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Performance and Emissions Analysis Using Diesel and Tsome Blends

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Abstract: *The present study covers the various aspects of biodiesels fuel derived from crude Tobacco oil and performance emissions study on four stroke compression ignition engine with Tobacco seed oil. Crude Tobacco oil is converted to Tobacco seed oil methyl esters by transesterification process. The obtained bio-diesel fuel properties are measured.*

The performance and emission parameters obtained by the above are compared with the base line data obtained earlier by using diesel and optimum Tobacco seed oil blend is obtained. The performance parameters obtained by the above tests are to be compared with diesel base line data and optimum blend B5.

Keywords: *blend, TSOME,CI Engine, emission, performance*

I. INTRODUCTION

Diesel fuel has an essential function in the industrial economy of a developing country and used for transport of industrial and agricultural goods and operation of diesel tractors and pump sets in agricultural sector. The requirement of petro diesel in India is expected to grow from 39.815 MMT in 2001-02 to 52.324 MMT in 2006-07 and just over 66 MMT in 2011-12. The domestic supply of crude oil will satisfy only about 22% of the demand and the rest will have to be met from imported crude. This has stimulated recent interest in alternative sources to replace petroleum-based fuels. Of the alternative fuels, bio-diesel obtained from vegetable oils holds good promises as an eco-friendly alternative to diesel fuel Vegetable oil is a promising alternative fuel for CI engine because it is renewable, environment friendly and can be produced in rural areas. The use of non-edible vegetable oils compared to edible oils is very significant in developing countries because of the tremendous demand for edible oils as food and they are too expensive to be used as fuel at present. The term, bio-diesel, was first introduced in the United States during 1992 by the National Soy Development Board (presently National Biodiesel Board), which has pioneered the commercialization of biodiesel in the USA.

Tobacco seeds an excellent source of oil. The work done so far at CTRI has brought out tremendous scope for exploiting the crop for extraction of oil. In this background, emphasis will be laid on tobacco seed oil and suitable R&D initiatives are envisaged. India is the third largest consumer of edible oils and will account for 11% of global edible oil demand and 16% of global imports. The demand for edible oils in India has shown a steady growth at the rate of 4.43% over the period from 2001 to 2011. The current per capita consumption levels of India (at 13.3 Kg/year for 2009-10) are lower than global averages (24 kg/year). In terms of volumes, palm oil, soybean oil and mustard oil are the three largest consumed edible oils in India. There has been a significant gap between demand and supply of edible oil because of limited availability of oil seeds and shifting of acreage to other crops in the domestic market. This gap has been met through imports, which account for almost 45-50% of the total oil consumption. The dependence on imported oils to continue in the foreseeable future due to anticipated domestic supply constraints and the high cost competitiveness of imported oils.

Tobacco seed is a rich source of oil. Tobacco seeds contain about 35%semi-drying oil which is nicotine free. Tobacco seed is very small. There are about 3,00,000 seeds in one ounce, or more than 10,000 seeds per gram. One tobacco plant may produce one-half an ounce, or about 1,50,000 seeds, which is enough for 100 square yards of seedbed area. Under favourable conditions seeds from one plant may provide enough seedlings from 2 to 5 acres of field tobacco. In the recent year some new industrial uses of tobacco have been envisaged as a strategic development in case the anti-tobacco movement curbs its conventional use so that tobacco leaf farmer do not suffer by producing crop. The strategy does not make tobacco leaf available for smoking but produce socially relevant useful products like good grade proteins and edible oils. It is appropriately named as "alternate use of tobacco."

Tobacco seed oil has low toxicity, and its smell is rather strong. It is burnt in lamps throughout India, and acts as good charcoal. The high calorific value of tobacco seed oil matches diesel. It blends with diesel, substituting for nearly 35% of the later, and has been suggested for use without any major engine modification and without any worthwhile drop in engine efficiency. A mature tobacco plant may produce 0.5- 1 kg of fruit each year. Tobacco seeds yield 35% oil. Presently, billions of tobacco seeds are wasted in India, because of the lack of a proper collect.

Biodiesel was produced from non-edible tobacco seed oil having a free fatty acid content of 19% in a two-step process, as free fatty acid of more than 1% in the feedstock adversely affects the single step alkali catalyzed transesterification process by soap formation. The first step of acid catalysed esterification reduced the free fatty acid content of tobacco seed oil to below 1%. The optimum combinations of parameters for pre-treatment were found to be 0.60 volume by volume (v/v) methanol-to-oil ratio, 1% v/v KOH acid catalyst and 1 hr reaction time. The next base catalysed transesterification process converted the pre-treated oil to tobacco seed biodiesel. The optimum combination of parameters for transesterification was found to be 0.24 v/v methanol to- oil ratio, 1.08% weight by volume (w/v) catalyst concentration and 60 min reaction time. This two-step process gave an average yield of 90%. The fuel properties of tobacco seed biodiesel were found to be comparable to those of diesel, and conform to the latest American Standards for Testing of Materials Standards.

