

“Performance Test on Karanja, Neem and Mahua Biodiesel Blend with Diesel in Single Cylinder IC Engine”

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Abstract - In the recent years, vehicle population increased enormously which increases the demand of fossil fuel. The availability of crude oil supply decreases continuously, these reasons makes the researchers to find new renewable alternative fuel especially biofuels. Some of the vegetable plants like karanja, neem, and mahua, rapeseed, jatropha, soabean, etc. were already found as successful production of biodiesel. But the problems in these sources were the land availability. Still, it has been reported that the use of biodiesel considerably reduced emission and increase the performance of the engine. The most promising method for the production of biodiesel is transesterification process. Now-a-days researchers have reported the possibility for the production of biodiesel. In the present study, karanja, neem and mahua biodiesel blend with diesel ratio of (10%), (20%) and (30%) is blends with diesel are used in the IC engine.

Key Words: Transesterification¹, IC Engine², Karanja, Neem and Mahua Biodiesel³,

1. INTRODUCTION

The resources of petroleum as fuel are dwindling day by day and increasing demand of fuels, as well as increasingly stringent regulations, pose a challenge to science and technology. With the commercialization of bio-energy, it has provided an effective way to figurant against the problem of petroleum scarce and the influence on environment. India is one of the fastest developing countries with a stable economic growth, which multiplies the demand for transportation in many folds. Fuel consumption is directly proportionate to this demand. India depends mainly on imported fuels due to lack of fossil fuel reserves and it has a great impact on economy. In Indian scenario, the data available from auto fuel consumption reveals that in the year 2017-18, 12.85 million metric tonnes (MMT) petrol and 66.91 MMT of diesel were consumed with a crude oil import amounting to rupees 3,88,044 corers. Biodiesel is a promising alternative for our diesel needs. India ranks 6th in terms of consumption of energy i.e. 3.5% of the total world’s commercial energy.

1.1 History of Engine

Although the history of the diesel engine extends back into the closing years of the 19th century when Dr Rudolf Diesel began his pioneering work on air blast injected

stationary engines, and in spite of the dominant position in now holds in many application, it is today the subject of intensive development and capable of improvements. Before 1914, building on the work of Dr Rudolf Diesel in Germany and Hubert Akroyd Stuart in the UK, the diesel engine was used primarily in stationary and ship propulsion applications in the form of relatively low speed four-stroke normally aspirated engines. Dr. Rudolf Diesel invented the diesel engine to run on a host of fuels including coal dust suspended in water, heavy mineral oil, and, vegetable oils. Dr. Diesel’s first engine experiments were catastrophic failures, but by the time he showed his engine at the world exhibition in Paris in 1900, his engine was running on 100% peanut oil. Dr. Diesel was visionary.

The 1914 -18 war gave considerable impetus to the development of the high speed diesel engine with its much higher specific output, with a view to extending its application to vehicles.

2. Research Methodology

2.1 Materials and method

Based on the availability of karanja, neem and mahua biodiesel blend with diesel, the properties like calorific value, kinematic viscosity, flash point and fire point, karanja, neem and mahua biodiesel blend with diesel is estimated in the table 3.1,3.2, and 3.3 selected for biodiesel preparation and experimental analysis. Various blending combinations of multi-blend biodiesel i.e. KF-1 (karanja fuel 10%, diesel 90% by volume), KF-2 (karanja fuel 20%, diesel 80% by volume), KF-3 (karanja fuel 30%, diesel 70% by volume) are prepared as shown in table 3.1

Tabl 2.1 Preparations of flue samples of multi-blend biodiesel along with diesel

| Preparation of flue samples of multi-blend biodiesel along with diesel | | | |
|--|--------------|-------------------|-------------------|
| S.No. | Fuel samples | KBD + Pure diesel | Quantity obtained |
| 1. | KF-1 | = 100ml + 900ml | = 1-litre |
| 2. | KF-2 | = 200ml + 800ml | = 1-litre |
| 3. | KF-3 | = 300ml + 700ml | = 1-litre |

