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EXPERMENTAL ANALYSIS OF PEANUT OIL AS BIO-DIESEL ON CI ENGINE

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Abstract-*In this study, we conducted experimental investigation on a IC engine using blends of methyl esters derived from peanut oil and diesel fuel. The process of transesterification is used to convert the peanut oil into methyl esters, which are then analyzed for various fuel properties including density, viscosity, flash point, fire point, and calorific value to determine their suitability for use as fuel.*

In the next phase of the study, experimental investigations are conducted on a test engine using blends of biodiesel and diesel, ranging from B10 to B30, under the same operating conditions. The engine performance parameters such as brake power, brake specific fuel consumption, brake thermal efficiency, indicated power, indicated thermal efficiency, mechanical efficiency, and exhaust gas temperature are measured and compared to those of pure diesel operation.

Key Words: Biodiesel, peanut oil, Diesel

1.INTRODUCTION

India is heavily dependent on crude petroleum and petroleum products imported from gulf countries, which as significant economic and environmental implications. To address this challenge, Indianscientists have been exploring alternatives to diesel fuel that can be produced domestically while also preserving the global environment. India's vast agro-forestry resources, bio fuels of agricultural and forest origin have emerged as a promising renewable fuel source for internal combustion engines. These bio fuels are considered to be ideal alternatives to conventional fossil fuels as they are renewable, sustainable, and can help reduce the green house gas emissions. By leveraging its abundant natural resources, India can significantly reduce its dependence on imported fossil fuels and transition to a more sustainable energy system.

The escalating demand for fuel coupled with the worsening climate conditions has raised concerns about environmental problems and energy crises. In light of this, biodiesel has emerged as a promising alternative to traditional diesel fuel. Biodiesel refers to the mono-alkyl esters with long chains of fatty acids derived from vegetable oils, animal fats, or waste cooking oil. Biodiesel is renewable, non-toxic, non-flammable, and readily available fuel source. It is also free from sulfur or aromatic compounds, which helps to reduce air pollution, including carbon monoxide, hydrocarbons, and particulate matter. As a result, biodiesel is gaining worldwide attention and is considered an ideal fuel for the future.

The primary sources of commodities for biodiesel production are edible oils such as peanut oil, sunflower oil, soybean oil, and others. Although vegetable oils have good ignition characteristics, their long-chain hydrocarbon structure can cause several issues when used as fuel in internal combustion engines. These issues include carbon deposits buildup, poor durability, high density, high viscosity, lower calorific value, high molecular weight, and poor combustion efficiency.

To address these issues and improve the thermal efficiency of vegetable oil in engines, various methods have been developed to reduce the viscosity of the oil. The most commonly used methods include transesterification, dilution and cracking.

Transesterification involves converting the vegetable oil into biodiesel by reacting it with an alcohol in the presence of a catalyst. This process reduces the viscosity of the oil and improves its combustion properties.

Dilution involves blending the vegetable oil with a lighter fuel, such as diesel, to reduce its viscosity and improve its flow properties. This method also helps to reduce carbon deposits and improve the combustion efficiency of the fuel.

Cracking involves breaking down the long chain hydrocarbons in the vegetable oil into smaller, lighter molecules using heat and pressure. This process reduces the viscosity of the oil and improves its combustion properties.

By implementing these methods, the issues associated with using vegetable oil as fuel in internal combustion engines can be addressed, leading to improved efficiency and reduced environment impact.

2. LITERTURE REVIEW

SANTHOSH SHIVAN D, et al [1] peanut is a potential oil crop as it contains the high amount of oil as compared to only about 15%-20% for soybean oil. Aside from engine testing, emission associated with the use of biodiesel also needs to be evaluated to assess its cleanliness as a fuel. There are two main process are performed in the production of the peanut oil is a biodiesel. These were transesterification is the process of exchanging the alkoxy group of an ester compound by another alcohol.

MAKASSON R. CLAND et al, [2] MATERIALS AND METHOD the materials for study comprises of conical flask, thermometer, water bath, beaker, fresh groundnut oil, KOH, methanol, reactor, and distilled water, sodium hydroxide, GC, FTIR.

WAIL M.ADAIEH AND KHALED S.AIQDAH. [3] Sunflower oil the performance of biodiesel and its blends (B5 to B20) were studied in comparison with diesel fuel. The biodiesel is mixing with the standard diesel in an external tank, according to the needed ratio which is in this case 5% biodiesel with 95% standard diesel, 20% biodiesel with 80% standard diesel. The compression ignition engine used for the study was a single cylinder, four stroke, direct injection, aircooled engine.

J.M. MAKAVANA, et al,[4] flash point test the flash point of a volatile liquid is the lowest temperature at which it can vaporized to form an ignitable mixture in air.Pensky-marten`s closed cup tester measures the lowest temperature at which the application of the test flame causes the vapor above the bio-biodiesel sample to ignite.