II. History of Tobacco

The genus *nicotiana* is one of the five major genera of the family *solanaceae*. *N. Tabacum* l. And *n. Rustica* l. Are the only two cultivated species in the genus and several commercial varieties of them are being cultivated throughout the world. Among the sixty four or more species of *nicotiana*, *n. Tabacum* is the most widely grown for commercial use. *N. Rustica* is grown commercially only in limited areas of china, india and the ussr. *N. Tabacum* is a natural amphidiploid (2n = 48) thought to have arisen by hybridization of wild progenitor species. Different types of tobaccos grown commercially are defined to a large extent by region of production, method of curing and intended use in the manufacturing as well as some distinct morphological characters and chemical differences. As the country is endowed with diverse agro-climatic zones, it grows all types of tobacco, which are broadly classified as flue-cured virginia (fcv) and non-fcv types.

Tobacco is one of the most economically important agricultural crops in the world. It provides livelihood for millions of people, billions of dollars in trade and trillions of dollars in business. Tobacco is a native of the subtropical zone. For economic reasons it is now being produced commercially in about every corner of the earth. Evidence suggests it originated from south america.

Tobacco is an important commercial crop of india with an area of about 4 lakhs ha and producing about 750 million kg. India stands at 2nd and 3rd position at world level for production and exports of tobacco respectively. Tobacco is contributing annually about rs. 20,000/- crores as excise duty and about rs.4020/- crores towards foreign exchange. Different types of tobacco *viz*. Flue-cured virginia (fcv), burley, bidi, natu, cheroot, hookah, cigar-wrapper, cigar-filler and chewing are being cultivated under different agro climatic conditions. In india, tobacco is grown mostly in andhra pradesh, gujarat, karnataka, tamil nadu, bihar, orissa, maharashtra, uttar pradesh and west bengal.

- The plant of tobacco for energy applications, contrary to the tobacco for the cigarettes industry, maximizes the production of flowers and seeds to the detriment of the leaves production and quality
- Its tobacco seed has a diameter of about 0.6 mm and is produced by the inflorescence in capsules 1.5 cm long, each capsule holds 0.5 g of seeds and each inflorescence more than 100 capsules
- The plant is extremely robust, able to grow in various climates and soils, as a matter of fact it can be cultivated on marginal lands which cannot be used for food production
- It is an annual plant, with the harvest in the same year of the sow, allowing farmers to plan every year the size of dedicated fields

Tobacco seeds maintain high viability under proper storage conditions. Kincaid (1958) reported tobacco seed maintained high viability for 25 years in tight containers, either refrigerated or desiccated or both. Seed stored in a paper envelope or a cloth bag in the laboratory deteriorated rapidly, while those in the refrigerator maintained high viability for 15 years but not for 20 years. Free access of air appeared un favourable to maintenance of viability for more than 15 years. The two principle factors affecting viability of seeds in storage are seed moisture and temperature. Under ideal storage conditions both the seed moisture content and temperature are kept low, but in practice it is often sufficient to control only one of these factors. It is the common practice to store tobacco seed at low moisture content (approximately 4%) with temperature below 21°c (70°f) in an air tight container. The seed contain reserve store of lipids, proteins, carbohydrates etc. To provide nourishment for the growing embryo. The degradation of these components influences viability.

Ageing is the major cause of loss of viability in seed. Ageing in all organism is the sum total of deteriorative process that eventually leads to death. Seeds are considered dead when in the absence of dormancy they fail to germinate under optimal conditions. Ageing and the consequent biochemical deterioration in the seeds gets accelerated at higher temperature and moisture content. At temperatures more than critical seed moisture level, seed respiration proceeds at faster than normal level and complex molecules like fats, proteins, and carbohydrates get broken down into simpler molecules (free fatty acids, amino acids and simple sugars). Membrane integrity and cellular compartment in the seed is slowly broken down on imbibition of water and the seed loses its food reserve into the surrounding medium resulting in the lack of nourishment for the embryo to grow and germinate. The result of ageing is accumulation of free fatty acids, amino acids and sugars in the seeds. The seed is thus central to crop production.