Table 2.2 Preparations of flue samples of multi-blend biodiesel along with diesel

| Preparation of flue samples of multi-blend biodiesel along with diesel | | | |
|--|--------------|---------------------------|---------------|
| S.No. | Fuel samples | NBD = Quantity obtaine | + Pure diesel |
| 1. | NF-1 | 100ml = 1-litre | + 900ml |
| 2. | NF-2 | 200ml = 1-litre | + 800ml |
| 3. | NF-3 | 300ml = 1-litre | + 700ml |

Table 2.3 Preparations of flue samples of multi-blend biodiesel along with diesel

| Preparation of flue samples of multi-blend biodiesel along with diesel | | | |
|--|--------------|----------------------------|---------------|
| S.No. | Fuel samples | MBD = Quantity obtained | + Pure diesel |
| 1. | MF-1 | 100ml = 1-litre | + 900ml |
| 2. | MF-2 | 200ml = 1-litre | + 800ml |
| 3. | MF-3 | 300ml = 1-litre | + 700ml |

2.2Catalytic Pyrolysis

Transesterification: it is most commonly used and important method to reduce the viscosity of vegetable oils. In this process triglyceride reacts with three molecules of alcohol in the presence of a catalyst producing a mixture of fatty acids, alkyl ester and glycerol. The process of removal of all the glycerol and the fatty acids from the vegetable oil in the presence of a catalyst is called esterification. This esterifies vegetable oil is called bio-diesel. Biodiesel properties are similar to diesel fuel. It is renewable, non-toxic, bio-degradable and environment friendly transportation fuel. After esterification of the vegetable oil its density, viscosity, cetane number, calorific value, atomization and vaporization rate, molecular weight, and fuel spray penetration distance are improved more. So these improved properties give good performance in CI engine.

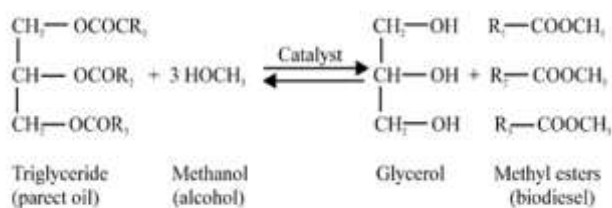


Fig 2.1 Transesterification equation

Physical and chemical properties are more improved in esterified vegetable oil because esterified vegetable oil contains more cetane number than diesel fuel. These parameters induce good combustion characteristics in vegetable oil esters. So unburnt hydrocarbon level is decreased in the exhaust. It results in lower generation of hydrocarbon and carbon monoxide in the exhaust than diesel fuel. The vegetable oil esters contain more oxygen and lower calorific value than diesel. So, it enhances the combustion process and generates lower nitric oxide formation in the exhaust than diesel fuel.



Fig 2.1 Photograph of experimentation I.C engine set-up

3. RESULTS AND DISCUSSION

3.1Introduction

The experimental results obtained from the tests carried out on engine performance presented in this section. These include results at constant speeds with different loads for the different fuels i.e. standard diesel fuel and the three multi-blend biodiesel products. The results are discussed from the viewpoint of using multi-blend biodiesel (karanja, neem and mahua) as an alternative fuel for compression ignition engines.

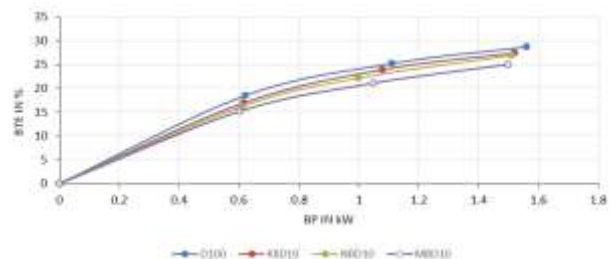


Chart1 Variation of brake thermal efficiency with respect to brake power

Chart1 shows the variation of brake thermal efficiency with brake power for various multi-blends biodiesel (karanja, neem and mahua) are KBD-10, NBD-10, MBD-10 along with pure diesel respectively. Brake thermal efficiency is

