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Experimental Investigation of Diesel Engine by using Diesel,Orange Peel Oil and Lemon Peel Oil Blends with Aluminum Oxide Nanoparticle Additive

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ABSTRACT

Most automobile manufacturer are looking for ways to minimize emissions, improve thermal efficiency, and reduce fuel consumption by employing biofuel blends. This helps to improve thermal efficiency while lowering fuel consumption and pollutants. Because of the exponential rate of depletion and environmental concerns, there is a huge demand for alternative fuels for internal combustion engines. When oils produced from orange peel oil and lemon peel oil are combined with aluminum oxide (Al203) as an additive, they are used to make diesel engine blends. Lemon peel and orange peel oil extracts are appropriate for blending with diesel due to their high boiling point, acid value, and maximum oil production. The impact on engine performance and exhaust emissions of a blend of lemon peel oil, orange peel oil, and aluminum oxide as an additive utilized without affecting the structural alteration in compression engines.

KEYWORDS:Emissions, additives, Engine, Fuels, Bio diesel blends.

1. INTRODUCTION

In recent years, many attempts have been made all over the world to reduce reliance on petroleum fuels for power generation and transportation. Vegetable oils and biomass-derived fuels have received a lot of attention in recent decades. These fuels have been identified as potential fuels for a country like India, which is heavily reliant on agriculture. Biomass is a renewable, environmentally friendly, and readily available source of energy. Ethanol, a biofuel made from sugarcane, has been used in gasoline engines for a long time. Biofuels, on the other hand, are three to five times the cost of fossil fuels. This has been a major roadblock to mainstream adoption. Biofuel has been presented as a potential alternative fuel for internal combustion engines. Even though India is one of the world's greatest producers of ethanol, it is rarely used for power generation or transportation due to a variety of issues. As a result, biomass- derived diesel engine fuels must be discovered and applied as a substitute. Recent research on biofuels generated from the peels of various fruits and vegetables has sparked interest around the world, with the goal of replacing standard diesel fuel with these renewable, biodegradable, and ecologically beneficial options. India has the capacity to produce tones of orange peel oil from orange fruits. For the culinary and cosmetics industries,

orange oil is currently produced in volumes of tones. The orange oil was extracted at room temperature from citrus peel using the cold pressed oil process, which relies on the main component.

D-limonene is a kind of limonene (C10H16). In diesel engines, using neat orange oil improved the delay duration and combustion length, resulting in a 31.7 percent increase in brake thermal efficiency above diesel fuel's 29.3%. The emissions of carbon monoxide and hydrocarbons from neat orange oil fuel are significantly lower than those produced by diesel fuel. Higher NOx emissions were found at all loads when comparing orange oil fuel to diesel fuel. They tried adding diethyl ether to an orange peel oil-diesel fuel blend to reduce NOx emissions. The addition of DEE to orange oil increases braking thermal efficiency while also lowering NOx emissions. The addition of DEE did, however, result in a slight increase in CO and HC emissions, which is still within permissible limits.

Lemons are inexpensive all around the world. We're utilizing steam distillation to obtain lemon peel oil from lemon rinds in this procedure. Lemon peels are placed on top of a grid within the steam chamber and cooked by the steam vapors in this method. The lemon peel oil and liquid water mixture is collected in a collecting tank, and then the lemon peel oil and water are separated owing to density differences. After that, the contaminants in the lemon peel oil are drained smoothly and blended with ether. After that, the combination is placed over a water bath, where the heat causes the ether to evaporate, leaving only pure lemon peel oil in the bath. Finally, solid particles are removed from the mixture using a 40mm filter paper. Lemon peel oil contains a variety of compounds such as lemonal, terpinolene, diene, pine, and a few more. In a qualified laboratory, the physical and chemical qualities of lemon peel oil are examined experimentally. Lemon peel has the same flash point and burn point as diesel fuel. Lemon peel oil has a high equivalent energy density, which makes it a viable alternative to diesel fuel. Lemon blends have a reduced viscosity, which helps with fine droplet distribution inside the combustion chamber, which can have a big impact on the combustion process. Oranges have high levels of limonene in glands near the surface of their peels, and when rubbed, heated, or otherwise agitated, they release it. Because they're easily available, most commercial producers employ the rinds left over from juicing oranges for a cold extraction procedure like machine abrasion or cold pressing. Many commercial oil operations gather oil from all parts of the plant, using steam distillation, solvent extraction, and hydro diffusion to extract oil from the leaves, stems, and flowers. Although commercial producers have extraction equipment, you may imitate a few of processes in your home using common household items.