Tobacco seed is a rich source of oil. Tobacco seeds contain about 35% semi-drying oil which is nicotine free. The seeds also contain a few protein species that are present in high amounts and provide a store of amino acids for use during germination and seedling growth. These storage proteins are of particular importance not only because they comprise nearly the total protein content of the seed but also because they determine its quality for various uses (shewry et al., 1995). Seed proteins have been classified in many different ways. Osborne's classification, based on solubility, dates from the turn of the century and one of the most useful methods. By solubility criteria, proteins are classified into groups on the basis of their extraction and solubility in water (albumins), dilute saline solutions (globulins), alcohol/water mixtures (prolamins) and dilute acid or alkali solutions (glutelins) (ashton, 1976). However, the divisions between these groups of protein are not always clearly defined. For instance, the extraction depends on the sequence in which the solvents are used, on the vigor of the extraction and on the conditions of the starting material (padhye and salunkhe,1979; shewry et al; 1995). On the other hand, the globulins from different plant sources usually require salt solutions of different ionic strength to solubilise completely (danielson, 1955).

In the recent years some new industrial uses of tobacco have been envisaged as a strategic development in case the anti-tobacco movement curbs its conventional use so that tobacco leaf farmer do not suffer by producing the crop. the strategy does not make tobacco leaf available for smoking but produces socially relevant useful products like good grade proteins and edible oils. it is appropriately named as "alternate use of tobacco.

Fig 1.Tobacco seeds

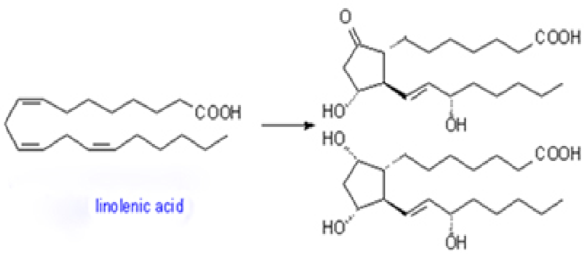

Fig 2 Chemical Structure of Tobacco seed Oil

2.1 Properties of Tobacco Seed Oil

Appearance:-	:yellow
Melting point:	:19°C
Boiling point:	: 320°C
Specific Gravity (gm. cm^{-3})	:0.917
Flash point:	:210°C
Auto-ignition temperature:	:343°C
Stability:	: Generally stable, but polymerizes gradually upon Exposure to air.
Combustibility:	: Incompatible with strong oxidizing agents. Reacts Violently with chlorine. Rags or paper impregnated with seed oil may spontaneously combust after a long period due to gradual exothermic reaction with oxygen.
Toxicology	: Skin irritant (not in all cases). May be allergenic.
Transport information:	: Non-hazardous for air, sea or road freight.
Personal protection:	: Gloves and adequate ventilation.

Tobacco seed Oil is also a valuable tool in the preservation of concrete. An application of seed oil penetrates the surface of the concrete forming barrier to water. It stabilizes the surface of the concrete, reduces the formation of dust and prevents corrosive breakdown of the steel reinforcing rods.

2.2 Steps in Production Of Bio-Diesel

1. Transesterification.
2. Settling and Separation of esters and glycerin.
3. Washing of bio-fuel
4. Heating.

The most common derivatives of agricultural oil for fuels are methyl esters. These are formed by trans esterification of the oil with methanol in the presence of a catalyst (usually basic) to give methyl ester and glycerol. Sodium hydroxide (NaOH) is the most common catalyst, though others such as potassium hydroxide (KOH) can also be used. Contents used in trans esterification process are

Veg oil: Cotton seed oil, sun-flower oil.
Alcohols: Methanol.
Catalyst: Sodium hydroxide, Potassium hydroxide.
100gr oil+25gr methanol+1gr KOH a 95gr biodiesel+26gr glycerine

2.3 Steps Involved In Transesterification

1. Catalyst is dissolved in alcohol using a standard agitator or a mixer.
2. Alcohol catalyst mix is then charged into a closed reaction vessel and bio lipid (Vegetable or animal oil or fat) is added.
3. Reaction mixture is kept just above the boiling point of alcohol with a recommended reaction of around 1-8 hours.
4. Un-reacted or excess alcohol is recovered by distillation which is recycled back.
5. The products containing the glycerol and ester namely the biodiesel are separated using a continuous decanter (with glycerin as underflow and biodiesel as overflow). Centrifuge is used to separate the two materials faster. Once separated from glycerin biodiesel is purified by washing gently with warm water to remove residual catalyst or soaps, dried and sent to storage.

We made the oil by extracting from the seeds by crushing process. Then the produced crude oil is filtered by using the serigraphy papers (A1,A2) filtered oil is preheated by direct heating. The molar ratio 16:1 we mixed methanol and KOH by the titration up to dissolving the KOH completely. This solution is mixed with tobacco crude oil

This solution is heated further to separate the glycerine and other fatty acids about 6hr. At constant temperature 60^{o}c-75^{o}c. The mixture solutions is cooled by using conical flask for 1daya keeping in atmosphere.