increasing with increasing brake power for all multi-blends of biodiesel (karanja, neem and mahua) and diesel. It may be due to reduction in heat loss and increase in power with increase in load. At rated power of 1.52 kW almost all the multi-blends have near efficiency to diesel in which KBD-10 have maximum thermal efficiency (27.47%) as compared to diesel (28.71%). It may be because of the presence of oxygen in biodiesel which enhances the combustion as compared to diesel and biodiesel is more lubricant than diesel that provides additional lubrication. Multi-blends of biodiesel (karanja, neem and mahua) have higher viscosity, density and lower calorific value than diesel.

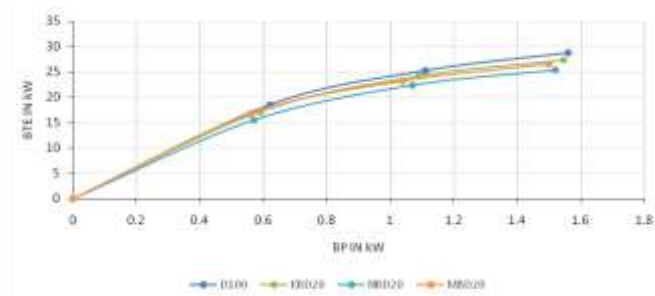


Chart2 Variation of brake thermal efficiency with respect to brake power.

For various multi-blends biodiesel (karanja, neem and mahua) are KBD-20, NBD-20, MBD-20 along with pure diesel respectively. Brake thermal efficiency is increasing with increasing brake power for all multi-blends of biodiesel (karanja, neem and mahua) and diesel. It may be due to reduction in heat loss and increase in power with increase in load

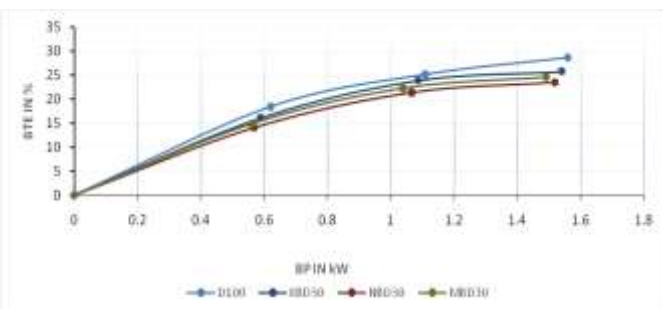


Chart3 Variation of brake thermal efficiency with respect to brake power

At rated power of 1.545 kW almost all the multi-blends have near efficiency to diesel in which KBD-20 and have maximum thermal efficiency (27.30%) as compared to diesel (28.71%). Multi-blends of biodiesel have higher viscosity, density and lower calorific value than diesel. Chart 3 shows the variation of brake thermal efficiency with brake power for various multi-blends biodiesel (karanja, neem and mahua) are KBD-30, NBD-30, MBD-30 along with pure diesel respectively. Brake thermal efficiency is increasing with increasing brake

power for all multi-blends of biodiesel (karanja, neem and mahua) and diesel.

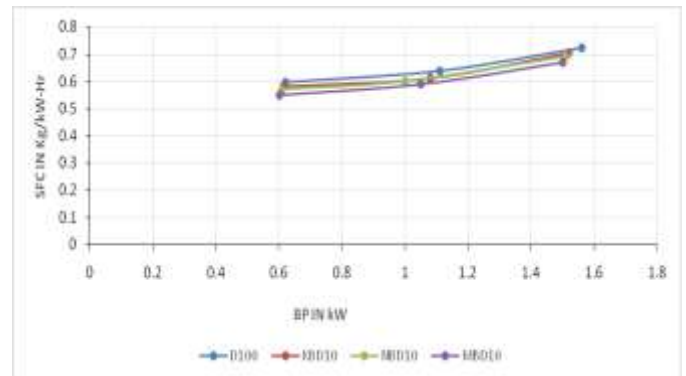


Chart4 Variation of specific fuel consumption with respect to brake power

The variation in SFC (specific fuel consumption) with brake power for various multi-blends biodiesel (karanja, neem and mahua) are KBD-10, NBD-10, and MBD-10 along with pure diesel as shown in Fig. 4.4 the specific fuel consumption when using multi-blend biodiesel is expected to increase as compared to the consumption of diesel fuel. SFC decreased sharply with increase in load for all fuel samples.