Preparation of fuel:

Diesel is a liquid fuel that is commonly used in compression-ignition engines. Diesel fuel is made from crude oil, biomass, animal fat, biogas, natural gas, and coal liquefaction. Petroleum diesel, often known as fossil diesel, is produced by fractionally distilling crude oil at temperatures ranging from 200 to 350 degrees Celsius. Synthetic diesel is made via the Fischer–Tropsch process from carbonaceous materials like biomass, coal, and biogas. Transesterification is a process that converts vegetable or animal lipids into biodiesel. The most used fuel is petroleum diesel, which is manufactured from crude oil.

2. LEMON PEEL OIL

Lemon peel oil is an essential oil derived from the peel of a lemon. Lemon is a citrus fruit that is commonly available. Lemon essential oil is classified as a flammable liquid of Class 3. Supercritical CO2 extraction, cold pressing, and steam distillation can all be used to extract essential oil from the peel. Cold pressing was utilized to obtain the oil used in this experiment. Cold pressing is the most common method for extracting high-quality essential oils, although there are various variations. The oldest method involves cutting each fruit in half, extracting the meat, and soaking the peel in water for a few hours before pressing it between two sponges that absorb a variety of essential oils, aqueous components, colloids, peel cells, and other things. The liquid phase is then released by wringing the sponges, and the essential oil is extracted by decantation or centrifugation.

Table 1: General range of properties of diesel and Lemon peel oil

Property	Diesel	Lemonpeeloil
Density(kg-m^{-3})	840 – 860	840–940
KinematicViscosity@40℃ (cST)	2.5–3.2	3–5
Calorificvalue(kJ-kg^{-1})	35,636–42,000	36,446–41500
FlashPoint(℃)	56 – 90	60–80

3. ORANGE PEEL OIL:

Oranges have large concentrations of limonene in glands close to the surface of their peels, and they release it when rubbed, heated, or otherwise stimulated. Most commercial producers use the rinds left over from juicing oranges for a cold extraction method, such as machine abrasion or cold pressing, because they're readily available. Many commercial oil operations cross-utilize all the plant tissue, using steam distillation, solvent extraction, and hydro diffusion to harvest the oil contained in the leaves, stems, and flowers. Although commercial producers have equipment that makes extraction easier, you can replicate a couple of methods in your kitchen using everyday tools.Cold pressing is one of the oldest methods of oil extraction and one you can replicate at home with a garlic press. You won't get as much oil pressing the peels as you would by steam distillation, which yields about 150 milligrams of oil per 15 grams of peel, but you'll extract enough for food flavoring. To extract oil using a garlic press, first scrape the white pith from the inside of the orange peel. Cut the peels into 1-inch pieces and heat them in 110- to 120-degree-Fahrenheit water on the stove; "cold" in this sense means not heating the peels enough to damage the oil. Pack the peels into the press and squeeze the oil into a food container. You need at least 25 large orange peels to extract a useful amount of oil. Using a clean form of ethyl alcohol, such as 100-proof triple-distilled vodka, to separate limonene from the orange peels doesn't require as much force as pressing but it takes more time. Cut the peels into 1/4- to 1/2-inch pieces and place them in a clean glass jar. Add enough vodka to barely cover the peels and store the container in a room-temperature cupboard for about two weeks. Shake the container at least once a day, then strain the vodka into a shallow dish. Allow the vodka to evaporate and scrape the oil into a food container.

Experimentation setup:

The possible mixes are picked one at a time, and the blend is put into the setup engine's fuel reserve. To stabilise the engine, it is started and allowed to run for several minutes. The load is applied to the engine electronically in steps of 0%, 25%, 50%, 75%, and 100%. The fuel consumption readings are taken by timing 10ml of gasoline consumption at each load. This process is repeated for each combination, and then pure diesel is produced.