Then it formed 2 layers glycerine and pure bio-diesel.now the bio-fuel is separated and the blends are prepared with these tobacco bio-fuel.

blends are (B5, B10, B20, B30, B40) in the performance and analysis criteria

2.3.1 Equipment for Constant Heating

In transesterification process we need constant heating to separate the esters, for this we used a steam bath it is shown in plate 3.2

Fig 3. Steam Bath

2.3.2 Separation of ethyl esters

After transesterification the mixture at the end is settle forat least 10 hours. The lower layer will be of glycerin and the upper layers methyl ester (bio-fuel). After settling we have to separate the methyl ester from the glycerine shown in plates 3.2(a) and 3.2(b). The mixture is separated by using a separating flask.

Fig 4 Process of Separation

Fig 5 Formation of Glycerin

Glycerin is the useful by–product produced in process of making bio-diesel, which is used in the makinng of soap's and many other beauty products.

III. Preparation of Blends with Diesel

The obtained Bio- Diesel is blended for conducting the performance test, the Tobacco seed Bio- Diesel is mixed in proper proportions.

3.1 Procedure

1. The Bio- Diesel is first filtered form impurities.
2. Required amount of fuel and Bio- Diesel is taken into the measuring jar and mixed thoroughly the amount of proportions shown in table 3.3(a) & 3.3(b).
3. Obtained TSOME fuel properties are find out and these values are tabulated in tables 3.10 to 3.13.

Table3.1 Blending Percentage of Fuel

Notation	Fuel Quantity	Bio-Diesel Quantity	Diesel Quantity
B5	1 LITRE FUEL	50 ml	950ml
B10	1 LITRE FUEL	100 ml	900 ml
B20	1 LITRE FUEL	200 ml	800 ml
B30	1 LITRE FUEL	300ml	700ml
B40	1 LITRE FUEL	400ml	600ml

Fig 5 Tobacco seed Oil Blends (B5, B10, B20, B30, B40)   fig 7 Diesel and Tobacco crude oil

3.2 Specificgravity- Result

Table 3.2 Results of Specific Gravity for TSOME and Diesel

S.No	Oil	Blend	Specific Gravity
1.	Diesel	D100	0.835
2.	Tobacco Oil Crude		0.917
3	Tobacco seed Oil Methyl Ester Blends With Bio-Diesel (TSOME)	B5	0.6859
		B10	0. 6988
		B20	0.7111
		B30	0.7282
		B40	0.7454

3.3 Viscosity – Results

Table3.3 Results of Viscosity for TSOME and Diesel at 40^{0}C

S.NO	OIL		Kinematic Viscosity (stokes)	Dynamic Viscosity (Poise)
1	Diesel	D100	0.364	0.652
2.	Tobacco Oil Crude		0.484	0.738
3	Tobacco seed Oil Methyl Ester Blends With Bio- Diesel (TSOME)	TSOME	0.80	0.64

3.4 Flash Ans Fire Points – Results

Table3.4 Results of Flash Point and Fire of TSOME and Diesel

S.No	Oil		Flash Point ^OC	Fire Point ^OC
1.	Diesel	D100	58	62
2.	Tobacco Oil Crude	B100	185	192
3	Tobacco seed Oil Methyl Ester Blends With Bio- Diesel (TSOME)	TSOME	50	56

3.5 Carbon Percentages – Results

Table 3.5 Results of Carbon Residue for TSOME and Diesel

Oil		% of Carbon
Diesel	D100	0.12
Tobacco seed Oil Methyl Ester Blends With Bio- Diesel (TSOME)	TSOME	0.22

3.6 Calorific Value Results

Table3.6 Results of Calorific Value in kJ/kg for TSOME and Diesel

	Crude	B5	B10	B20	B30	B40
Tobacco seed oil kJ/kg	38438	42181	41862	41224	40586	39948
Diesel kJ/kg	42500	42500	42500	42500	42500	42500

After find all properties of TSOME then next stage performance and emissions parameters are find with the help of 4-stroke single cylinder compression ignition diesel engine, gas analyser and smoke meter.

IV. Experimental Setup and Procedure

4.1 Introduction

Using TSOME oil tests are to be conducting on different equipment's, to be found some of the fuel properties. Later performance and emission tests were conducted on 4- stroke single cylinder water cooled diesel engine coupled with a rope brake dynamometer, with the help of Smoke meter and multigas analyzer.

4.2 Diesel Engine

Experimental set up consists of a water cooled single cylinder vertical diesel engine coupled to a rope pulley brake arrangement it shown in plate 4.6, to absorb the power produced necessary weights and spring balances are induced to apply load on the brake drum suitable cooling water arrangement for the brake drum is provided. A fuel measuring system consists of a fuel tank mounted on a stand, burette and a three way cock. Air consumption is measured by using a mild steel tank which is fitted with an orifice and a U-tube water manometer that measures the pressures inside the tank. For measuring the emissions the gas analyser is connected to the exhaust flow.

