Experimental Analysis of Emission of Single Cylinder Four Stroke Stationary Diesel Engine with Bio-Diesel

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***Abstract*— Biodiesel are becoming increasingly popular because of their low environmental impact and potential as a green alternative fuel for diesel engine and they would not require significant modification of existing engine hardware. Bio-diesel derived through transesterification process. Experimental analysis of emission of single cylinder four stroke water cooled stationary diesel engine when fueled with bio diesel to diesel. An experimental study is conducted to evaluate the effects of using blends of different oil with conventional diesel fuel so Break thermal efficiency is slightly reduced and hydrocarbon, carbon monoxide and smoke emission in the exhaust are reduced. The tests are conducted using each of the above fuel blends or neat diesel fuel, with the engine working at a constant speed and at different loads. Moreover, for each test, volumetric fuel consumption, exhaust smokiness and exhaust regulated gas emissions are measured.**

***Index Terms*— Diesel Engine, Fuel, Biodiesel, Cylinder, Blends fuel.**

I. INTRODUCTION

Transesterification of a vegetable oil was conducted as early as 1853 by E. Duffy and J. Patrick, many years before the first diesel engine became functional. Rudolf Diesel's prime model, a single 10 ft. (3 m) iron cylinder with a flywheel at its base, ran on its own power for the first time in Augsburg, Germany, on 10 August 1893 running on nothing but peanut oil. In remembrance of this event, 10 August has been declared "International Biodiesel Day".

It is often reported that Diesel designed his engine to run on peanut oil, but this is not the case. Diesel stated in his published papers, "at the Paris Exhibition in 1900 (Exposition Universally) there was shown by the Otto Company a small Diesel engine, which, at the request of the French government ran on arachnid (earth-nut or pea-nut) oil (see biodiesel), and worked so smoothly that only a few people were aware of it.

The engine was constructed for using mineral oil, and was then worked on vegetable oil without any alterations being made". Diesel himself later conducted related tests and appeared supportive of the idea. In a 1912 speech Diesel said, "The use of vegetable oils for engine fuels may seem insignificant today but such oils may become, in the course of time, as important as petroleum and the coal-tar products of the present time."

Despite the widespread use of petroleum-derived diesel fuels, interest in vegetable oils as fuels for internal combustion engines was reported in several countries during the 1920s and 1930s and later during World War II. Belgium, France, Italy, the United Kingdom, Portugal, Germany, Brazil, Argentina, Japan and China were reported to have tested and used vegetable oils as diesel fuels during this time.

More recently, in 1977, Brazilian scientist Expedito Parente invented and submitted for patent, the first industrial process for the production of biodiesel. This process is classified as biodiesel by international norms, conferring a "standardized identity and quality." As of 2010, Parente's company Tecbio is working with Boeing and NASA to certify bioquerosene (bio-kerosene), another product produced and patented by the Brazilian scientist. Research into the use of transesterified sunflower oil, and refining it to diesel fuel standards, was initiated in South Africa in 1979. By 1983, the process for producing fuel-quality, engine-tested biodiesel was completed and published internationally.

II. VARIOUS TYPES OF BIODIESEL

Neem biodiesel

Neem (Mellia azadirachta) is of Meliaceae family. The other names of neem are margosn, Veppam, Vepun, Nimba and Vepa (Telugu) etc. Neem is a fast growing tree and can reach up to a height of 15-20 merrily to 35-40m. Neem oil is a vegetable oil pressed from fruits and seeds of neem, an evergreen tree which is widespread to the Indian Subcontinent and in many tropical areas.

Palm biodiesel

Palm oil is the second most traded vegetable oil crop in the world, after over 90% of the world's palm oil exports are produced in Malaysia and Indonesia. Palm oil is still mostly used in the manufacture of food products and is found in one in ten products sold in

UK supermarkets. However, palm oil is now starting to be used as an ingredient in bio-diesel and as a fuel to be burnt in power stations to produce electricity.

Corn biodiesel

Corn is a popular feedstock for ethanol production in the United States due to its abundance and relative ease of conversion to ethyl alcohol (ethanol). Corn and other high-starch grains have been converted into ethanol for thousands of years, yet only in the past century has its use as fuel greatly expanded. Conversion includes grinding, cooking with enzymes, fermentation with yeast, and distillation to remove water. For fuel ethanol, using a molecular sieve to remove the last of the water.

Jatropha biodiesel

When jatropha seeds are crushed, the resulting jatropha oil can be processed to produce a high-quality biofuel or biodiesel that can be used in a standard diesel car or further processed into jet fuel, while the residue (press cake) can also be used as biomass feedstock to power electricity plants, used as fertilizer (it contains nitrogen, phosphorus and potassium), or as animal fodder. The cake can also be used as feed in digesters and gasifiers to produce biogas.