Table 2: General range of properties of diesel and orange peel oil

Property	Diesel	Orange peel oil
Density(kg-m^{-3})	840 – 860	816–850
KinematicViscosity@ 40°C(cST)	2.5–3.2	2.7– 3.52
Calorificvalue(kJ-kg^{-1})	35,636–42,000	34700–43000
FlashPoint(°C)	56 – 90	52–74

The engine is connected to a PCB, and the performance parameters, such as Brake Power (BP), Indicated Power (IP), Friction Power (FP), Specific Fuel Consumption (SFC), Brake Mean Effective Pressure (BMEP), Indicated Mean Effective Pressure (IMEP), Mechanical and Volumetric Efficiencies, are generated into a digital document file by the "EnginesoftLV" Engine performance analysis software. Manual mathematical computations might be used to validate the above-mentioned performance characteristics. At various crank angles, cylinder pressure and net heat release are also measured.

4. PERFORMANCEGRAPHS

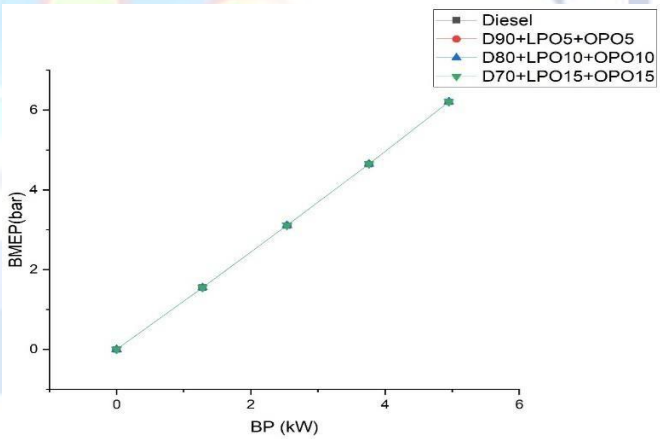

Fig.1: Brake power vs Brake Mean Effective Pressure (BMEP)

No variations have been observed in brake mean effective pressure (BMEP) for any blend compared to diesel due to much alike calorific values. The BMEP at full load is 6.21 bar for all fuels.

Specific Fuel Consumption of diesel is slightly less compared to the lemon peel oil blends. This indicates that the engine is more efficient with diesel, but only on a

negligible scale. D70+LPO15+OPO15 has the highest SFC with 4.55% higher than that of diesel.

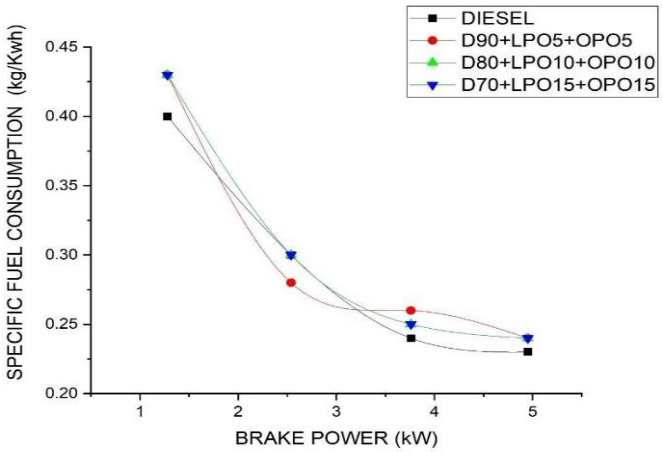

Fig.2.: Brake power vs Specific Fuel Consumption (SFC)

EMISSION GRAPHS

Graphs are plotted between various emissions and Brake power. These graphs are helpful in analysing quantity of emissions at various loading conditions.

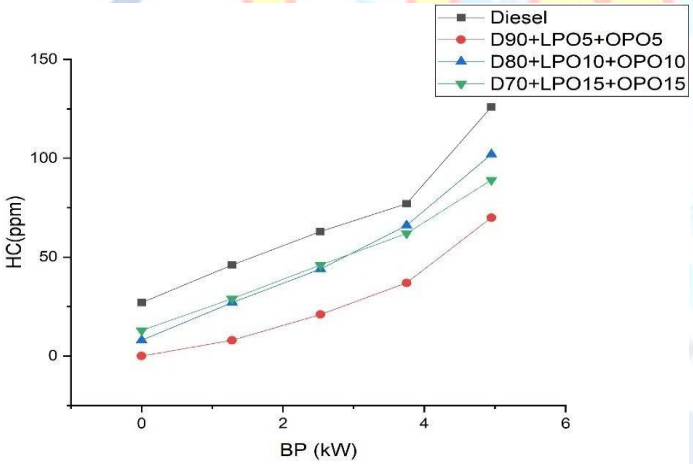

Fig. 3.: Brake power vs Hydrocarbon emissions

From the graph 3, it can be clearly inferred that the Hydrocarbon emissions have substantially dropped using lemon peel oil blends compared to diesel. D90+LPO05+OPO05has 44.44% lower hydrocarbon emissions compared to diesel. D70+OPO15+LPO15 has the highest hydrocarbon emissions compared to other blends. D70+LPO15+OPO15 shows a sudden fall in hydrocarbons emissions from 25% load condition, compared to D90+LPO05+OPO05 and D80+LPO10+OPO10.

