Effect of Tio2 Nanoparticles In Spirulina Biodiesel- Diesel Blends at Various Injection Strategies: Performance, Combustion and Emission characteristics

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Abstract. Since so many years all the automobile engines are running by using the fossil fuels. Day by day the usage is increasing. So, by using the fossil fuels it reaching the last stage and finally it leads to the depletion. So, the fossil fuels are the responsible for air pollution, global warming, and the gradually increasing of global climate. So, the algae biofuels are considered to be the most renewable source of energy and also it is eco-friendly. Microalgae considered to be the potential source which can produce biofuel from algae. Nitrates, phosphates, and carbon dioxide which were produced from atmosphere are consider to be growing environment for algae. Spirulina is a blue-green algae. Autotrophic and alkallophylectic are the two attributes of spirulina. For spirulina lesser amount of sunlight is needed than the homes. pH is the important ingredient in the culture medium. After the transesterification process about 87.75% of biodiesel yield was obtained at optimum level conditions. By comparing of both spirulina bio-oil and chlorella bio-oil the parameters like viscosity and density of chlorella were very equally to the conventional diesel fuel. By the above reasons spirulina is strongly considered to be a potential raw material or feedstock for the biodiesel production to be used in diesel engines. For this investigation to measure the engine performance parameters like exhaust temperature, brake specific fuel consumption and emission parameters like hydrocarbons, carbon dioxide, nitrogen oxides, oxygen, carbon monoxides and smoke are measured by changing the injection timings like retard 23 degree, retard 21 degree and retard 19 degree. Finally B20 is the blend taken and this blend is mixed with 75 ppm of Titanium dioxide as a nanoparticle experiment was conducted on four stroke, twin cylinder diesel engine used.

1. Introduction

Spirulina based biodiesel is a long chain fatty acids made up of mono-alkyl esters (1). It is beneficial to the environment because it produces lesser emissions (2, 3). Due to the less amount of yielding of oil leading to the more amount of feedstock is required for the production of biodiesel (4). The larger amount of usage of fossil fuels is lead to the global warming. To reduce these consequences the scientists are searching the new technique to yield more amount of oil in less land. Biofuel is an energy contained fuel from living organism. Biomass is the raw material for the production of biofuel. The convenient energy contains in the three varieties of ways such as thermal conversion, chemical conversion and biochemical conversion (5). Pure form of ethanol is used to run the vehicles. To increase octane number and to reduce the engine emissions it is used as gasoline additive. The production of biodiesel from food crops creating a new competition to the human food. So the world is adopting algae biodiesel. Nuclear energy sources are coming for extinction. The wind energy and solar energy don’t have the capability of reaching the requirements for alternative energy. Due to the poor technological developments it is difficult to use wind, solar and other forms of energy to replace the fossil fuels. Here some of the advantages are listed than petrol and diesel fuels(6).

Biodiesel can be used as a fuel in present engines without any engine modifications.
Vegetables are the main source of biodiesel so it does not contain any metal or crude residues, Sulphur and aromatic hydrocarbons. Occupational safety and health administration states that it is a non flammable liquid.(7).

Future is ready to adopting the perfect option is to selecting biodiesel (8). Esterifies vegetable oils are known to be biodiesel, non-edible vegetable oils are called as straight vegetable oils, ethyl esters or methyl esters are to be considered vegetable oils (9). Rural areas are the best place to gain the vegetable oils easily they are with high cetane number so they can blend easily with diesel (10-13). (14) states that sunflower oil, rapeseed oil, jatropha oil, coconut oil, algae oil can be used in IC engines. (15) states that microalgae fuel properties were evaluated. The research proved that waste cooking oil biodiesel and diesel blends are good alternative fuel for diesel engines (16, 17). (18) has stated that waste cooking oil biodiesel are good alternative fuel. The results which were obtained by the experiment on influence of soybean biodiesel on DI diesel engine performance, emission and combustion characteristics are to be known that biodiesel is an eco-friendly fuel (19). (20) conducted an experiment by using the sources like pongamia and jatropha and conducted that biodiesel can be used as an alternative fuel in the near future. (21) done an experiment with mahua oil conducted that mahua oil ethyl ester can be used as a substitute. (22) studies the minimization of VCR-CI fueled with dunaliellasalina oil and corn oil using taguchi approach finalized that CO was lower than diesel. (23) NOx emissions are increased by increasing of the combustion temperatures known by conducting an experiment named investigated the effects of preheated cotton seed oil methyl ester on performance and emission of diesel engines. (24) accepted that pine oil can be used as a fuel by without any transesterification process. (25) states that by conducting an experiment impact of compression ratio and injection parameters on performance and emission of DI diesel engine states that by increasing of compression ratio then temperature is also reaches maximum. At higher compression ratio lesser emission will produced from biodiesel (26). (27) studied the effects of compression ratio on an engine filled with waste oil finally concluded that biodiesel has more benefits than pure diesel. (28) analyzed the usage of chicken fat oil blended with diesel CI engine. Generally the microalgae is more efficient because it convert into biomass by taking lesser amount of energy and CO2 (29). Algae have the good characteristics is that they grow in lands which are not fit for food (30). Microalgae produces 40 times more amount of fuel per acre than plants (31). Other than biodiesel a lot of products can make such as pharmaceutical and cosmetic products (32). Due to the presence of phytonutrient value and pigments can be used in therapeutics and diagnostics (33, 34). Algae has have the capacity to cure some of the diseases like anemia, tumor growth malnutrition (35, 36). Algae can be served as fish food and animal food (37). Adjustment of engine injection tuning is possible by based on blend level to improve engine emission and performance (38). Spirulina is a valuable product having high nutrition value (39-42). It is the major source for B12 vitamin (43). Absence of cellulose in its cell wall 85- 95% is along with an organism (44). Arthrospira plantesis is available in tropical regions with the concentrations of Nacl and bicarbonates are the concentrations available in the tropical regions of arthro spira plantesis (45-48).