Soybeans biodiesel

Soybeans can be used to produce ethanol. Soybean hulls contain significant amount of carbohydrate for ethanol production and producers prefer to use soybean hulls for animal feeding because of its high protein content (Mielenz et al., 2009). Although, biodiesel is usually used as a blend with petro-diesel at varying ratios, it can also be used to fuel compression ignition engines alone. The results of engine emission tests showed that use of biodiesel alone produced less emissions of CO, HC, NOx and smoke than petro-diesel.

Coconut biodiesel

This work considers the use of coconut oil for the production of alternative renewable and environmental friendly biodiesel fuel as an alternative to conventional diesel fuel. Test quantities of coconut oil biodiesel were produced through transesterification reaction using 100g coconut oil, 20.0% ethanol (wt% coconut oil), 0.8% potassium hydroxide catalyst at 65°C reaction temperature and 120 min. reaction time.

Sunflower biodiesel

Oilseed sunflower (Helianthus annuus L.) is quickly gaining popularity as a feedstock crop for biodiesel because it shares several positive agronomic features with other common oil crops such as canola and soy; yields well in a variety of conditions, and can be grown easily and profitably at both small farm and large field scales. The high oil content of sunflower seed, often over 40%, makes it an excellent choice for a biofuel crop.

III. OBJECTIVE OF WORK

1. As world reverses of fossil fuels and raw material are limited, it has stimulated active research interest in nonpetroleum fuels. Diesel engines are the major source of power generation and transportation hence diesel is being used extensively, but due to the gradual impact of environment pollution there is an urgent need for suitable fuels for use in diesel engine without any modification.
2. There are different kinds of vegetable oils and biodiesel have been tested in diesel engines its reducing characteristic for greenhouse gas emissions.
3. There are more than 350 oil bearing crops identified, among which only jatropha, sunflower, Soybean, cottonseed, rapeseed, palm oil and peanut oil are consider as potential alternative fuels for diesel engines.
4. Improving employment opportunities in rural areas.
5. Main objective are:
    a. Taking trial on diesel engine fuel with diesel for engine performance and exhaust emission.
    b. Taking engine trial on same diesel engine fuel with renewable liquid fuel for engine performance and exhaust emission.
    c. To use fuel derived from renewable biological resources in diesel engine.

IV. EXPERIMENTAL SETUP

The engine used in present study is a 4-stroke, single cylinder, water cooled engine. The line diagram and actual diagram of experimental setup is a shown below: -As shown in picture the arrangement of the rope brake dynamometer which is mounted on rigid frame for measurement of brake power of engine.

The other device in setup are flywheel, manometer, air box, calorimeter, temperature indicator etc. Manometer is used to take measurement of air and burette is used to take fuel consumption for desire time. Basic elements of engine are indicated in figure. Specification of engine are listed in table. Performance are engine will measure by rope brake type dynamometer.

Fig. 1.1 Engine setup

V. EXPERIMENT TEST PROCEDURE

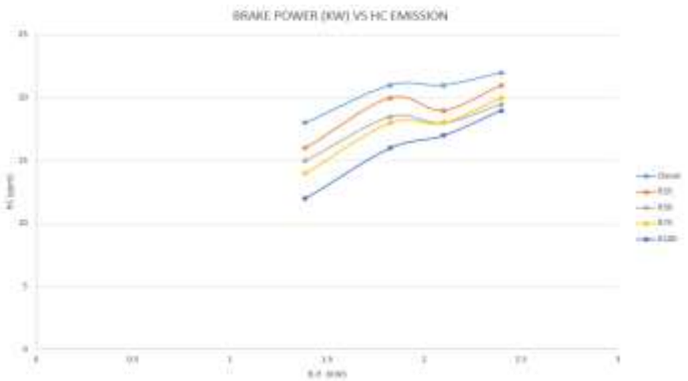
1. Fill up sufficient fuel in diesel tank.
2. Check oil level in the Engine and it should be set up top edge of the flat portion provide over the oil dipstick. If oil level is reduced, add up clean 20w/40 oil to the crank case by opening the valve cover after filling the oil.
3. Fill up mercury in manometer up to half of the manometer height.
4. If diesel tank is empty before filling the fuel, remove air bubbles in fuel pipe by opening the vent screw provided at the sides of the fuel pump.
5. Lift up decompression lever present at the sides of the valve covers, put the handle over the starting shaft and rotate the shaft. As Engine picks up sufficient speed drop the decompression levers.
6. As Engine picks up the speed, switch" ON" the main switch.
7. Speed of engine is to be set at constant speed using tachometer for all load conditions.
8. Now slowly apply load so that engine gets loaded.
9. Open the valve at bottom of the burette. Take sufficient fuel in the burette, close the valves of tank line so that diesel in the burette passes to the engine. Note down the time required to consume 50 ml of fuel.
10. Note down,
    a. Engine Speed using tachometer
    b. Load on Rope Brake dynamometer
    c. Height Difference between two limbs of Manometer connected to air box.
    d. Cooling Water Temperature entering/ leaving jacket using thermometer.
    e. Mass flow rate of cooling water using beaker.
    f. Temperatures of Engine Exhaust Gas using IR Temp. Gun and measuring
    g. HC & CO using exhaust gas analyzer.
11. Repeat the procedure for different loads.
12. After completion of test, remove all load. Switch OFF the main switch and put off the engine by pressing governor lever near to flywheel.