A significant amount drop in Carbon Monoxide emissions can be observed from Fig. 4, by usage of D90+LPO05+OPO05 compared to diesel D80+LPO10+OPO10, D70+LPO15+OPO15 at low loading conditions exhibits higher CO emissions compared to diesel and eventually decrease as load increases.

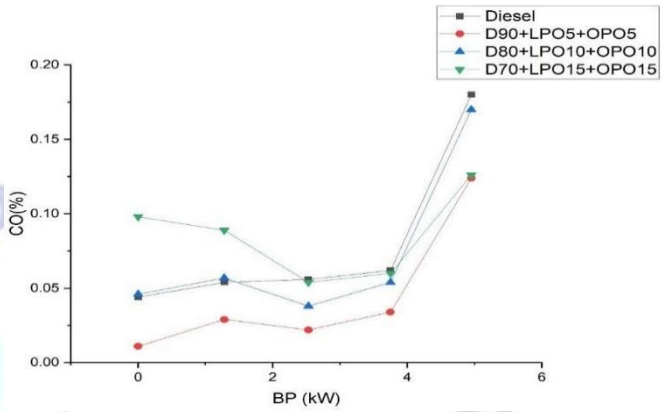

Fig. 4: Brake power vs Carbon Monoxide emissions

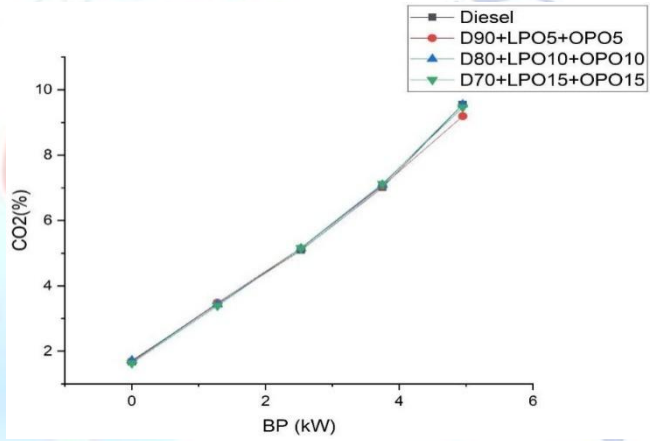

Fig. 5: Brake power vs Carbon Dioxide emissions

From Fig. 5, it can be inferred that, no significant reduction or promotion can be observed in case of Carbon Dioxide emissions due to use of lemon peel oil – diesel blends compared to diesel. D90+LPO05+OPO05 emits the least CO_2 at full load condition.

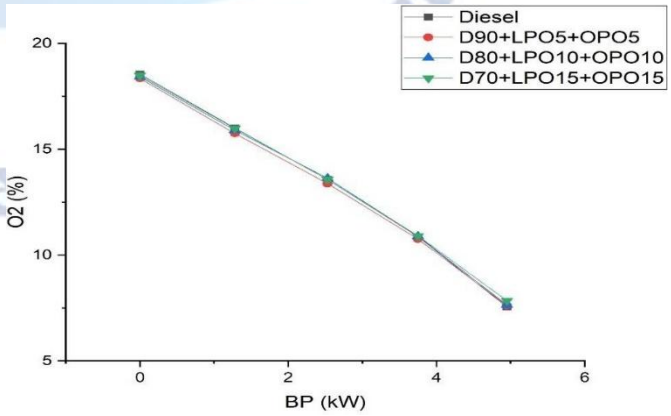

Fig.6:Brake power vs Oxygenpercentageinexhaust

From Fig.6, no significant reduction or promotion can be observed in case of Oxygen emissions due to use of lemon peel oil – diesel blends compared to diesel.

