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A Review Of Using Nonedible Oils For IC Engine

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ABSTRACT

This review will be purposeful on the application of vegetable oils produced from the biomass (triglyceriedes) to internal combustion (IC) engines such as compression ignition (CI) engine. The use of inedible vegetable oils as an alternative fuel for diesel engine, they use in energy conversion systems lower the impact, from the economic, energetic and environmental points of view, with respect to biodiesel production. Of a lot of inedible vegetable oils which can be exploited for substitute fuel as diesel fuel, seven vegetable oils, i.e., sunflower, rapeseed, canola, soybean, palm, coconut, jatropha, caster, mahua, linseed, cottonseed, rubber seed, karanaja and neem oils were selected for discussion in this review paper.

Jatropha oil, give the brake thermal efficiency and higher specific fuel consumption. Unsaturated biodiesel fuel emits higher HC, CO and Smoke emissions but only exception LOME cannot be used higher NO formation and lower thermal efficiency. Palm oil is selected in tropical countries and palm oil smoothly and knocking problem reduced and Higher BSFC and lower BTE were noticed for the blends because of their lower calorific value. Canola oil is a preferred choice in cold-climate countries.

INTRODUCTION

In the economy of all country energy consumption play important role. In the whole world oil is the main source of energy because it is easy to carry and easy to store. In the future century the fossil fuel gruesome condition and they will be expensive and the coming year increasing the demand of vehicles and the internal combustion engine. Albeit, the increasing fuel economy and the problem of ecosystem has been most renovate through continues researcher workers across the world and improving the condition. But high demand of fuel in future decades due to faster rate of industrialization world up. There is, therefore, a requirement to develop alternative fuels induced by the shortage of the dependency upon fossil fuel due to the incomprehensive resources (Kuber singh mahra 2014). Many oxygenize fuels are probable usage for the alternative gasoline and diesel fuel. Those oxygenize fuel may be classified as alcohol component (include ethanol, methanol, propanol, butanol etc,) ether (oxygen atom connected to alkyl or aryl groups), ester, carbonate and acetate compounds [3]. This problem solved by using the alternative bio-fuel, where as the fossil fuel releases dangerous gases it's unsafe for human body and ecosystem, these types of fuels are responsible for the climatic effect. In our future year totally effected and ecosystem totally misbalanced [1].

Bio-fuel builds up a raw material like as edible, inedible, animal fat, plant algies, and waste vegetable oil. The utilization of edible vegetable oil or biodiesel to it has replaced to diesel fuels be able control of a problem to self substantial in vegetable production. The usage of non-edible vegetable oils is of concernment because of the more need for edible oil like food. In sum the collection of inedible vegetable oil can decrease the output cost of biodiesel due to proportional exalted cost of edible vegetable oils [3].Vegetable oil use in the static production of energy. Rudolf Diesel, test the compression ignition engine it's result is exactly known, by peanut oil like fuel, and in his way he said that the "vegetable oil use for engine fuel may being insignificant at present but such oil may occur in the way of time, as valuable as petroleum"[1].

Last many years we are choice the diesel fuel for the petroliume based diesel engine, because it's rich supply and less prices of fuel. At the same time, methyl esters obtained of animal and vegetable oils (biodiesel) are afterwards being re-assessment for applied as a fuel in the diesel engines proper to their environmental benefits, neat burning tendency, and energy security reasons [1]. The reduction rate of GHG (green house gases) and to promote clean transport, by contribute of the bio-fuel, the European Directive 2009/28/EC founded that the intersect of energy from renewable source final energy consumption in the transport sector by must amount to at least 10% of 2020. In particular, biodiesel has received vast consideration as a replace for diesel fuel since it's biodegradable, environmentally less contaminant, and nontoxic being relevant with conventional diesel fuel [4]. The main benefit of the biodiesel fuel using its preferable property exhausts gas emissions. Ahead, biodiesel has an advantage of effective fuel properties such as exalted flash point which make it easy to carry and good lubricity. And other side as cloud point and cetane number depend significantly upon the feedstock type. Due to increasing price of the food wares and deliverance of waste in environment, there is a current state change the use of non-edible oils and (WVO) waste vegetable oil as low rank feedstock in biodiesel production. The main drawback of vegetable oils is their high viscosity which causes dangers to injector system for its resulting in bed atomization and for the end of operation leads to problems such as engine deposits [7]. Basically some specific methods reduce the vegetable oil viscosity: transesterification, esterification, pyrolysis, and emulsification, dilution with petroleum-based fuel. Transesterification is the one most popular method by using the biodiesel production which produced of mono alkyl esters by long chain free fatty acids (FFA) or free fatty acid alkyl ester (FFAAE) via transesterification with short chain alcohols. Transesterification of natural glycerides is a technically important it's used for some places soap and manufacturing world means industrialization for many years.[14] Biodiesel is produced in an almost all similar chemical process in which using base catalyzed transesterification as it's an economical process, process completed in the low temperatures and pressures while producing a 98% conversion yield. This technique was started in 1938 that has no calorific value and is appropriate to reason more carbon content in the engine, therefore the glycerine portion and there should be removed from drive onto the residue free fatty acid [9]. The residuum free fatty acid is which is known as "biodiesel", albeit ester was not described during this period. Infect, the glycerol portion in triglyceride particle is responsive for the higher viscosity of oil, where as the free fatty acid parts is 10 times less viscous than vegetable oil.