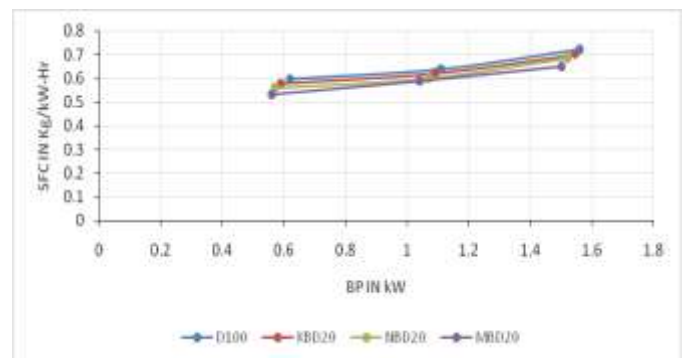


Chart5 Variation of specific fuel consumption with respect to brake power

The variation in SFC (specific fuel consumption) with brake power for various multi-blends biodiesel (karanja, neem and mahua) are KBD-20, NBD-20, and MBD-20 along with pure diesel as shown in Fig. 4.5 the specific fuel consumption when using multi-blend biodiesel is expected to increase as compared to the consumption of diesel fuel. SFC decreased sharply with increase in load for all fuel samples. The main reason for this may be that the percent increase in fuel required to operate the engine is less than the percent increase in brake power due to relatively less portion of the heat losses at higher loads. As the SFC is calculated on weight basis, so higher densities resulted in higher values of SFC. Maximum SFC is obtained in KBD-20 (0.701) at 1.545 kW.

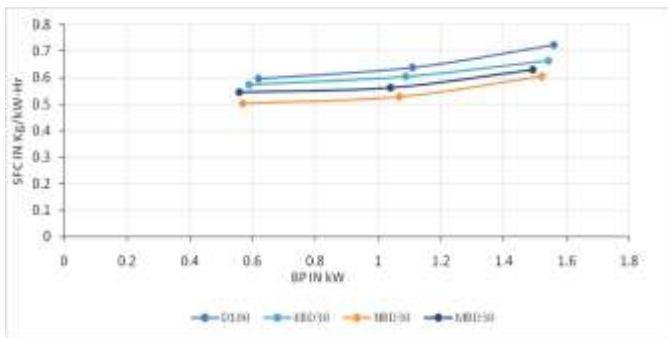


Chart6 Variation of specific fuel consumption with respect to brake power

The variation in SFC (specific fuel consumption) with brake power for various multi-blends biodiesel (karanja, neem and mahua) are KBD-30, NBD-30, and MBD-30 along with pure diesel as shown in Fig. 4.6 the specific fuel consumption when using multi-blend biodiesel is expected to increase as compared to the consumption of diesel fuel. SFC decreased sharply with increase in load for all fuel samples. The main reason for this may be that the percent increase in fuel required to operate the engine is less than the percent increase in brake power due to relatively less portion of the heat losses at higher loads. As the SFC is calculated on weight basis, so higher densities resulted in higher values of SFC. Maximum SFC is obtained in KBD-30 (0.665) at 1.541 kW.

