Fabrication of Small Scale Biodiesel Production Plant

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Abstract- **The depletion of fossil fuels and the worst impact on environmental pollution caused of their burning have led to the search for renewable clean energies. Nowadays, there are many sources of renewable energy. Biodiesel is just one source, but a very important one. Biodiesel is gaining more and more importance as an attractive fuel due to the depleting fossil fuel resources. Chemically biodiesel is monoalkyl esters of long chain fatty acids derived from renewable feed stock like vegetable oils and animal fats. This Project work describes the small invention setup (Plant) for preparation of biodiesel from any biodiesel feedstock. This project also gives details of work carried out for fabrication of small scale biodiesel production plant. The plant is not only portable but also suitable to support rural population who wish to become self manufacturer of biodiesel, also for research and experimental purpose. The project work includes fabrication of reactor vessel made of Stainless Steel 304 (for 2 liter capacity) which includes heating oil, ceramic insulation, temperature sensor, motor with blades also includes separating funnel, receiver. It also describes the method of synectics of biodiesel. in this project work biodiesel was produce from soybean oil and properties obtained from biodiesel shows close relevance to biodiesel standard. This project is also gives simple and detailed working structure of large biodiesel plant and their production line.**

Index Terms- Biodiesel plant, Oil Recovery, Oil, Transesterification process, synectics

INTRODUCTION

Biodiesel, an alternative to fossil petroleum diesel fuel, is made from renewable biological sources such as vegetable oils and animal fats.[1] It is biodegradable, nontoxic and has low emission profiles making it environmentally benign (Michael et al, 1996). Under Indian conditions to avoid conflict with scarcity of cultivable land for growing demand of food crops, an emphasis by the Government has always been to explore the possibility of using non-edible oils for biodiesel production (Planning Commission Report, 2003).[1] Fossil fuels are non-renewable energy resources. Although, these fuels are contributing largely to the world energy supply, their production and use have raised environmental concerns and political debates. It has been shown that 98% of carbon emissions are resulted from fossil fuel combustion.[2] The diesel engine came into its existence in the year 1893 when the paper titled “The theory and construction of a rational heat engine” was published by a great German inventor Dr. Rudolph Diesel [3]. The use of vegetable oil was first started by Rudolph Diesel. He developed the first diesel engine working on peanut oil at the World’s Exhibition in Paris, 1900 [4]. The main focal points for biodiesel production to expand were the oil seed crops. Until 1920s vegetable oils were utilized as the source of energy in the diesel engine. The factors like profitability, availability, low sulfur content, low aromatic content, biodegradability and renewability makes vegetable oils more advantageous over diesel fuel [4]. Energy is the chief mover of economic growth, and plays a vital role in sustaining the modern economy and society. Our future economic growth considerably depends on the long-term accessibility of energy from the sources that are easily available, safe and affordable. The global economic growth has seen a dramatic increase in the energy demand of the world.[4] Energy consumption is expected to increase by 84 percent by 2035 in most of the developing countries. India faces a dreadful challenge in meeting its energy needs and in providing sufficient energy of preferred quality in various forms in a sustainable manner and at competitive prices[5]. If India has to eradicate poverty and meet its human development goals, then it has to sustain an 8% to 10% economic growth rate, over the next 25years. For delivering a sustained growth rate of 8%, India needs to increase its primary energy supply by 3 to 4 times. New sources of energy like biofuels may play a significant role in meeting the energy demands[5].