The use of these oils as feedstock in the production of biodiesel is viable with respect to cost reduction and they have attracted much attention since they are renewable and readily available.

2. Physical and chemical property of biodiesel in IC engine:

2.1 Chemical Properties:

2.1.1. Fatty acids

All different type of Vegetable oils contain fatty acids, whose nature depends on the vegetable oil and determines its capable to proper burn in an engine. The high the iodine number and degree of unsaturation (number of double bond are less stable than single bonds and can react with iodine) of the compound, the viscosity is lower of the oil. As the lower viscosity defined the increasing efficiency of the combustion, due to short evaporation time, ignition delay and lower of sediments in the engine[16]. The behaviour of fatty acids on the pure vegetable oils as well effected the tendency to polymerization. The double bonds defined more direct route to the soot precursors, as the high unsaturation leads to higher amount soot emission [3, 18, 19].

2.1.2. Phospholipids content

Fouling valves are depend upon the phopholipids, combustion chamber and cylinders walls when vegetable oil is used as fuel in internal combustion engines. Their content depends on the oil phosphorus content [3, 19]. Phospholipids in WVO can also negatively affect enzyme activity in biodiesel production processes [3].

2.1.3. Wax content

Wax content affected influence the correct operation of secondary elements, like as filters, pumps, and power supply devices but does not the combustion. It varies according to the behaviour of the raw seed and kaneel and to the oil exit temperature [19, 20].

2.1.4. Peroxide value

It affect the oxidation level and degree of stability, unsaturated oils are characterized, by the double bonds between carbon atoms that are not fully stable by hydrogen atoms. The single bonds easily react with oxygen atom, therefore be oxidized more easily [25]. Chemical variation of unsaturated fats and oils, by oxygen atom in the present of air, begins with the formation of peroxides [20]. Peroxide value of waste vegetable oil (WVO) is higher than in pure vegetable oils since the contact of hot oil with food reduces the oxidation stability [24].

2.2. Physical Properties:

2.2.1. Viscosity:

As previously paper mentioned, vegetable oil a viscosity much greater than petro-diesel, which creates problems such as poor fuel atomization, non-optimal combustion, mechanical issues related from damage of pumps or injector elements and high energy required working of the pump [3, 19]. It is normally expected that the high viscous fuel, the more emission of the NO_X production. There is as well a correlation of high density and higher iodine values lead to high emission of NO_X, and high level of polyunsaturated fats tends to have high production of NO_X emission. Whenever using the minor amounts of polyunsaturated fatty acids decreasing the production of NO_X, such as coconut and palm [1, 14].

2.2.2. Density

The weight per unit volume of vegetable oils is larger than that of petrol-diesel almost by 10% [20, 27]. Higher density define high momentum and liquid droplets give the longer break-up time, therefore very bed conditions of atomization, and high amount for droplets access in the combustion chamber walls [19].

2.2.3. Bulk modulus

The bulk modulus is a measure it's incompressible/resistant to a uniform compression. It is define as the ratio of the resulting relative decrease of the volume by the infinitesimal pressure increase. The bulk modulus of petro-diesel is less than as compared vegetable oils, as confirm by measurements performed on blends with different oil percent at various temperatures [23].

2.2.4. Cetane number

Cetane number is a measure of the fuel ignition delay and the time period between the start of injection and the first identifiable pressure increase during combustion of the fuel. It indicates the behaviour of ignition, therefore it affected cold start, combustion development and engine noise. In a special diesel-engine, higher cetane fuels will have shorter ignition delay periods than lower Cetane fuels.

2.2.5. Flash point

The flash point of a flammable liquid is the lowest temperature at which it can from an ignite presence in air [20]. The value depends on the pressure and it is normally measured at a standard pressure of 1013 Mbar. The higher the flash point, gives the safety of storage, transport and handling of the fuel [25]. Its value has no direct influence on the combustion efficiency or engine performance [20].