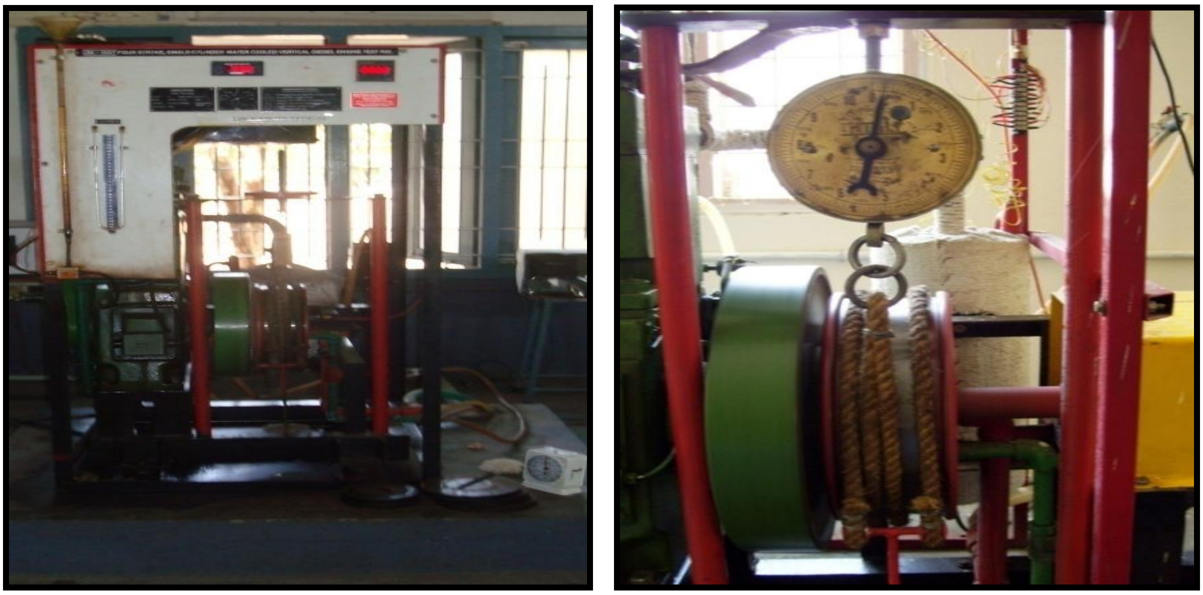

Fig 8 (a) 4- Stroke diesel engine (b) Dynamometer

4.2.1 Description

This is a water cooled single cylinder vertical diesel engine is coupled to a rope pulley brake arrangement to absorb the power produced necessary weights and spring balances are induced to apply load on the brake drum suitable cooling water arrangement for the brake drum is provided. Separate cooling water lines are provided for measuring temperature. A fuel measuring system consists of a fuel tank mounted on a stand, burette and a three way cock. Air consumption is measured by using a mild steel tank which is fitted with a orifice and a U-tube water manometer that measures the pressures inside the tank. Also digital temperature indicator with selector switch for temperature measurement and a digital rpm indicator for speed measurement are provided on the panel board. A governor is provided to maintain the constant speed. For measuring the emissions the gas analyser is connected to the exhaust flow.

4.2.2 Procedure

Note down engine specifications and ambient temperature.

1. Calculate full load (W) that can be applied on the engine from the engine specifications.
2. Clean the fuel filter and remove the air lock.
3. Check for fuel, lubricating oil and cooling water supply.
4. Start the engine using decompression lever ensuring that no load on the engine and supply the cooling water
5. Allow the engine for 10 minutes on no load to get stabilization.
6. Note down the total dead weight, spring balance reading, speed, time taken for 20cc of fuel consumption and the manometer readings.
7. Repeat the above step for different loads up to full load.
8. Allow the engine to stabilize on every load change and then take the readings.
9. Before stopping the engine remove the loads and make the engine stabilized.
10. Stop the engine pulling the governor lever towards the engine cranking side. Check that there is no load on engine while stopping

V. Experimental Observation

5.1 Introduction

The engine was first operated on diesel fuel with no load for few minutes at rated speed of 1500 rpm until the cooling water and lubricating oil temperatures comes to certain temperature. The same temperatures were maintained throughout the experiments with all the fuel modes. The baseline parameters were obtained at the rated speed by varying 0 to 100% of load on the engine.

The diesel fuel was replaced with the Tobacco seed oil biodiesel (B5) and test was conducted with the blend of 95% diesel and 10% biodiesel by varying 0 to 100% of load on the engine with an increment of 20%. After the Tobacco seed oil biodiesel, the test was conducted with the blend of 90% diesel and 10% biodiesel (B10). After the Tobacco seed oil biodiesel, the test was conducted with the blend of 80% diesel and 20% biodiesel (B20). After the Tobacco seed oil biodiesel, the test was conducted with the blend of 70% diesel and 30% biodiesel (B30) and after the Tobacco seed oil biodiesel, the test was conducted with the blend of 60% diesel and 40% biodiesel (B40).