LITERATURE REVIEW

Soybean oil is currently a major feedstock for production of biodiesel (NBB). The most common method of biodiesel production is a reaction of vegetable oils or animal fats with methanol or ethanol in the presence of sodium hydroxide (which acts as a catalyst). The transesterification reaction yields methyl or ethyl esters (biodiesel) and a byproduct of glycerin. Note that biodiesel is not straight vegetable oil burned in a diesel engine[6]. Numerous studies between 1980 and 2000 have shown the use of straight vegetable oil, including soybean oil, causes carbon deposits and shortens engine life (Jones and Peterson 2002). Biodiesel use in diesel engines does not have similar negative effects. Use of soybean oil for biodiesel was greatly influenced by promotion from U.S. soybean farmers through the United Soybean Board (USB) and subsequent creation of the National Biodiesel Board (NBB).[6] In U.S. production of soybeans in 2009 was 3.4 billion bushels from 77.4 million acres. Average yield per acre for the United States was 44 bushels per acre (National Agricultural Statistics Service). One bushel of soybeans can yield 1.5 gallons of biodiesel (NBB). Using all U.S. soybeans for biodiesel could produce 5.1 billion gallons of biodiesel. However, using all soybean production for biodiesel has not been proposed and is not realistic. In 2009, biodiesel production was 700 million gallons with a production capacity of 1.83 billion gallons (Biodiesel Magazine, 2008). Based on a yield of 44 bushels per acre, an acre of soybeans could yield 66 gallons of biodiesel, compared to 69 gallons for a 1,300-lb per acre canola yield, 84 gallons for sunflower and over 600 gallons for palm oil (Hill et al., 2006 and SDSU, 2008).[6]

Biodiesels have higher viscosity than diesel oil and preheating is used to reduce the viscosity. This approach is to improve combustion without modifying the engine design. Pure vegetable oils were used in diesel engines. Oil blends. Performance included the comparison of Load and Brake thermal efficiency, Load and brake power and load and BSFC (brake specific fuel Consumption).The Blends used were proportions and found that Brake Power does not get much effected in these proportions, Brake specific fuel consumption is Higher due to lower calorific value of biodiesels and brake thermal efficiency is higher[5].

METHDOLOGY

There are different methods which can be applied to synthesize biodiesel such as direct use and blending, micro emulsion process, thermal cracking process and the most conventional way is transesterification process. This is because of the fact that this method is relatively easy, carried out at normal conditions, and gives the best conversion efficiency and quality of the converted fuel.[7]

DIRECT USE AND BLENDING

The direct use of vegetable oils in diesel engine is not favorable and problematic because it has many inherent failings. Even though the vegetable oils have familiar properties as biodiesel fuel, it required some chemical modification before can be used into the engine. It has only been researched extensively for the past couple of decades, but has been experimented with for almost hundred years.[9]. Although some diesel engine can run pure vegetable oils, turbocharged direct injection engine such as trucks are prone to many problems. Energy consumption with the use of pure vegetable oils was found to be similar to that of diesel fuel. For short term use, ratio of 1:10 to 2:10 oil to diesel has been found to be successful [9].

MICRO EMULSION

To solve the problem of the high viscosity of vegetable oils, micro emulsions with solvents such as methanol, ethanol and 1-butanol have been studied. A micro emulsion is defined as a colloidal equilibrium dispersion of optically isotropic microstructures with dimensions generally in the 1 ± 150 nm range formed spontaneously from two normally immiscible liquids and one or more ionic or non-ionic amphiphiles.

They can improve spray characteristics by explosive vaporization of the low boiling constituents in the micelles.[10] .

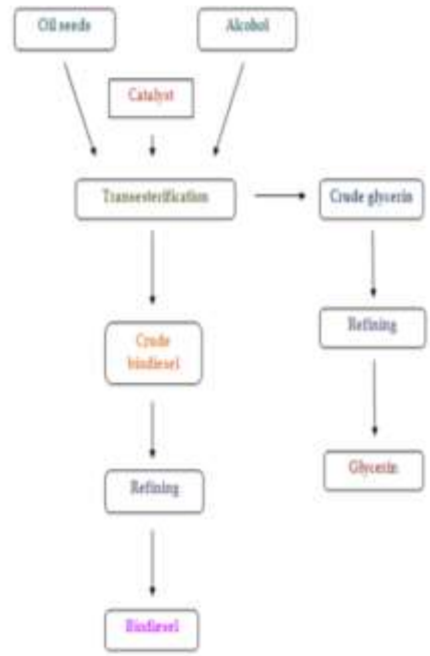
THERMAL CRACKING (PYROLYSIS)

Pyrolysis is defined as the conversion of one substance into another by means of heat or heating with the aid of a catalyst. Pyrolysis involves heating in the absence of air or oxygen and cleavage of chemical bonds to yield small molecules. The pyrolysis of vegetable oil to produce biofuels has been studied and found to produce alkanes, alkenes, alkadienes, aromatics and carboxylic acids in various proportions. The equipment for thermal cracking and pyrolysis is expensive for modest biodiesel production particularly in developing countries. Furthermore, the removal of oxygen during the thermal processing also removes any environmental benefits of using an oxygenated fuel. Another disadvantage of pyrolysis is the need for separate distillation equipment for separation of the various fractions. Also the product obtained is similar to gasoline containing sulphur which makes it less ecofriendly [11].