3.METHODOLOGY

The production of peanut oil biodiesel typically involves two main processes: transesterification and washing. Transesterification is the process of converting triglycerides, such as those found in peanut oil, into biodiesel by exchanging the alkoxy group of ester compound with another alcohol, typically methanol. This reaction is often catalyzed by an acid or base catalyst.

After the transesterification reaction, the resulting biodiesel is typically washed with water to remove any remaining impurities. This is done because biodiesel produced by transesterification typically contain some methanol, glycerol, and other impurities that must be removed before the biodiesel can be used as fuel. Water washing is the most common method of cleaning biodiesel, and it works by soaking up the methanol and dissolving impurities, which are then washed away with water. The result is pure biodiesel of peanut oil.

4. METHODS AND PROCEDURE

4.1WORKING PROCESS

Two operations are performed these are transesterification and washing process

4.1.1 TRANSESTERIFICATION PROCESS

Transesterification reaction is the produce ester from groundnut oil using methanol-NAOH mixture as a catalyst. The reaction was carried out at a temperature of 60^0C and allowed to settle for 48 hours to complete the reaction.

During the reaction, the methanol-NAOH mixture was added to the groundnut oil in a transesterification reaction occurred, resulting in the formation to ester. The mixture was stirred rapidly to ensure proper mixing, and then allowed to settle for 48 hours to complete the reaction.

After the reaction was complete, the glycerol layer, which is the heavier liquid, collected at the bottom, while the ester product was at the top. The glycerol layer was drained off, and the ester layer remained as the final product.

4.1.2WASHING PROCESS

The Peterson et al. (1996) method for washing consists of two steps:

Step 1: initial settling

- Allow the mixture of glycerol and ester layers to settle until a clear separation between the two layers is observed.

Step 2: washing process

- After the initial settling, re-mix the glycerol layer with the ester layer.
- Add 15% water to the mixture and stir for 10 minutes.
- Allow the mixture to settle for 48 hours to allow for complete separation of the glycerol and ester layers.
- Carefully remove the top layer of glycerol and bottom layer of water.
- Repeat the washing process with fresh water until the water layer is free of impurities.

To modify the method, you could try different percentages of water or adjust the settling time to optimize the washing process. Additionally, you could experiment with using different solvents or washing agents to improve the efficiency of the process. However, any modifications should be tested and evaluated to ensure that they do not negatively impact the quality or purity of the final product.

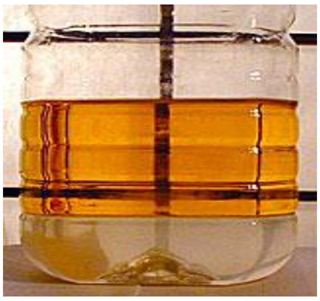

FIG1-WASHING PROCESS OF BIOFUEL

4.2TESTS CONDUCTED

- Density
- Viscosity
- Flash and fire point test
- Calorific value

4.2.1 DENSITY

Density is a physical property that represents the amount of mass per unit volume of a substance. It is commonly denoted by the greek letter ρ(rho), although the latin letter D may also be used. The mathematical formula for density is given by;

$\rho = m/V$

The SI units of density is kilogram per cubic meter(kg/m^3). However the other units such as grams per cubic centimeter (g/cm^3).

4.2.2 VISCOSITY

Viscosity is a physical property that characterizes a fluid`s resistance to deformation or flow due to internal friction between its molecule. In simpler terms, it is a measure of "thick" or "thin" a fluid is.

A fluid with high viscosity, such as honey or molasses, such as water or gasoline, has a thin and runny consistency and flow easily. The viscosity of a fluid depends on its molecular composition and the forces between its molecules.

4.2.3 FLASH AND FIRE POINT TEST

It seems like you have described the procedure for determining the flash point and fire points of a material, a closed cup apparatus is used. First, the material is filled in the cup up to a designated filling mark, and a lid is placed on top to create a closed system. A thermometer with a specified range is attached, and the apparatus is set up with all necessary accessories. To being testing, the test flame is first applied at least 17^{0}C below the expected flash point. Then, at every 1-3^{0}C increase in temperature, the test flame is reapplied until the flash point is reached. It`s important to note that stirring should be stopped during each test flame application. Once the flash point has been determined, testing continues until the fire point is reached. The same processing is applying the test flame at regular intervals is followed until the material ignites and continues to burn.