The directly blended fuel does not require any modifications to diesel engines. Hence direct blending method was used in this test. The tests were conducted with these three blends by varying the load on the engine. The brake power was measured by using an electrical dynamometer. The mass of the fuel consumption was measured by using a fuel tank fitted with a burette and a stop watch. The brake thermal efficiency and brake specific fuel consumption were calculated from the observed values. The exhaust gas temperature was measured by using an iron-constantan thermocouple.

The exhaust emissions such as carbon monoxide, carbon dioxide, nitrogen oxides, hydrocarbons and unused oxygen were measured by exhaust an analyser and the smoke opacity by smoke meter.The results from the engine with a blend of diesel and biodiesel and compared with the baseline parameters obtained during engine fuelled with diesel fuel at rated speed of 1500 rpm.Out of these three blends best blend is obtained on the basis of performance parameters. In this experiment B5 shows the best results. and compared with the baseline parameters obtained during engine fuelled with diesel fuel at rated speed of 1500 rpm.

VI. Results and Discussion

6.1 Introduction

The experiments are conducted on the four stroke single cylinder water cooled diesel engine at constant speed (1500 rpm) with varying 0 to 100% loads with diesel and different blends of TSOME like B5, B10, B20, B30

and B40.The performance parameters such as brake thermal efficiency and brake specific fuel consumption were calculated from the observed parameters and shown in the graphs.

The other emissions parameters such as exhaust gas emissions such as Carbon monoxide, hydrocarbons, and oxides of nitrogen, carbon dioxide, unused oxygen and smoke were represented in the form of graphs from the measured values. The variation of performance parameters and emissions are discussed with respect to the brake power for diesel fuel, diesel-biodiesel blends and obtained optimum blend are discussed in below article.

6.2 Performance Analysys Using Pure Diesel and Its Blends of Tsome

In this stage various performance parameter characteristics are discussed in below for diesel, TSOME -diesel blends.

6.2.1 Brake Thermal Efficiency

The variation of brake thermal efficiency with brake power for different fuels is presented in Fig.6.1. In all cases, it increased with increase with brake power. This was due to reduction in heat loss and increase in power with increase in load. The maximum thermal efficiency for B5 at full load 44.27%, was higher than that of diesel (32.16%). Increase in thermal efficiency due to % of oxygen presence in the biodiesel, the extra oxygen leads to causes better combustion inside the combustion chamber. The thermal efficiency of the engine is improved by increasing the concentration of the biodiesel in the blends and also the additional lubricity provided by biodiesel. The reason may be the leaner combustion of diesel and extended ignition delay resulting in a large amount of fuel burned.

The increment of BTE was observed with B5 at full load is 12.11% higher than that of diesel fuel.

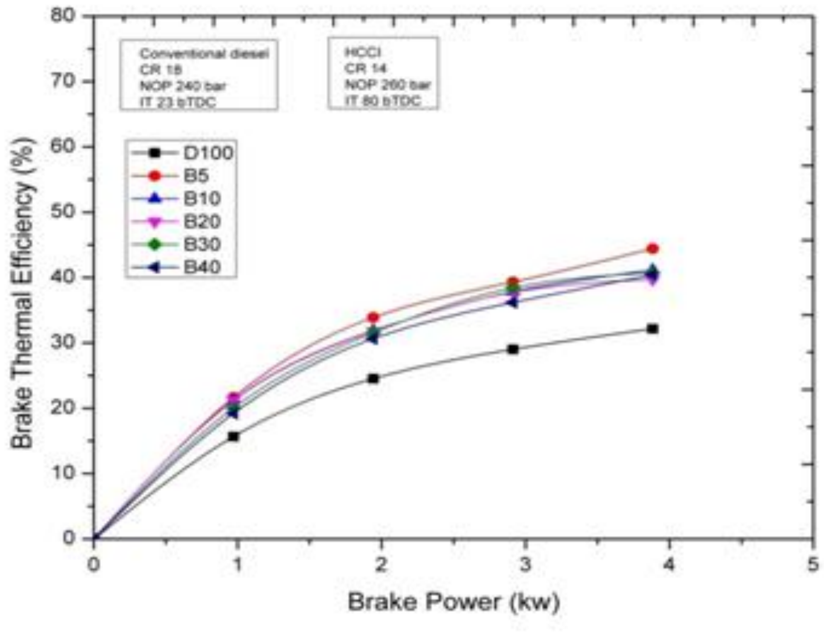

Fig.9 Variation of Brake Themral Efficiency with Brake power using TSOME Blends

6.2.2 Brake Specific Fuel Consumption

The variation in BSFC with brake power for different fuels is presented in Fig.6.3. Brake-specific fuel consumption (BSFC) is the ratio between mass fuel consumption and brake effective power, and for a given fuel, it is inversely proportional to thermal efficiency. BSFC decreased sharply with increase in brake power for all fuels. The main reason for this could be that the percent increase in fuel required to operate the engine is less than the percent increase in brake power, because relatively less portion of the heat is lost at higher loads.

