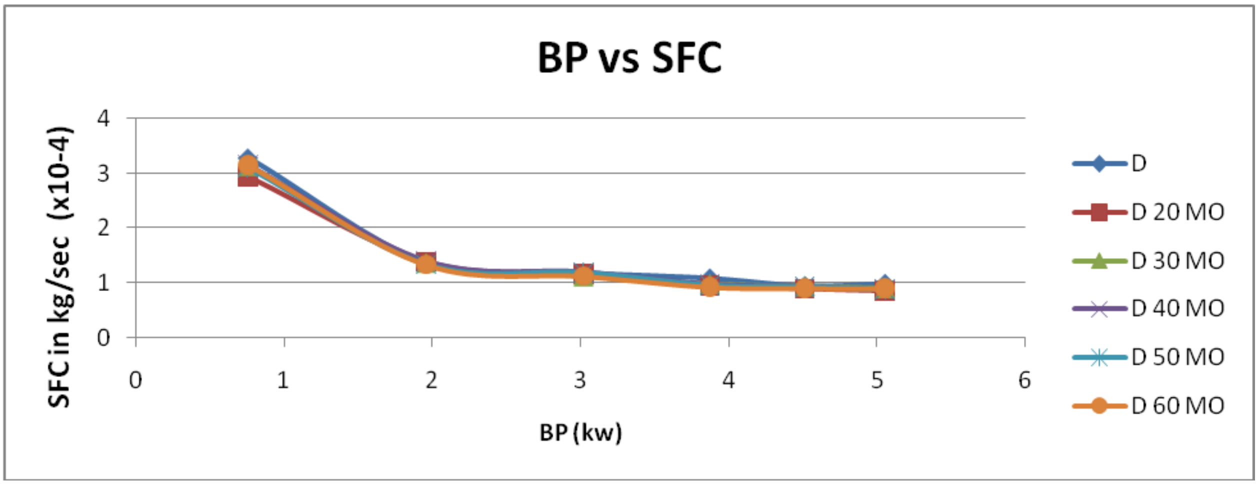


Fig.3: Performance of diesel blends at 180bar BP vs SFC

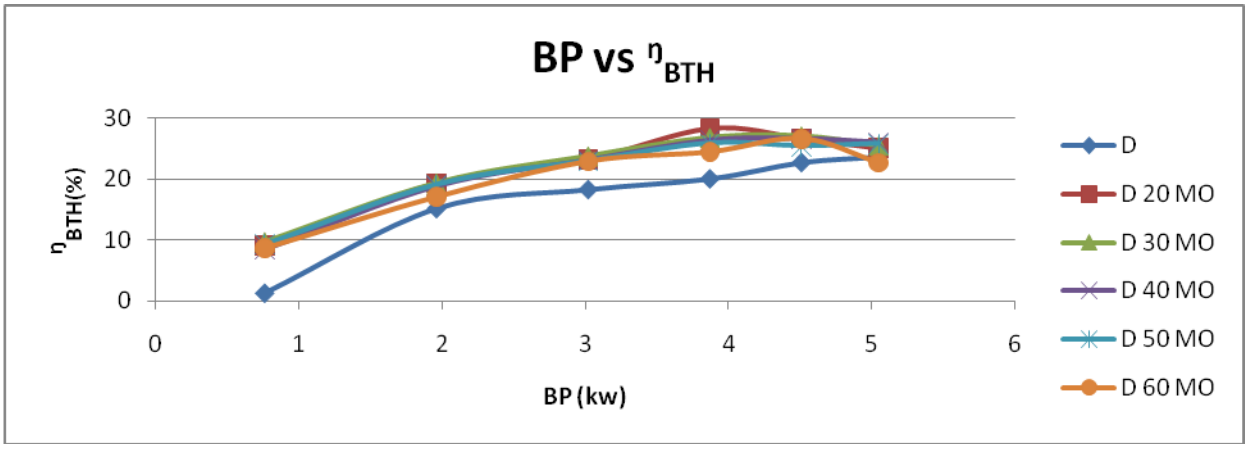


Fig.4: Performance of diesel blends at 180bar BP vs η BTH