2. Materials and methodology

2.1 Blending of biodiesel with diesel

Actually the blending can be defined as the mixing or adding the things together to form like one thing. In fuels purpose the biodiesel is mixing with diesel. Splash method and inline methods are the two methods of blending. The blending work has done correctly in the proportions by using fuel measuring instruments. B20 is only one blend taken for the research purpose and it contains 80% of
diesel fuel and 20% of spirulina biodiesel finally this B20 is mixed with 75 ppm of titanium dioxide (Nanoparticle).

2.2 Experimental setup

The engine setup is explained through the help of a schematic diagram by figure 1. Engine specifications are discussed in the table 1. For this research twin cylinder four stroke simpson diesel engine is selected. The engine was connected with dynamometer along with this computer system is present for knowing the readings. With the help of stopwatch measure the fuel consumption. The exhaust gases temperature are measured with thermocouple and with temperature indicator. U tube manometer is placed to air tank measure the air consumption. For measuring the exhaust emissions and smoke intensity gas analyzer and smoke meter are taken. At no load condition engine was run for 300 seconds by using diesel fuel. And then maintain the constant 1500 rpm. After the fuel consumption has completed several engine performance parameters and emissions are measured.

![Figure 1: Schematic diagram of engine setup](image)

**Equipments**

1. Engine
2. Dynamometer
3. Computer
4. Controlpanel
5. Burette
6. Gasanalyzer
7. Smokemeter
8. Air tank or box
9. U-tube manometer
10. Cooling water
11. Air
12. Exhaust gases
3. Results and discussion

3.1 Brake Specific Fuel Consumption (BSFC)

The comparison of BSFC with load is plotted in the fig. 2. From the fig. 2, we are knowing that BSFC is gradually reducing when there is an increasing of load. Retard 21 degree is showing lesser amount of BSFC. But retard 19 degree is showing the maximum amount of BSFC.

![Fig. 2 Load vs BSFC](image1)

3.2 Exhaust temperature

The variation of exhaust temperature with load is plotted in the fig. 3. From the fig. 3, knowing that exhaust temperature is gradually increasing by increasing of load. Retard 19 degree is possessing lesser temperature and maximum temperature at minimum load condition and in maximum load conditions. But retard 23 degree is showing more amount of exhaust temperature at both minimum and maximum load conditions.

![Fig. 3 Load vs Exhaust temperature](image2)
3.3 Carbon monoxide (CO)

The comparison of CO with load is plotted in fig.4 from the fig.4 knowing that amount of CO is gradually increasing by the increasing of load conditions. All retards are at same point when the load condition is minimum. But at maximum load condition both retards 21 and 23 are at minimum level of CO but retard 19 degree is showing the maximum level of CO.

3.4 Hydrocarbons (HC)

The variation of HC with load conditions are plotted in the fig.5. There is a great value of retard 19 degree of HC are observed at some instant condition of load. But finally it follows the remaining retards at both minimum and maximum load conditions. It is observing that all retards are pointed at same point at minimum and maximum load conditions.

3.5 Nitrogen oxides (NOx)

From the fig.6 knowing that the comparison of NOx with load. It is knowing that NOx is increased by the increasing of load conditions. Retard 21 degree is showing the lesser amount of NOx at both minimum and maximum load conditions. But retard 19 degree is showing the higher amount of NOx at minimum and maximum load conditions.
3.6 Oxygen(O2)

The comparison of O2 with the load is plotted in the fig.7. The amount of oxygen is gradually reduced by the increasing of load is known from fig.7. Retard 19 degree showing lesser amount of oxygen at minimum load condition while at maximum load condition it is showing more. At minimum load conditions both retard 21 and 23 degree are showing higher amount of oxygen. But retard 19 degree is showing higher amount of oxygen at maximum load conditions.

3.7 Carbon dioxide(CO2)

The amount of CO2 is increasing by the increasing of load condition were known by the fig.8 and it is telling that retard 19 degree is showing lesser amount of CO2 an higher at minimum and maximum load conditions But in case of retard 21 degree is slightly more amount of CO2 at minimum and maximum load conditions.
3.8 Smoke

The gradually increasing of smoke by the increasing of load is shown in fig.9. Retard 19 degree showing lesser amount of smoke and maximum amount at minimum and maximum load conditions. In case of retard 21 degree is more amount of smoke and lesser amount of smoke is observed at minimum and maximum load conditions.

4. Conclusion

This research is concluded that effects of biofuel in the engine performance and emission characteristics of diesel engine by using spirulina biodiesel. From this research retard 21 degree showing best results for brake specific fuel consumption, smoke and carbon dioxide. Retard 23 degree showing the best results for oxygen. And last but not the least retard 19 degree showing the best results for exhaust temperature, NOx, carbon monoxide and hydro carbons. From this research more best results are showing retard 19 degree.

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