It can be observed that the BSFC of 0.256kg/kW-hr were obtained for diesel and 0.1324 kg/kW-hr B5 at full load. It was observed that BSFC decreased with the increase in concentration of TSOME in diesel. The BSFC of Bio-diesel is decreases up to 18.52% as compared with diesel at full load condition.

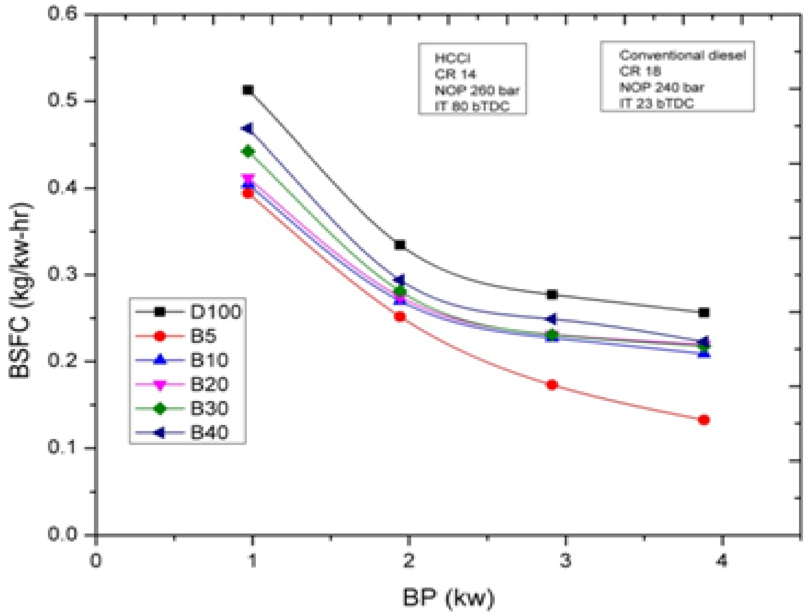

Fig.10 Variation of Brake spacific fuel conjumption with Brake Power using TSOME Blends

6.2.3Air-Fuel Ratio

The A/F ratio that was obtained from calculations is plotted against brake power and compared the results for different blends of fuels as shown in Fig.6.6. As the percentage of TSOME is increased in blends A/F ratio increased negligibly for B10,B20,B30 and B40 blends at constant injection pressure. A/F for diesel is 23.16, where as in case of B5 40.23 from that it is observed decrease in A/F up to 5.56% compares with diesel at full load condition. In the same way decrement of A/F occurred in B10 and B40.

The air fuel ratio decreases due to increase in load because of the compensation of load can only be done with increasing the quantity of fuel injection to develop the power required to bare the load.

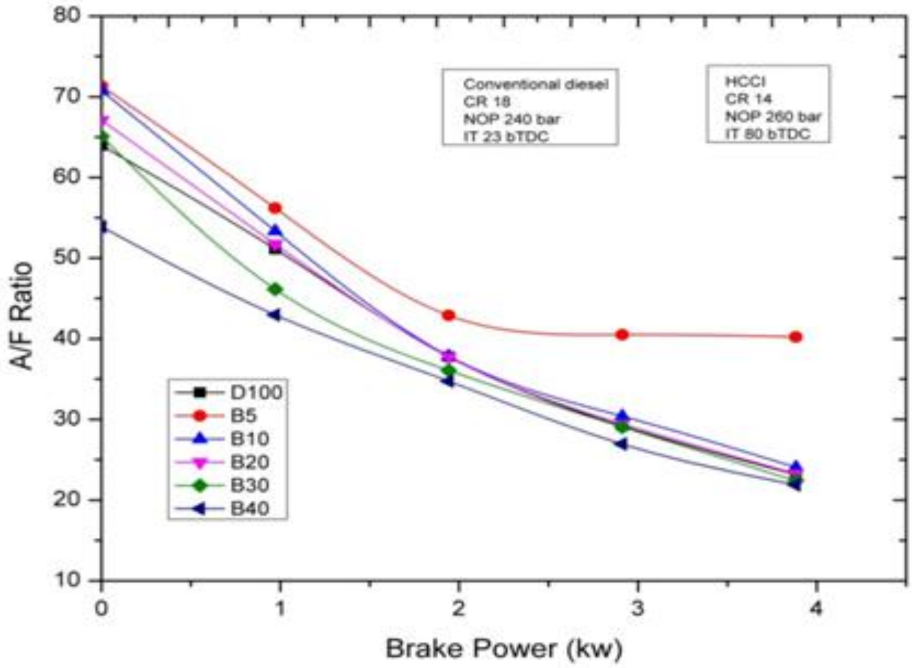

Fig.11 Variation of Air-Fuel Ratio with Brake Power using TSOME Blends

6.2.4. Smoke Density

The variation of Smoke density emissions with brake power for diesel fuel, biodiesel-blends is shown in the Fig.6.12. The smoke is formed due to incomplete combustion in engine.