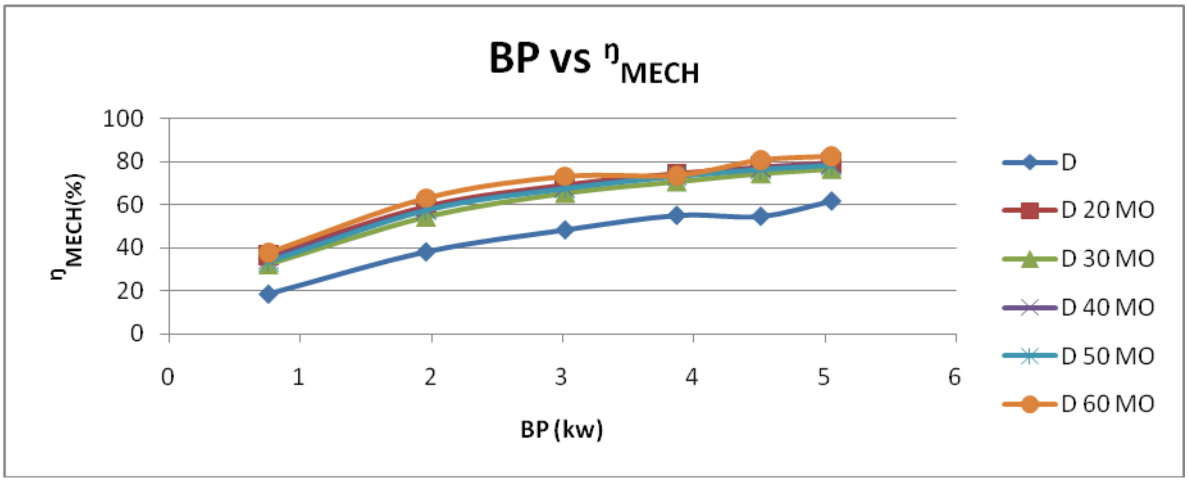


Fig.5: Performance of diesel blends at 180bar BP vs η mech

6.2 Pressure at 205bar without piston coating

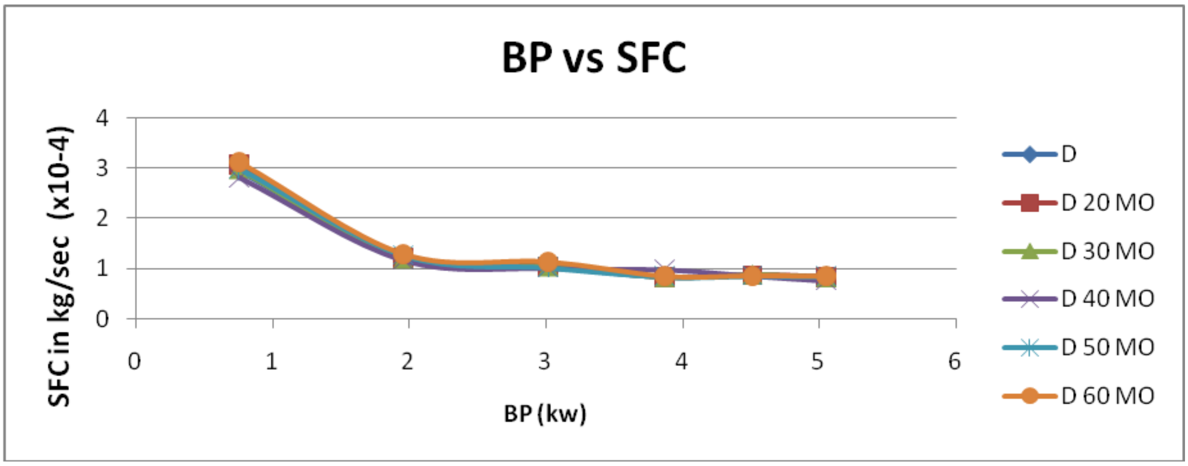
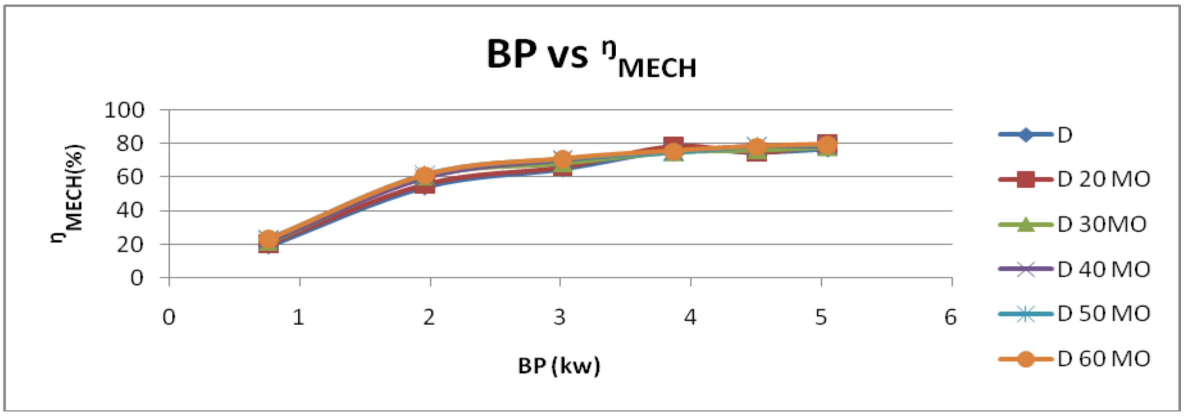