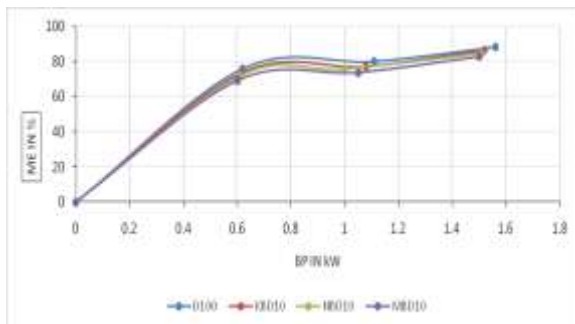


Chart7 Variation of mechanical efficiency with respect to brake power

The variation of mechanical efficiency with brake power for pure diesel and multi-blend biodiesel (karanja, neem and mahua) are shown in Fig. 4.7 the mechanical efficiency of pure diesel is slightly higher than the multi-blend biodiesel. In this case the pure diesel and KBD-10, NBD-10 and MBD-10 are almost nearer to each other. From the graph it is evident that as the percentage of multi-blend biodiesel increases in diesel the mechanical efficiency goes on decreasing. The mechanical efficiency of the engine is maximum at 1.520 kW pure diesel compare to other multi-blend biodiesel. This happens due to lower calorific value and higher viscosity of multi-blend biodiesel compared to pure diesel.

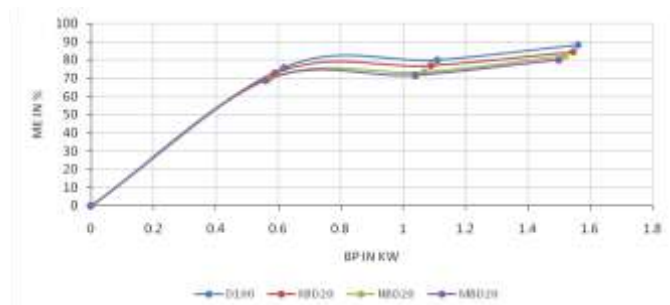


Chart8 Variation of mechanical efficiency with respect to brake power

The variation of mechanical efficiency with brake power for pure diesel and multi-blend biodiesel (karanja, neem and mahua) are shown in Fig. 4.8 the mechanical efficiency of pure diesel is slightly higher than the multi-blend biodiesel. In this case the pure diesel and KBD-20, NBD-20 and MBD-20 are almost nearer to each other. From the graph it is evident that as the percentage of multi-blend biodiesel increases in diesel the mechanical efficiency goes on decreasing. The mechanical efficiency of the engine is maximum at 1.545 kW pure diesel compare to other multi-blend biodiesel. This happens due to lower calorific value and higher viscosity of multi-blend biodiesel compared to pure diesel.

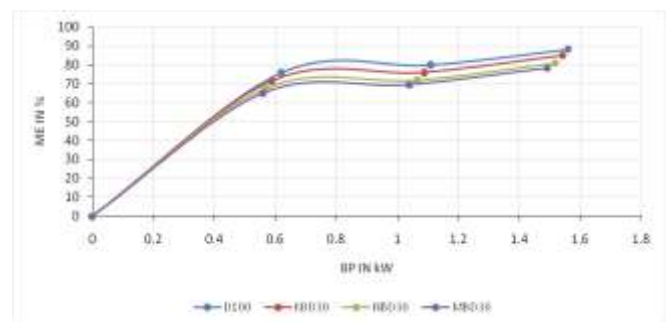


Chart9 Variation of mechanical efficiency with respect to brake power

The variation of mechanical efficiency with brake power for pure diesel and multi-blend biodiesel (karanja, neem and mahua) are shown in Fig. 4.9 the mechanical efficiency of pure diesel is slightly higher than the multi-blend biodiesel. In this case the pure diesel and KBD-30, NBD-30 and MBD-30 are almost nearer to each other. From the graph it is evident that as the percentage of multi-blend biodiesel increases in diesel the mechanical efficiency goes on decreasing. The mechanical efficiency of the engine is maximum at 1.541 kW pure diesel compare to other multi-blend biodiesel. This happens due to lower calorific value and higher viscosity of multi-blend biodiesel compared to pure diesel.