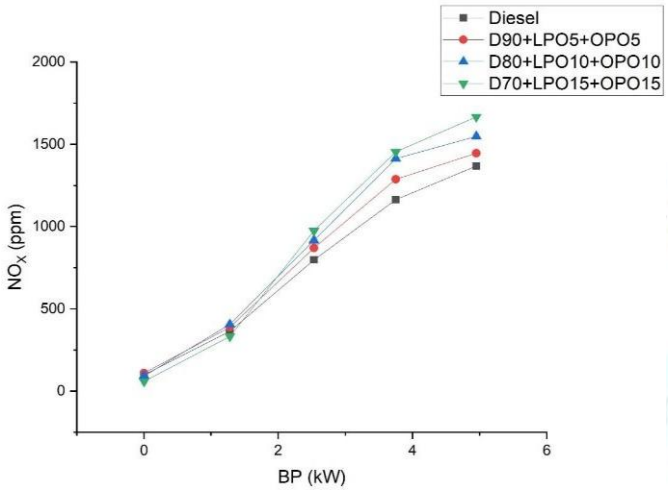

Fig. 7: Brake power vs Nitrogen oxides (NOx) emissions

From Fig. 7, the release of nitrogen oxides increases with usage of lemon peel oil and orange peel oil– diesel blends when compared to diesel. This is a common effect observed using alternative fuels. D70+OPO15+LPO15 has the highest NOx emissions, 29.36% higher than diesel at full load condition. Catalytic converters must be used for reduction of theseemissions. D70+LPO15+OPO15 has the least NOx emission at no load condition and drastically increases as load increases, due to higher heat release rate.

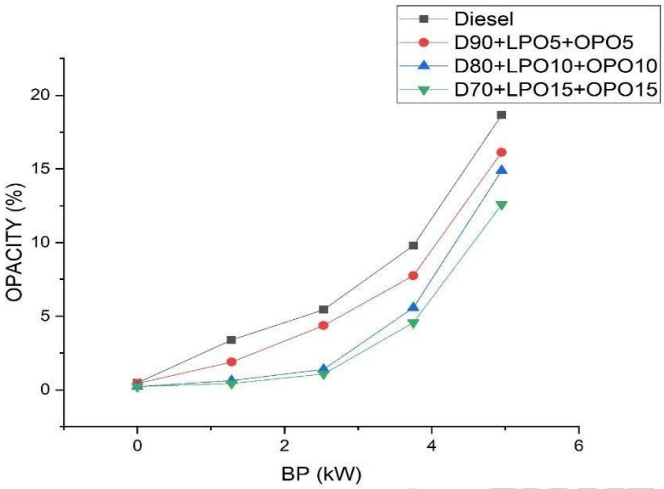

Fig. 8: Brake power vs Filter Smoke Number (FSN)

Filter Smoke Number indicates the amount of particulate matter in the exhaust gas. An indirect measure, opacity of smoke is used to estimate the particulate matter. It is clear from Fig. 8 that use of lemon peel oil and orange peel oil blends has reduced the amount of particulate matter in the exhaust, compared to diesel. D80+LPO10+OPO10 exhibits the least FSN.

5. CONCLUSION

From the results and discussions, it can be concluded that the usage of lemon peel oil – diesel blends on existing diesel engines has very little effect on performance parameters. Engine exhibits better performance and emissions using D90+OPO05+LPO05. The only major drawback is the NOx emissions, which can be improved by using external catalytic convertors Use of D70+OPO15+LPO15 resulted in high peak pressure and NOx emissions, compared to diesel. This is not a desirable effect, as higher peak pressures can result in increased vibrations. Hence, D70+OPO15+LPO15 is not recommended. D80+OPO10+LPO10 exhibits irrational volumetric efficiency, which is not preferred as combustion residuals do not exit the cylinder properly, affecting performance. A low calorific value diesel fuel has been used for the experiment. The rated power is 5.2 kW at full load and the average power at full load using blends is 4.96 kW. So, even when the lemon peel oil is blend with high quality diesel fuel, only a slight variation in performance can be expected. Also, an improvement in emission characteristics can be observed, except for NOx. The present price of cold pressed lemon peel oil and orange peel oil is □ 400 and □ 600 per kg. Currently there are no potential applications for lemon peel oil and orange peel oil and hence limited in production. Production depends on demand of the product. Lemon peel oil and orange peel oil can be extracted at an economical price if it is used as an alternative fuel in existing diesel engines. It can also be used in CRDI engine due to its low viscosity compared to biodiesel, supporting the injection pressure as demanded by the engine for atomization of fuel, which is required for better combustion.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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