Fig.6: Performance of diesel blends at 205bar BP vs SFC



Fi.g7: Performance of diesel blends at 205bar BP vs η mech

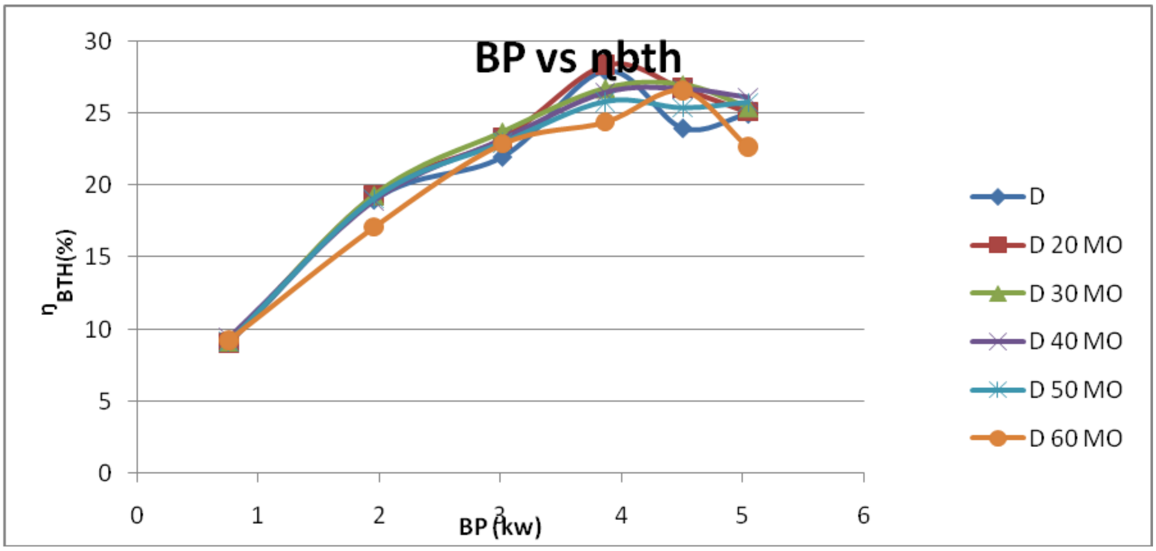


Fig.8: Performance of diesel blends at 205bar BP vs η BTH

6.3 Pressure at 180bar with piston coating:

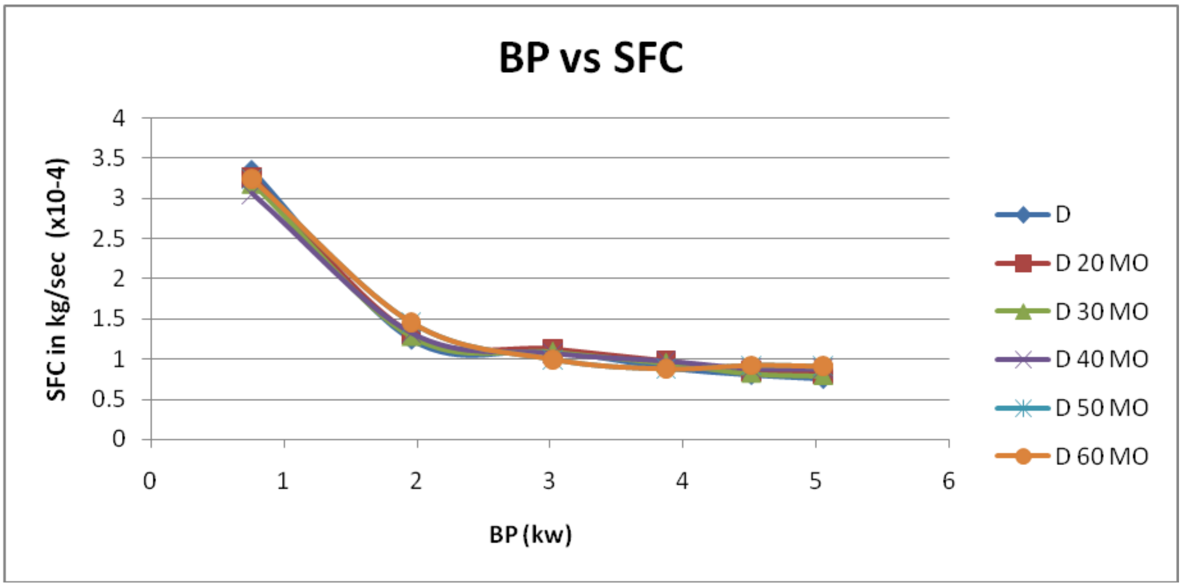


Fig.9: Performance of diesel blends at 180bar BP vs SFC

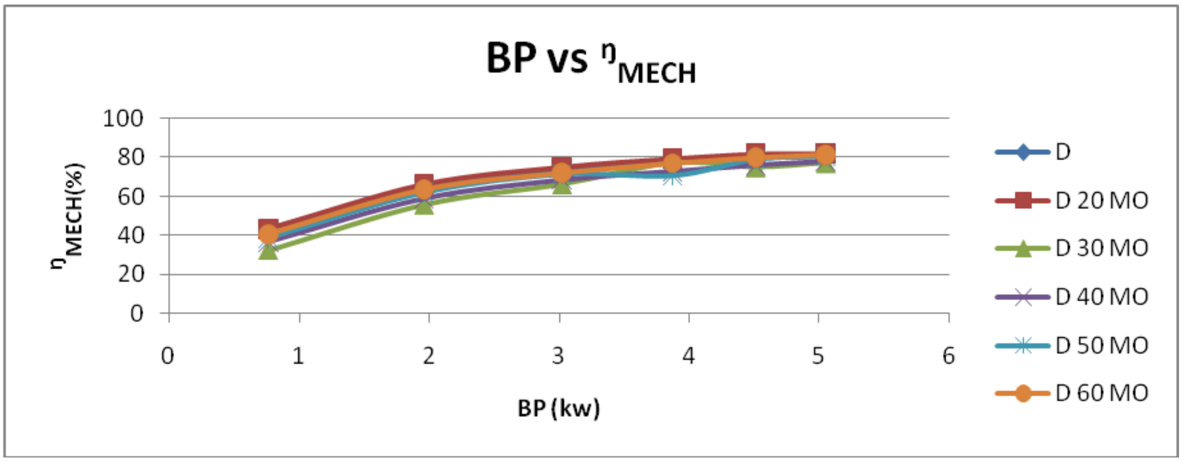


Fig.10: Performance of diesel blends at 180bar BP vs η mech

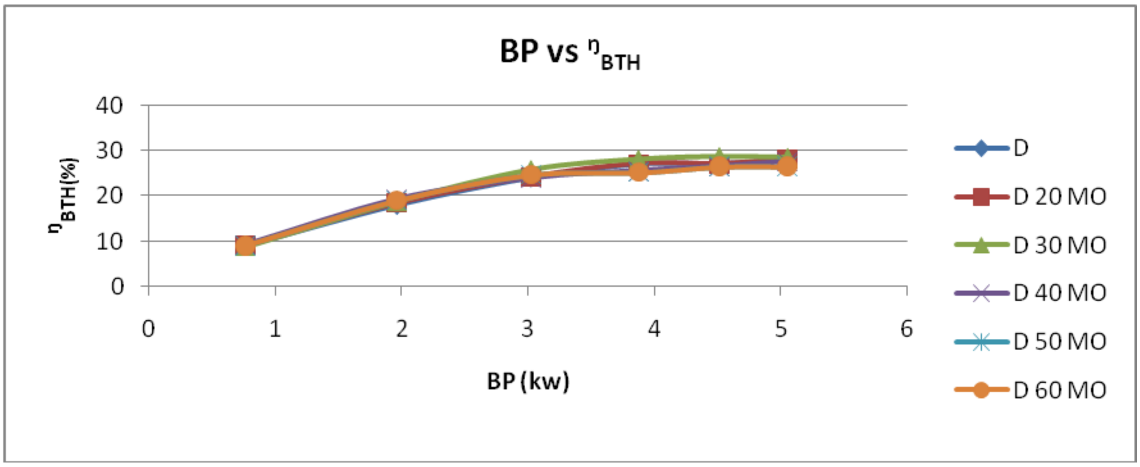


Fig.11: Performance of diesel blends at 180bar BP vs η BTH

6.4 Pressure at 205bar with piston coating:

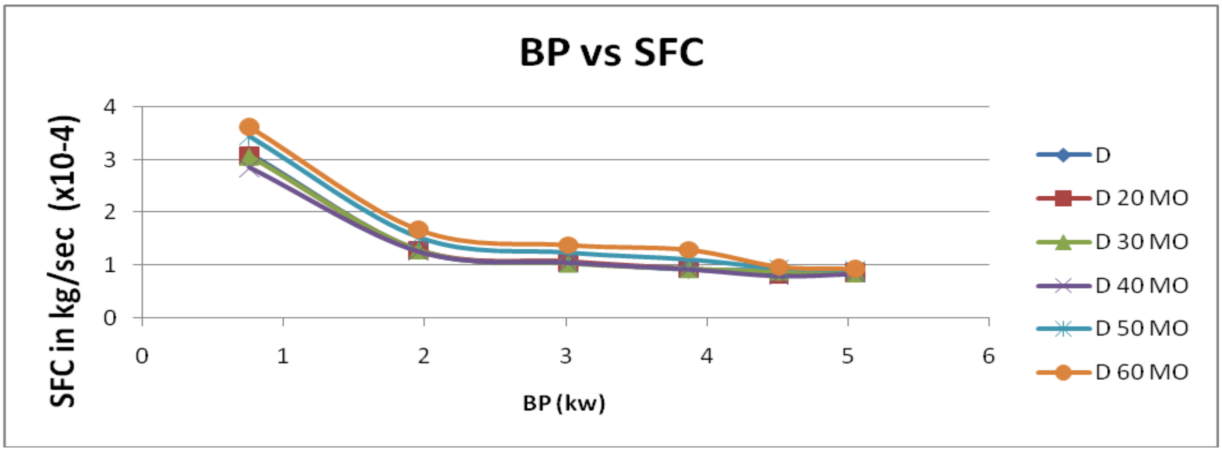


Fig.12: Performance of diesel blends at 205bar BP vs SFC