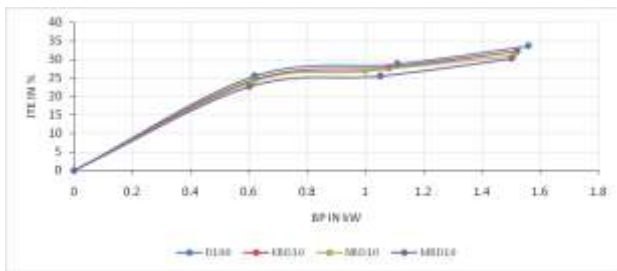


Chart10 Variation of indicated thermal efficiency with respect to brake power

Chart10 shows variation of indicated thermal efficiency with respect to brake power. From the graph it observed that the indicated thermal efficiency is maximum at starting brake power in the range of 0-1.52 kW brake power. Pure diesel has higher indicated thermal efficiency compared with all multi-blendbiodiesel. This is due to higher calorific value of diesel with lower viscosity. Maximum indicated thermal efficiency is obtained that 32.21% at 1.52kW

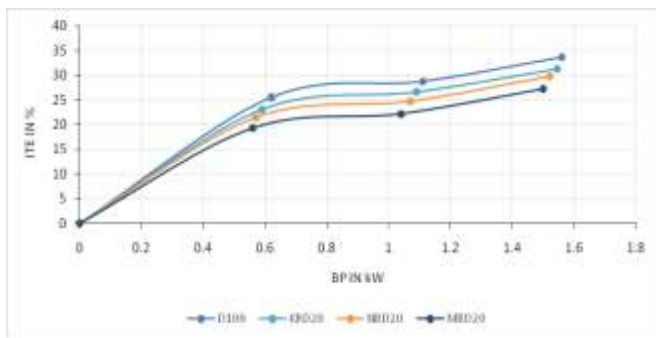


Chart11 Variation of indicated thermal efficiency with respect to brake power

Chart11 shows variation of indicated thermal efficiency with respect to brake power. From the graph it observed that the indicated thermal efficiency is maximum at starting brake power in the range of 0-1.545 kW brake power. Pure diesel has higher indicated thermal efficiency compared with all multi-blend biodiesel. This is due to higher calorific value of diesel with lower viscosity. Maximum indicated thermal efficiency is obtained that 31.26% at 1.545 kW

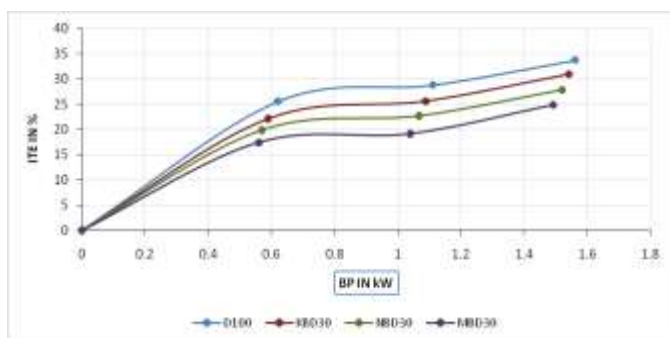


Chart12 Variation of indicated thermal efficiency with respect to brake power

Chart12 shows variation of indicated thermal efficiency with respect to brake power. From the graph it observed that the indicated thermal efficiency is maximum at starting brake power in the range of 0-1.541 kW brake power. Pure diesel has higher indicated thermal efficiency compared with all multi-blend biodiesel. This is due to higher calorific value of diesel with lower viscosity. Maximum indicated thermal efficiency is obtained that 30.93% at 1.541kW

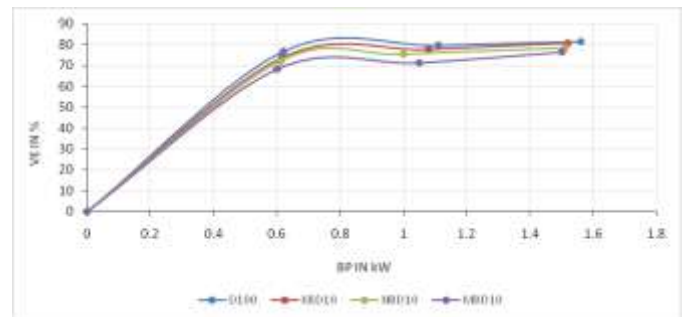


Chart13 Variation of volumetric efficiency with respect to brake power.