4.2.4 CALORIFIC VALUE

Calorific value is a measure of the amount of energy produced by the complete combustion of a unit quantity of substance, typically expressed in units of calories or joules. This value is determined using a bomb calorimeter, which ignites the substance in a sealed chamber and measures the resulting heat release. When it comes to the calorific value of coal, there are actually two different measures: the gross calorific value (GCV) and the net calorific value (NCV). The gross calorific value, also known as the high heating value (HHV), takes into account the latent heat of water vaporization that is released when the coal is burned. This means that it includes the energy required to convert water vapor into liquid water, which is produced during the combustion process.

BIO-DIESEL PROPERTIES

TABLE-1 Properties of the diesel and biodiesel

Properties	Diesel	Bio-diesel
Kinematics viscosity (cSt)	3.2	16
Density (kg/m^3)	830	844
Heating value (MJ/KG)	45.5	44
Flash point	50^{0}C	60^{0}C
Fire point	70^{0}C	100^{0}C

4.2.5 PERFORMANCE TEST

The given context deals with the performance analysis of an engine. The maximum load that can be applied to the engine can be determined by conducting a load test on the engine. The load test involves gradually increasing the load on the engine and nothing the engine speed and fuel consumption at each load increment. The load is increased until the engine reaches its maximum load capacity. Before conducting the load test, it is essential to ensure that the engine has sufficient fuel, lubricant, and cooling water supply. The engine should also be started in a no-load condition and allowed to run for a few minutes to attain the rated speed. During the load test, the time taken for the consumption of 10cc of fuel is noted at each load increment. The speed of the engine is also recorded at each load increment. The data obtained from the load test is tabulated to calculate the specific fuel consumption, indicated power, brake power, brake thermal efficiency, indicated thermal efficiency, and mechanical efficiency. The maximum load that can be applied to the engine is determined by observing the load at which the engine reaches its maximum performance based on the parameters mentioned above.

4.2.6 EMISSION TEST

Emissions testing are an important tool in the efforts to reduce air pollution from motor vehicles. The first emission testing was indeed conducted in California in 1966, and since then, many other states and countries have implemented similar testing requirements for all registered vehicles. When a vehicle undergoes an emissions test, the level of air pollutants emitted from the exhaust is measured. If the vehicle fails the emissions test, repairs must be done to bring it into compliance with the applicable standards, and the vehicle must be retested. To ensure consistent and comparable results across different engines and vehicles, emissions testing protocols include test cycles that specific conditions under which the engine or vehicle is operated during the test. These test cycles are often based on the emissions standard established by national and international governments and working groups. There are many different test cycles used around the world, each with its own specific requirements and conditions. Some of the most commonly used test cycles include the US EPA FTP-75 and HFET cycles, the European NEDC and WLTP cycles, and the Japanese JC08 cycle. These test cycles take into account factors such as vehicle speed, acceleration, and driving conditions to provide a standardized method for measuring emissions. Overall, emissions testing and the use of test cycles play a crucial role in helping to reduce air pollution from motor vehicles and promoting cleaner, more sustainable transportation.

5. RESULTS AND DISCUSSIONS

5.1 PERFORMANCE TEST

TABLE2-Performance characteristics of diesel and biodiesel at halfkg load of 16:1 compression ratio

S.NO	PERFORMANCE CHARECTERISTICS	PURE DIESEL	B20
1	BP (KW)	1.74	1.72
2	IP (KW)	5.07	4.75
3	BMEP (bar)	2.13	2.13
4	IMEP (bar)	6.22	5.88
5	BTHE (%)	17.61	24.08
6	BSFC (kg/kWh)	0.49	0.38
7	ITHE (%)	51.38	66.54
8	MECH (%)	34.28	36.19

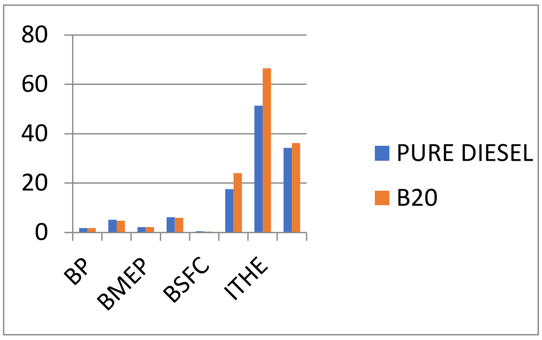

FIG2-PERFORMANCE GRAPH OF DIESEL Vs BIODIESEL

TABLE3- Performance parameters of diesel and biodiesel at half kg load of 18 compression ratio

S.NO	PERFORMANCE CHARECTERISTICS	DIESEL	B10	B30
1	BP (KW)	1.63	1.66	1.66
2	IP (KW)	5.76	5.77	5.94
3	BMEP (bar)	2.02	2.05	2.05
4	IMEP (bar)	7.16	7.14	8.58
5	BSFC (kg/kWh)	0.47	0.21	0.42
6	BTHE (%)	19.83	23.2	20.40
7	ITHE (%)	70.22	84.99	90.67
8	MECH (%)	28.24	38.25	23.90