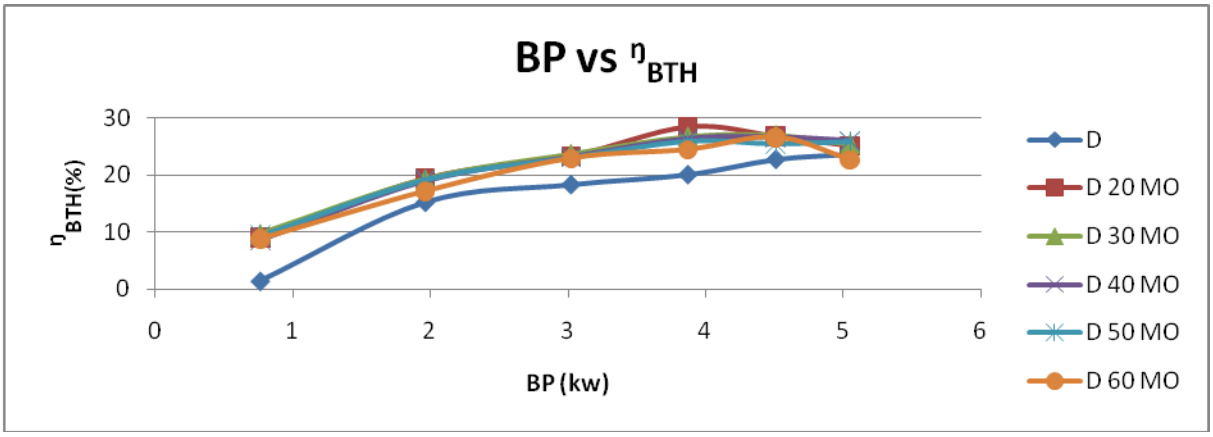


Fig.13: **Performance of diesel blends at 205bar BP vs η BTH**

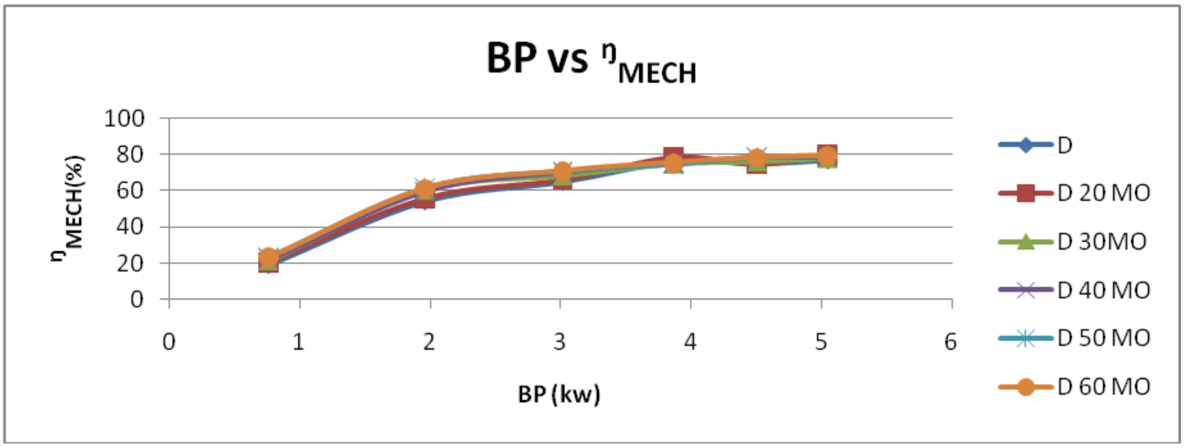


Fig.14: Performance of diesel blends at 205bar BP vs η mech

6.5 Emissions at 180 and 205bar pressure

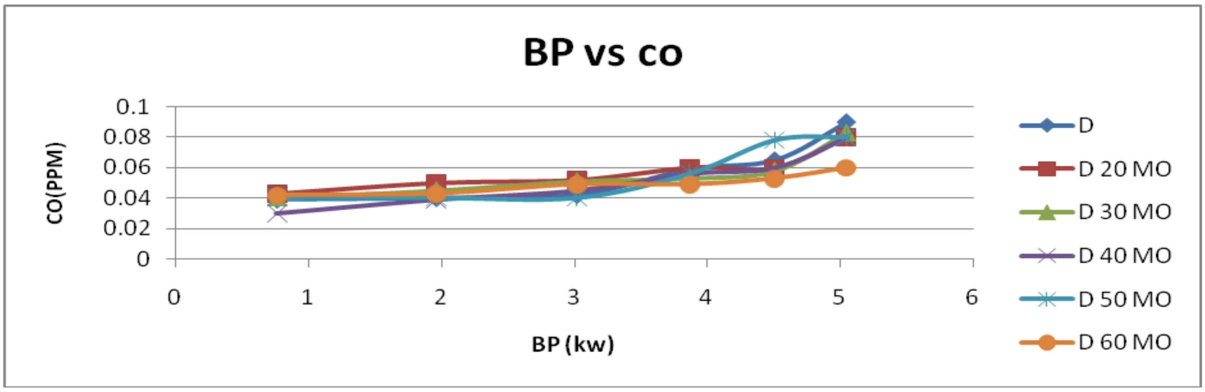


Fig.15: Emissions of diesel blends at 180 & 205bar BP vs CO

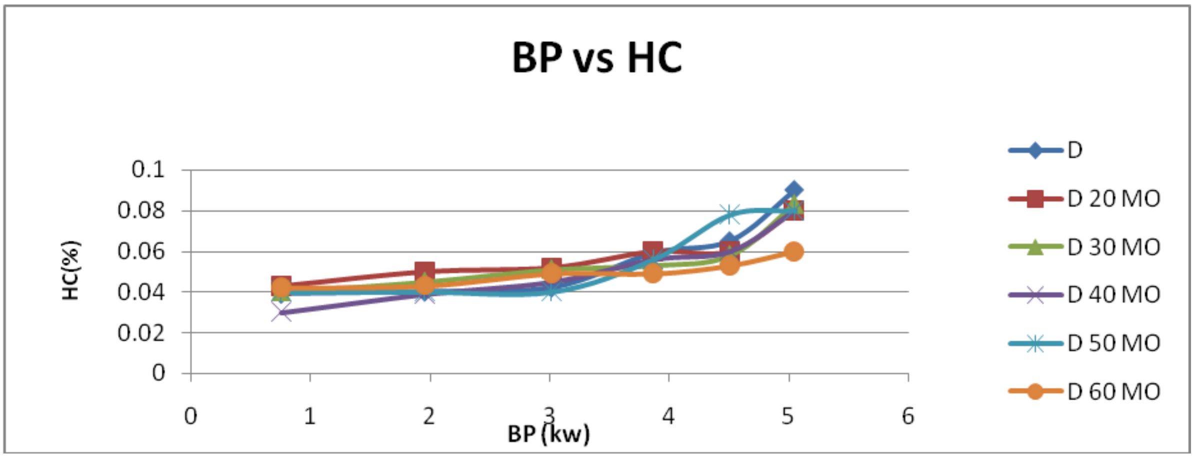


Fig.16: Emissions of diesel blends at 180 & 205bar BP vs HC

VII. CONCLUSION

Based on the results of this study the following specific conclusions are mentioned below.

1. In the diesel engine mainly using without & with Piston coating of Zirconium Dioxide is used.