TRANSESTERIFICATION

The most common way to produce biodiesel is the transesterification method, which refers to a catalysed chemical reaction involving vegetable oil and alcohol to yield fatty acid alkyl esters (biodiesel) and glycerol. The reaction requires a catalyst, usually a strong base, such as sodium and potassium hydroxide or sodium methylate [12-13]) and / or sulfuric acid based transesterification processes. Acid catalysts are too slow to be practical for converting triglycerides to biodiesel; however, acid catalysts are quite effective at converting FFAs to biodiesel. Therefore, an acid-catalyzed pretreatment step to convert the FFAs to esters, followed by an alkali-catalyzed step to convert the triglycerides should provide an efficient method to convert high FFAs to biodiesel [14]. Transesterification process helps reduce the viscosity of the oil [13].

BLOCK DIAGRAM



WORKING

This plant is fabricate for 2 lit capacity having 4 main component includes reactor vessel , control panel, separating funnel, and receiver. Firstly vegetable oil (Soybean oil) of quantity 1 lit is poured inside reactor vessel, then heater switch is ON for heating the oil up to 45oC, then after reaching a desired temperature switch is OFF of heater switch. Now motor is ON for stirring the oil with 110 RPM and at high torque because of viscous fluid, at a same time stirring of reactant (Methanol) and catalyst (KOH Pallet) in a beaker until all KOH was dissolved, this form methoxide solution. Then pour this methoxide solution inside the reactor vessel with continuous stirring of oil and methoxide this called as transesterfication reaction, after proper mixing of methoxide solution and oil, the motor switch is OFF. Then this solution is transfer into the separating funnel to form two different layer of biodiesel and glycerol. During this separating process the bottom layer is of glycerol and top layer is of biodiesel because of its density. Now after separating process this biodiesel solution is taken out from the separating funnel and then passing for washing process. In washing process hot water is mixed with biodiesel for removing moisture particles inside the biodiesel.

Fig :- Setup of small scale biodiesel plant

Then it again pour into the separating funnel for separating process, then tap out the biodiesel from separating funnel and this pure biodiesel is ready to used.

CALCULATION

For Reactor

Let,

Diameter of Reactor = 13cm= 0.13m

Capacity of reactor = 3 Liter = 0.003 m^3

we know that

$$V= \frac{\pi}{4} \times D^2 \times L$$

$$0.002 = \frac{\pi}{4} \times 0.13^2 \times L$$

L = 0.22 m= 22 cm.

THERMOPHYSICAL PROPERTIES

Properties of Biodiesel:-

Sr.No	Properties	Flash Point	Fire Point	Calorific Value	Viscosity	Density
1	Diesel	65°C	78 °C	10590.431cal/gm	0.850 gm/ml	2.88 cst
2	Jetropha Oil	164 °C	171°C	9076.148 cal/ gm	0.872 gm/ml	3.82 cst
3	Soybean Oil (100%)	118 °C	136 °C	10727.6 cal/gm	0.892 gm/ml	3.88 cst
4	B10	70.3°C	83.80 °C	10853.50 cal/gm	0.854 gm/ml	2.97 cst
5	B20	75.6 °C	89.6 °C	10839.51 cal/gm	0.858 gm/ml	3.07 cst
6	B30	80.9 °C	95.4 °C	10825.52 cal/gm	0.862 gm/ml	3.17 cst

CONCLUSION

Hence fabrication of small scale biodiesel plant is portables and easy to assemble and dismantle. It is used as experimental setup in educational institute for experiment. It also used in research laboratories for research purpose. Because of less capacity of this setup it is economical. The experimental work carried out in this project shows that bio-diesel of acceptable quality can be produced on a small scale from a number of low-cost raw materials. However, the search for alternative feed-stocks needs to be continued. More research on the esterification of used vegetable oil is needed, to establish process requirements for high yield and quality, and to find ways of improving its low-temperature properties so that a higher proportion could be included in bio-diesel blends.

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