The smoke density is lower for B5 compared to B10 and D100.The maximum smoke density recorded for the diesel was 83.57 HSU, 64.37HSU for B10, 60.65 HSU for B20, 50.36 HSU for B30, 65.57 HSU for B40 and 45.69 HSU for B5 at maximum load. The decrease in smoke density of B5, B10, B20, B30 and B40 is 45.32%, 22.97%, 27.42%, 39.72% and 21.53% respectively compared with diesel fuel at full load. In case of TSOME, the smoke emission is low. This is because of better combustion of TSOME. The smoke density increased with the load for diesel fuel and diesel blends. The smoke opacity of the pure biodiesel was higher than those of all the other fuels used generally. Smoke opacity of the blends B5, B10, B20, B30 and B40 were lower than those of the diesel fuel at all loads on the engine.

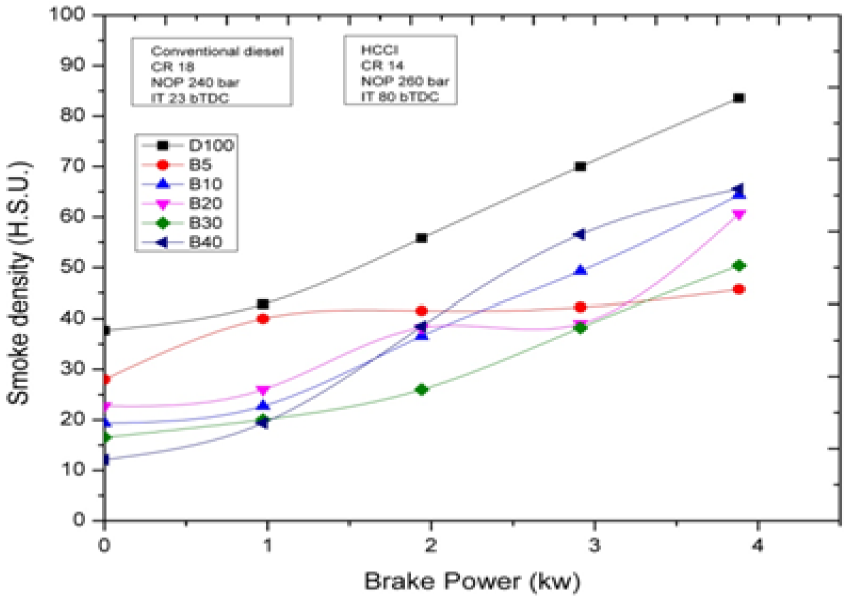

Fig.12 Variation Smoke deensity with Brake power using TSOME Blends

VII. Performance And Emissions Analysis Using Diesel And Tsome Blends

In this experimental study, the effect of Tobacco seed oil Methyl ester blends and diesel fuel on engine performance and exhaust emissions were investigated on single cylinder ,water cooled and direct injection at constant speed of 1500 rpm.Out of all blends of Tobacco oil methyl esters B5 shows best results in performance and Smoke Density parameters.

The conclusions of this investigation are compared with diesel base line data at full load as follows:

- The maximum brake thermal efficiency for B5 (44.42%) was higher than that of diesel.
- The brake thermal efficiency increased in 12.11% compared with diesel.
- Brake specific fuel consumption is decreases in blended fuels. In B5 fuel the BSFC is lower than the diesel in 18.52%.
- Significant reductions were obtained in smoke Density, Smoke Density was increased by45.32% with B5 compared to diesel at maximum load of the engine.

VIII. Conclusion

The performance and emission characteristics of conventional diesel, diesel and biodiesel blends were investigated on a single cylinder diesel engine. The conclusions of this investigation at full load are as follows:

- The brake thermal efficiency increases with increase biodiesel percentage. Out of all the blends B5 shows best performance and emissions parameters. The maximum brake thermal efficiency obtained is 44.42% with B5 blend.
- As a CI engine fuel, B5 blend results in an average reduction of 21.53% smoke densities.
- Since B5 blend reduces the environmental pollution, high in thermal efficiency when compared with diesel it will be a promising renewable energy source for sustaining the energy.

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