2. Comparing at the pressures 180 & 205bar without piston coating and pressures 180 & 205bar with piston coating. The pressure 205bar with Zirconium piston coating gives better results than the others.
3. Specific fuel consumption for B3 (40%MO + 60% Diesel) is lower than the Diesel fuel and increases as blend ratio increases.
4. The maximum Brake thermal efficiency for B3 (40%MO + 60% Diesel) at 205bar pressure coating 29.35 was higher than that of the Diesel. The brake thermal efficiency obtained for B1, B2, B4, B5 were less than diesel.
5. The exhaust temperature increases as a function of the concentration of biodiesel blend and it is higher percentage of blend.
6. The fuel properties of Mustard oil except calorific values all other properties are found to be higher compared to diesel.
7. Viscosity of biodiesel is higher than that of any other blend and its concentration increases the blend, the viscosity of the blend increases.

REFERENCES

1. M.Anwesh & R.Manohar Babu " Effect of Titanium oxide piston coating on performance and Emission characteristics of a Diesel engine by using Transformer oil with pressure variation " Imperial Journal of Interdisciplinary Research (IJIR), Vol-2, Issue-12,2016. ISSN: 2454-1362, pages: 216-222, http://www.onlinejournal.in ***INTERNATIONAL JOURNAL.***
2. A. Siva Kumar, D. Maheswar, K. Vijaya Kumar Reddy, Comparision of Diesel Engine Performance and Emissions from Neat and Transesterified Cotton Seed Oil, Jordan journal of mechanical and industrial

enginnering. 3, num-3 (2009), 190-197..

3. G. Venkata Subbaiah, K. Raja Gopal, Syed Altaf Hussain, B. Durga Prasad & K. Tirupathi Reddy, Rice bran oil biodiesel as an additive in diesel- ethanol blends for diesel engines, IJRRAS 3 (3) (2010).

4. A.B.M.S. Hossain and M.A. Mekheld, Biodiesel fuel production from waste canola cooking oil as sustainable energy and environmental recycling process, Australian journal of crop science. 4(7) (2010), 543-549.

5. Gaurav Dwivedi, Siddharth Jain, M.P. Sharma, J. Mater, Diesel engine performance and emission analysis using biodiesel from various oil sources – Review, Environ.Sci. 4(4) (2013), 434-447.