PRODUCTION OF BIODIESEL FROM MILK SCUM
AND STUDY ON THE PERFORMANCE AND
EMISSION OF DIESEL ENGINE WITH BIODIESEL
BLENDS

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Introduction:

Biodiesel, a diesel fuel substitute that can be made from a variety of oils, fats, and greases, is of interest to farmers for a number of reasons: It can provide an additional market for vegetable oils and animal fats; it can allow farmers to grow the fuel they need for farm machinery; and it can decrease U.S. dependence on imported oil since fuel feedstock can be grown domestically.

Biodiesel is a renewable source of energy that can help reduce greenhouse gas emissions and minimize the “carbon footprint” of agriculture. It contributes less to global warming because the carbon in the fuel was removed from the air by the plant feedstock. Two chemists, E. Duffy and J. Patrick, are credited with first experimenting with trans-esterification using vegetable oils to make soap in 1853. The resultant biofuel by-product was later named biodiesel after a motor engine inventor. In 1983 in Austria, Dr. Mittelbach developed a commercial process to turn old cooking oil into biodiesel. Dr. Thomas Reed is credited as being the first person in the US to turn old cooking oil into biodiesel on a small scale in 1989. Rudolph Diesel, on August 10, 1893, first demonstrated the use of peanut oil to run his compression ignition engine. 1900 Diesel engine demonstrated on peanut oil at the Paris Exhibition. This date has since come to be known as International Biodiesel Day.

Gas chromatography was used to determine the fatty acid composition of Dairy Waste Scum Oil. Results revealed that the low free fatty acid content was a notorious parameter to determine the viability of alkaline Transesterification. The yield of bio-diesel reached 96.7% when 1.2 wt.% of Potassium Hydroxide, reaction temperature of 75°C, 30 min of time and 6:1 Methanol oil ratio at 350 rpm. Thermo gravimetric analysis followed the evaluation of Transesterification process.

Objectives

- To successfully produce neat biodiesel from milk scum.
- To blend the neat bio diesel with regular diesel and obtain the blended fuel samples.
- To study the properties such as calorific value, viscosity, etc. of the blended fuel samples.
To successfully run performance tests and emission tests on compression ignition engine for different blend samples.

To compare the performance of blended fuel with that of diesel in order to distinguish effect of different blends on performance.

To generate cost analysis of the entire process in order to know the economic feasibility of the concept in reality.

To successfully arrive at a conclusion and put light on future possibilities and scope in this particular sector.

Methodology

Stage 1: Extraction of scum oil

- The scum collected was first purified by hand picking of coarse and floating impurities.
- It was later heated till it reaches 100 degree centigrade to lose all it moisture contents and was strained which in turn filtered it.
- After the filtration process purified scum/clarified butter was obtained.
- Purified scum was used for experimentation.

Free fatty acid test

- 10ml of is propanol is taken in a flask.
- 3-4 drops of phenolphthalein indicator is added to propanol.
- 1 gram of scum oil is then added to propanol and phenolphthalein indicator mixture.
- KOH (0.01) solution is allowed drop by drop to the scum oil solution till the solution become pink for 5-10sec and then disappear.
- KOH (0.01) solution consumed to get pink color is noted down. Depending on the amount of KOH (0.01) consumed fatty acid present in the oil is decided.

Stage 2: Trans-esterification Process

Trans-esterification process was carried out for the purified scum by a 2 stage process depending upon the FFA Test results which involves

- Acid catalyzed esterification
- Base catalyzed esterification

Acid Catalyzed Esterification

- Scum is heated to 70 degree centigrade.
- Add 300ml methanol and sulphuric acid into a beaker.
- Transfer the heated scum to the round bottom flask of the esterification set up.
- Pour the methanol and acid mixture to the other beaker in the set up.
- Slowly allow the methanol acid mixture by opening the valve into the flask containing scum.
- The magnetic stirrer stirs the mixture of scum, methanol and acid, there by does not allow the mixture to solidify.
- The stirring is carried on for 90 minutes.
- In a test tube a sample of mixture is taken and kept aside for few minutes to check if the FFA is are forming a separate layer on top.
- If the FFA is form a separate layer the process is complete.
- Pour the mixture in the flask to the settling flask and allow settling for 60 minutes for the FFA is to form a separate layer.
- Separate the FFA is layer from the remaining.

Base Catalyzed Esterification

- The product of acid catalyzed esterification obtained from is heated for 70 degree centigrade.
- In a beaker add 166.6ml of methanol and 12 grams of NaOH pellets and allow it to dissolve.
- Transfer the heated scum to the round bottom flask of the esterification set up.
- Pour the methanol and NaOH mixture to the other beaker in the set up.
- Slowly allow the methanol NaOH mixture by opening the valve into the flask containing scum.
- The remaining procedure follows similar to acid transesterification as mentioned above.
8) Results and Conclusions

The overall studies based on the production, fuel characterization, engine performance and exhaust emission of milk scum biodiesel and its blends B20, B40, B60, B80, and B100 were successfully carried out. The following conclusions can be drawn:

- The production of Milk scum biodiesel is a two stage transesterification process.
- Cost of one litre milk scum biodiesel = 41.00 rupees.
- The density of biodiesel is 855kg/m$^3$ and it is more than fossil diesel (0.815kg/m$^3$).
- The CV of B100 was found to be 36580 KJ/Kg and the CV of different blends were also determined according to ASTM standards. The CV of blends was found to be less than the fossil diesel (44515.6 KJ/KG).
- The specific gravity of biodiesel B100 is 0.855 and it is more than fossil diesel (0.815).
- The minimum BSFC was found in B20. BSFC is decreases with increase of diesel content.
- The maximum thermal efficiency is for B20 and it was slightly lesser than that of diesel. The brake thermal efficiency obtained for B40, B60, B80 & B100 were less than that of diesel.
- The minimum CO emission produced was found in B100 and it was observed that a reduction of 41.5%, as compared to diesel.
- The HC emission shows a reduction from 70 ppm to 45 ppm was obtained resulting in B100 and it is 70.2%, as compared to diesel at the maximum load.
- CO2 emission increases linearly as the load increases, the maximum CO2 emission was found in B100 because of complete combustion of fuel as compared to fossil diesel.
- The amount of NOx produced for B100 was found to be 1250ppm and it little higher when compared to diesel 1185 ppm.
- The blend of 20% also gave minimum brake specific energy consumption. Hence, this blend was selected as the optimum blend for further investigations and long-term operation.

Scope for Future Work

- Variation in performance and emission of the engine with variation of compression ratio of the engine can be studied.
- This project was carried out in a single cylinder engine for which satisfactory results were obtained. Results with multi-cylinder engine fueled by conditioned oils can be carried out and compared with that of single cylinder engine performance and emissions.
- Various other biodiesel can be used as additive for diesel-ethanol blends to study the performance and emission characteristics.
- Performance and emission characteristics of the engine can be analyzed by ANN-Modelling for Diesel-Biodiesel-ethanol blends.
- Performance and emission characteristics of the engines can be done by changing the geometry of the piston for Diesel-Biodiesel-ethanol blends.