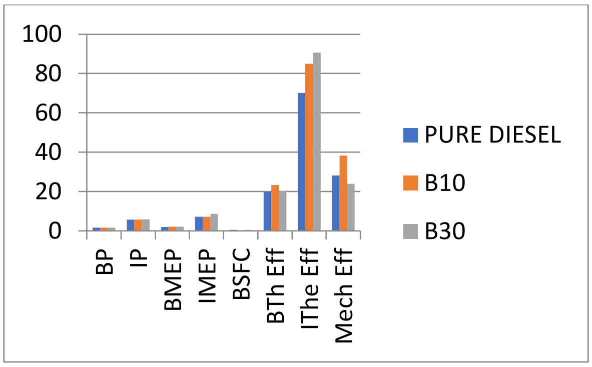

FIG3-PERFORMANCE GRAPH OF DIESEL Vs BIODIESEL

5.2 EMISSION TEST

TABLE4-Emission of biodiesel Vs diesel at 16compression ratio

S.NO	EMISSION	PURE DIESEL	B20
1	HC	28ppm	19ppm
2	CO	0.23%	0.08%
3	CO2	0.09%	3.04%
4	O2	14.70%	16.25%
5	NOX	339ppm	329ppm

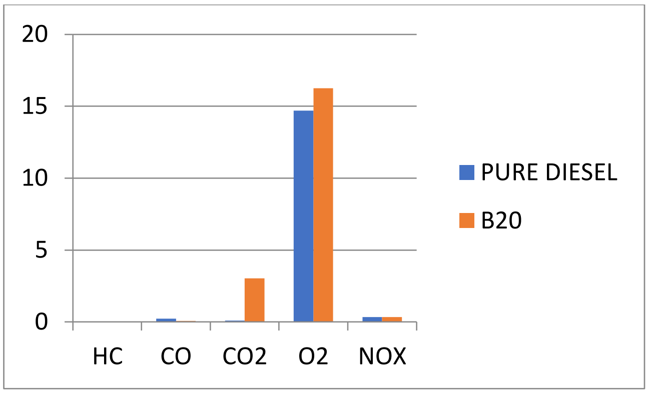

FIG4-EMISSION OF BIODIESEL Vs DIESEL

TABLE5-Emission of biodiesel Vs diesel at 18compression

S.NO	Emission	Pure Diesel	B10	B30
1	HC	25ppm	18ppm	29ppm
2	CO	0.05%	0.08%	0.14%
3	CO2	3.27%	3.03%	3.08%
4	O2	17.43%	17.92%	17.87%
5	NOX	358ppm	323ppm	286ppm

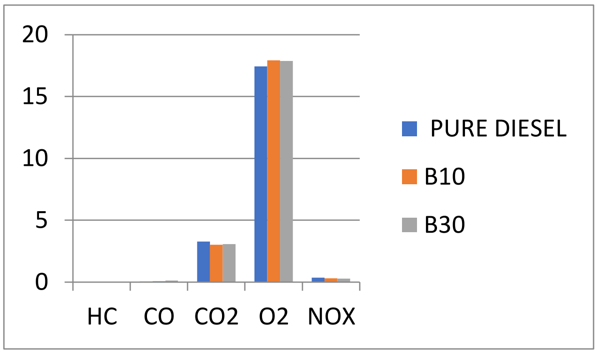

FIG5-EMISSION OF BIODIESEL Vs DIESEL

5.3 DISCUSSIONS

From the fig2 the performance characteristics of diesel and biodiesel B20 at half kg load of 16 compression ratio is nearest values of various performance tests.

From the fig 3 the performance characteristics of B10 values is high as compared to the B30 and nearer to the diesel at half kg load of 18 compression ratio of various performance tests.

From the fig 4 B20 emissions values is low as compared to the pure diesel due to low un burnt carbon gases.

From the fig 5 emissions values of B30 is low as compared to the B10 emission values and nearer to the pure diesel.

6.CONCLUSION

It`s great to hear that there`s a simple and eco-friendly method for synthesizing biodiesel from peanut oil. Biodiesel is a renewable and sustainable alternative to fossil fuels, and using peanut oil as a source for its production can provide several advantages.

It`s good to know that the synthesized biodiesel was confirmed by flash and fire point tests. These tests measure the temperature at which the biodiesel ignites and burns, respectively, and are important indicators of its safety and performance.

The emission test results are also encouraging, as they show that the synthesized biodiesel produced emissions that were similar to or better than standard emission tests. This is important because the emissions from transportation are a significant contributor to airpollution and dimatechange, and biodiesel can help reduce those emissions.

Finally the synthesis of biodiesel from peanut oil has a lot of potential as a sustainable and environmentally friendly energy source.

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