VI. EMISSION RESULT ANALYSIS

The variation in HC, CO, NOx and exhaust gas temperature with different load for diesel and soybeans biodiesel is shown in below graphs.

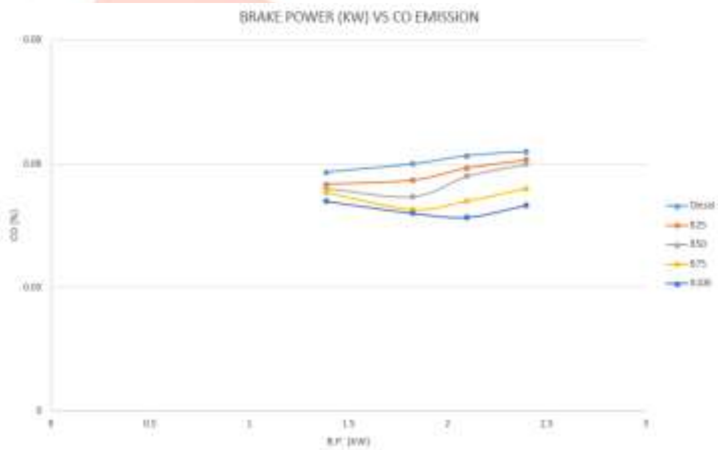
1. Hydrocarbon (HC):

- From graph of Brake power vs HC, it can be inferred that with increase in Brake power, HC also decreases for all test fuels.
- Among all the blends, B100 gives the lowest Hydrocarbon than all other blends.
- Diesel gives highest HC compare to all other fuel proportion.
- Graph shows that slightly variation while we use B25.



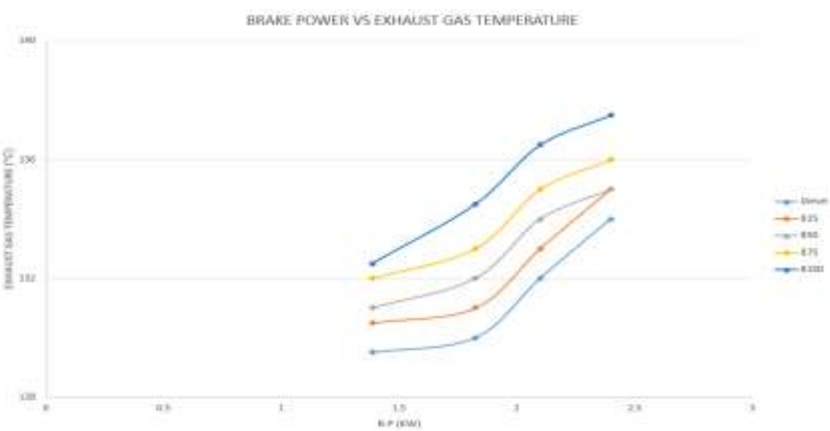
2. Carbon Monoxide (CO):

- CO is produced due to incomplete combustion of fuel. CO is increased with brake power.
- Among all the blends, B100 has the lower CO contain.
- Diesel gives the highest CO with all brake power.
- For maximum brake power, CO contain in case of Biodiesel is minimum compared to others. Likewise CO contain in case of diesel is maximum compared to other fuels.
- It can be inferred that with increase in Brake power, CO also increases for almost all test fuels.



3. Exhaust gas temperature (EGT):

- Graph shows that with increase in Brake power, Exhaust Gas Temp. also increases for almost all test fuels.
- EGT100 > EGTB75 > EGTB50 >EGTB25 > EGTdiesel
- This may be due to Lower heating value of biodiesel compared to that of diesel.
- For maximum brake power, EGT in case of diesel is minimum compared to others. Likewise EGT in case of Biodiesel is maximum compared to other fuels.



VII. CONCLUSION

Following conclusion were drawn from this study:

a. Diesel engine can be run on biodiesel blend and biodiesel without any modification.
b. Due to lower heating value of biodiesel, fuel consumption is more.
c. Mechanical efficiency is almost same for diesel, biodiesel and different blends. So, we can this biofuel can use to replace the diesel.
d. B50 and B75 gives lower HC emission than B25 and diesel.
e. B25 and B50 gives lower CO_2 emission than pure diesel. But B100 gives lowest CO_2 emission. Among all blends.
f. NO_X emission for all blends is higher than diesel.

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