2.2.6. Calorific value

Calorific value of vegetable oil is lower than 10–15% for the petrol-diesel [20,]. A resume of some of the before-mentioned properties of different types of vegetable oils and waste vegetable oil has been reported, as derived from different papers of literature, which aims to increase using biodiesel production and its local market entry [8].

3. Application of different inedible oils:

The data from the previous year review paper are summarized as different according to climate, soil, variety, etc. In which showing the Compression of vegetable oil to diesel fuel, higher density and kinematic viscosity, lower cetane number and calorific value of are shown. Because of the low cetane number and high kinematic viscosity of the inedible vegetable oil, several problems in diesel engines such as engine choking, cease of fuel injector, gum formation and piston sticking under long term use may occur

3.1. Sunflower Oil

Sunflower oil is extracted from sunflower seeds and this oil is commonly used for cooking as well as to produce limitation butter and biodiesel. Sunflower oil is cheaper compared to olive oil but costly compared for the neem oil. Sunflower different vary in their fatty acid content some “high oleic” types contain a high level of monounsaturated fatty acids in their oil compared to olive oil. High oleic sunflower oils have many qualities that render it suitable for lubricants such as good oxidation stability and lubricity. And some studies shows that higher oleic sunflower oil (HOSO) can be used to substitute for mineral oils in textile and tannery applications without technical problems or modification of facilities [5,6,8].

3.2. Rapeseed Oil

Rapeseed is a bright yellow flowering member of the mustard family and it contains high levels of erucic acid (~ 45%). Rapeseed oil was first produced in the 19th century as a base for steam engine lubricant. Rapeseed contains four major components (i.e. oil, water, protein and fibre) but it also contains several minor constituents for lubricating applications such as- free fatty acids, phosphatised (gum), enzymes (particularly myrosinase) and glucosinolate. Rapeseed oil is not suitable for human and animal consumption because it has a bitter taste which is due to the high levels of glucosinolates. However, there are new varieties of rapeseed with lower glucosinolate content and therefore, they are more edible [3.9.19].

3.3. Canola Oil

Canola is a genetically modified variant of rapeseed which has gained prominence commercially due to its nutritional quality (lowerucic acid and low-glucosinolate rapeseed oil) [7]. Both canola and rapeseed oils are primarily composed of unsaturated fats, there is a significant difference in the composition of these oils, whereby the amount of erucic acid in canola oil is nearly negligible (< 1%).

3.4. Soybean Oil

Soybean is a species of legumes which is native to East Asia. It is widely cultivated for its edible beans, which have numerous uses. The cultivation of soybean is successful during hot summers in which the optimum mean temperature is within a range of 20 to 30 °C. Soybean can be grown on a wide range of soils but the optimum growth is achieved on moist, muddy soils with good organic content. Soybean oil has been successfully used to produce dielectric liquids for transformers, since it increases the fire point and service life of the transformer by extending the life of the insulating paper. Soybean-based oil has also been used as the hydraulic fluid for the lift of the famous Statue of Liberty in New York Harbour [1,3].

3.5. Palm Oil

Palm oil is edible oil which is derived from the mesocarp of the oil palm fruit. Oil palm thrives in hot; humid tropical regions with an annual rainfall within a range of 1500–2000 mm. Oil palms will grow well provided that there is no more than three months of drought. The optimum temperature range is 26–32 °C, and 5–7 h of direct sunlight per day is beneficial. One hectare of oil palm is sufficient to produce almost 10times as much oil compared to other vegetable oil [6,5]. Hence, palm oil has great potential to fulfil the demand for vegetable oil-based lubricants. A large number of experiments have been carried out on the use of palm oil as an additive in engines as well as a lubricant for cold forward extrusion, and minimum quantity lubrication (MQL).

3.6. Coconut Oil

It is rare to find coconut trees in dry regions because these trees are unable to grow without frequent irrigation. These trees are mostly found in tropical regions. The fruits of coconut trees are light, buoyant and highly water-resistant and these fruits have evolved to disperse at significant distances via sea currents [5]. Coconut oil is rich in saturated fatty acids (91%) and therefore, it does not oxidize easily. Coconut oil has been widely used as a lubricant in rickshaws and scooters in Southern India. This oil has been shown to improve vehicle mileage, engine pick up and operations. In addition, coconut oil produces less smoke when it is burned.

3.7. Jatropha Oil

Jatropha is a drought-counteraction bush or tree which join to the family Euphorbiaceous. It is widely cultivated in Central America and South America, as well as Southeast Asia, India and 6Africa [3,19]. Even though Jatropha oil is one of the common feed stocks for biodiesel production, its function as a lubricant is not really known. Jatropha oil has potential for lubricant production due to its high fatty acid content (61–64%).The production techniques and optimum parameters needed to produce high yields of lubricant from Jatropha oil are still investigated to date.