From the chart it observed that the volumetric efficiency is slightly variation in the average brake power and almost constant. There is no much variation in the pure diesel compared to multi-blend biodiesel. From the graph pure KBD-10 having least it observed that 73.52%,77.5% and 80.57% at 0.615 kW, 1.08kWand 1.52 kW. This is due to presence of oxygen during the combustion.

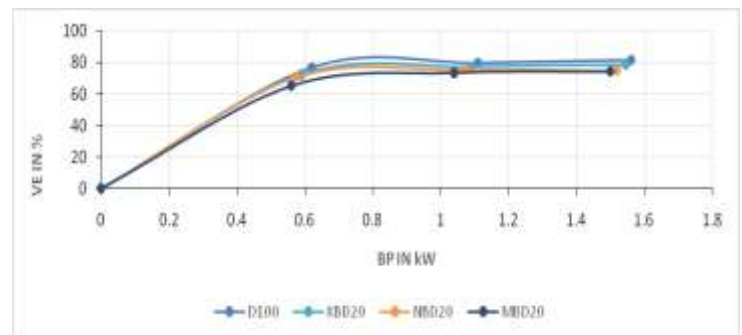


Chart13 Variation of volumetric efficiency with respect to brake power.

There is no much variation in the pure diesel compared to multi-blend biodiesel. From the graph pure KBD-20 having least it observed that 72.18%,77.13% and 78.41% at 0.590 kW, 1.09 kWand 1.545 kW.This is due to presence of oxygen during the combustion. From the chart it observed that the volumetric efficiency is slightly variation in the average brake power and almost constant

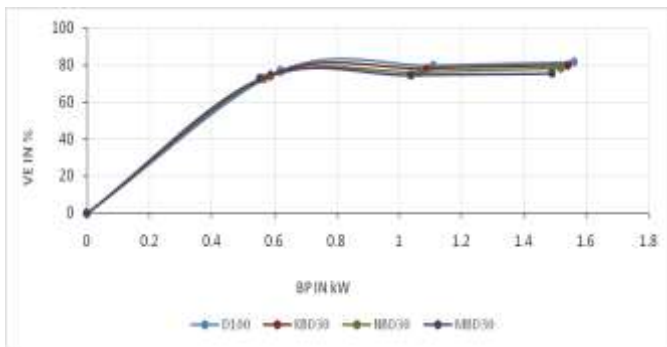


Chart14 Variation of volumetric efficiency with respect to brake power.

There is no much variation in the pure diesel compared to multi-blend biodiesel. From the graph pure KBD-30 having least it observed that 61.578%, 67.65% and 67% at 0.589 kW, 1.088 kW and 1.541 kW. This is due to presence of oxygen during the combustion.

CONCLUSIONS

Use of a multi-blend biodiesel is considered as a new possible source of alternative fuel for diesel engine. No difficulty was faced at the time of starting the engine and the engine ran smoothly at constant engine speed of 1500 RPM. Based on the experimental work with multi-blend biodiesel, at maximum load, the following conclusions are drawn. The performance parameter like brake thermal efficiency, brake specific fuel consumption, brake specific energy consumption, torque have similar result at wide range of power output.

- The brake thermal efficiency of KBD-30 has maximum 26.02% compare to pure diesel 18.71% at 1.5 kW brake power due to the presence of oxygen in the molecular structure of multi-blend biodiesel intensifies the complete combustion phenomenon.
- The mechanical efficiency of pure diesel is slightly higher than the multi-blend biodiesel at 1.5 kW brake power due to lower calorific value of multi-blend biodiesel.
- The indicated thermal efficiency have maximum at average brake power in the range of 0.5-1.5 kW. Pure diesel has higher indicated thermal efficiency compared with other multi-blend biodiesel.
- The volumetric efficiency is slightly decreases in the average brake power and almost constant. There is no much variation in the pure diesel compared to multi-blend biodiesel.
- Maximum specific fuel consumption is obtained in NBD-30 (0.903) compare to pure diesel at 1.5 kW brake power.

REFERENCES

1. DivyaBajpai., Tyagi.V.K. (2006) Biodiesel: source, production composition, properties and its benefits. *Journal of oleo science*, 55(10): 487-502.
2. GuoqingGuan, KatsukiKusakabe, Nozomi Sakurai, Kimiko Moriyama, (2009) Transesterification of vegetable oil to biodiesel fuel using acid catalysts in the presence of dimethyl ether. *Fuel*, 88: 81-86.
3. TitipongIssariyakul (2011) Development of Biodiesel Production Processes.
 - a. From Various Vegetable Oils
4. Dr. K.VIJAYA KUMAR REDDY (2010) Experimental investigation on performance and emission characteristics of diesel engine using bio-diesel as an alternate fuel.
5. V.DhanaRaju, P.Ravindra Kumar, "Experimental investigation of linseed and neem methyl esters as biodiesel on CI engine", *International Journal of Engineering Science and Technology (IJEST)*, Vol. 4 No.06 June 2012.
6. AshishJawalkar, KalyanMahantesh, "Performance and Emission Characteristics of Mahua and Linseed Biodiesel Operated at Varying Injection Pressures on CI Engine", *International Journal of Modern Engineering Research (IJMER)*, Vol.2, Issue.3, May-June 2012.
7. IlkerTurgutYilmal, MetinGumus, Mehmet Akcay, Thermal Barrier Coatings For diesel Engines. *International scientific conference 19-20 November 2010, Gabravo Turkey*.
8. RajendraPrasath, B., P. Tamilporai, P. and Mohd.Shabir, F., "Analysis of combustion, performance and emission characteristics of low heat rejection engine using bio-diesel" *International Journal of Thermal Sciences*, Volume-49, pp: 2483-2490, 2010.
9. Naveen. P, C.R. Rajashekhar, C. Umashankar & VinayakaRajashekharKiragi "Effect of Titanium Oxide Coating on Performance Characteristics of Bio-Diesel (Honge) Fuelled C.I.Engine" *International Journal of Modern Engineering Research (IJMER)* Vol.2, Issue.4, July-Aug 2012 pp-2825-2828 ISSN: 2249-6645
10. Sudheer B.P.K, Murthy V.S.S, KalyaniK.radha, Anjaneyaprasad.B, Ramjee. E, nagaprasad CH.S, K.V.K. reddy and Rajagopal.K "PERFORMANCE EVALUATION OF A LOW HEAT REJECTION CI ENGINE USING VEGETABLE OILS" *International J.ofMulti.displ.Research&Advcs in Engg. (IJMRAE)*, ISSN 0975-7074, Vol.1, No. 1, November 2009, pp 53-70 performance.

11. P. Lawrence, P. Koshy Mathews and B. Deepanraj Experimental Investigation on Performance and Emission Characteristics of Low Heat Rejection Diesel Engine with Ethanol as Fuel, American Journal of Applied Sciences 8 (4): 348-354, 2011 ISSN 1546-9239 © 2010 Science Publications.
12. Ilker Turgut Yilmal, Metin Gumus, Mehmet Akcay, Thermal Barrier Coatings For diesel Engines. International scientific conference 19-20 November 2010, Gabravo Turkey.
13. Gaurav Dwivedi, Siddharth Jain, Mahendra Pal Sharma, "PONGAMIA AS A SOURCE OF BIODIESEL IN INDIA" Received May 19, 2011; revised June 2, 2011, accepted June 9, 2011.
14. Elango T. And Senthilkumar T. Effect Of Methyl Esters Of Neem And Diesel Oil Blends On The Combustion And Emission Characteristics Of A C.I. Engine. Arpn Journal Of Engineering And Applied Sciences, Issn 1819-6608, Vol. 5, No. 10, October 2010