3.8. Castor Oil

Ricinus communis (castor) is a fast-growing, suckering perennial shrub which can reach the size of a small tree (around 12 m) and it is not a cold-hardy plant. This plant also known as castor beans. The seeds contain around 40–60% of oil that is rich in triglycerides, particularly ricinolein. Castor oil has better low-temperature viscosity and high temperature lubrication properties compared to most vegetable oils. Therefore, castor oil is desirable to be used as a lubricant in jet, diesel and race car engines. Castor oil, with its 80% ricinoleic acid content, has unique characteristics and it is the only source of C18:1- OH. This gives the oil a unique combination of physical properties such as relatively high viscosity and specific gravity as well as solubility in alcohol in any proportions. However, castor oil has limited solubility in aliphatic petroleum solvents [8,9,10].

3.9. Mahua Oil

It was observed by them that all mahua oil blends (10, 20 and 30%) have almost similar thermal efficiency and are very close to the thermal efficiency of diesel fuel. It should be pointed out that 30% mahua oil blend is found to be most thermally efficient from their work. It was also found that smoke density is higher for mahua oil blends compared to diesel at lower loads. Smoke density increased with proportion of mahua oil in diesel [6,7]. They concluded that macro emulsion of MO with up to 10% alcohol can substitute diesel fuel partially with no difficulty.

3.10. Linseed oil

That brake thermal efficiency decreases as the proportion of diesel fuel decrease in the diesel fuel linseed oil blends [2,6]. They also reported the results of exhaust gas temperature, NO_x emission level, CO emission level, and smoke density in the semi-adiabatic type of engine by using diesel fuel linseed oil blends according to the variation of piston coating thickness and compression ratio. that 50% LSO blend showed maximum thermal efficiency and lowest brake specific energy consumption (BSEC), but higher smoke density, compared to all other LSO blends (10, 20, 30%, v/v). They found that a biodiesel with more unsaturated fatty acid composition has more density and iodine number but less viscosity, heating value and cetane number. In addition, a more unsaturated biodiesel emits higher HC, CO and PM compared to highly saturated biodiesel fuel [14].

3.11. Rubber Seed Oil

Their results show that the brake thermal efficiency increases from 26.56% to 27.89% when the fuel is preheated to a temperature of 155^{0}C. Specific fuel consumption of neat RSO is more than that of diesel fuel. However, fuel preheating leads to the improvement in specific fuel consumption [24,25]. NOx emission for neat RSO operation is 6.9 and 10.69 g/kWh with diesel at full load. However, NOx emission increased with increase in fuel inlet temperature, but the preheated RSO is still 20% lower than that of diesel operation. This may be due to larger SMD of vegetable oil which will increase the evaporation time and poor fuel air mixing rate [22].

3.12. Cotton Seed Oil

The use of neat CSO under varying injection pressures. Their paper that 30% CSO and 70% diesel blends was practically optimal in ensuring relatively high thermal efficiency of engine, as well as homogeneity and stability of the blends their paper that 30% CSO and 70% diesel blends was practically optimal in ensuring relatively high thermal efficiency of engine, as well as homogeneity and stability of the blends. They concluded that vegetable oil methyl esters gave performance and emission characteristics closer to the petro diesel [21,24].

3.14. Karanja Oil

Pongamia pinnata L. is medium-sized evergreen tree which belongs to the Millettieae family. This plant takes 4 to 7 years to reach maturity and it is regenerated through direct sowing, transplanting and root cutting. Karanja oil has been used for traditional medicines, timber, pesticides and fuel in India as well as neighbouring regions [24]. The seeds are rich in oleic acid with oil content within a range of 30–40 wt%. Fatty acid composition of various vegetable oils ensure safe operation and minimum volatilization at the maximum [21].

4. Discussion and summary

The use of Vegetable oil leads to a lower environmental impact. Firstly, we are discussed chemical-physical characteristics, considered estimate the quality of vegetable oil. During this resume, it has been defined that the most considerable problem for Vegetable Oil use is described by the viscosity, which is larger than the petro-diesel. In order to decrease viscosity, vegetable oil preheated above 60^{O}C preheating or blends with petrol-diesel can be adopted. Various test described in different papers have salient point the following vegetable oil combustion. In all the cases the results obtained with petrol-diesel were used as reference.

- The preheating and blending of SVO (straight vegetable oil) it's a most practically decreasing the viscosity of SVO.

- When direct use of waste vegetable oil longer ignition delay, reduction of efficiency and an increase in brake specific fuel.
- For the transesterification process using SVO Increasing levels of CO than decreasing the viscosity of vegetable oil and emitting the lower levels of NO_x.
- When using the waste vegetable oil the reducing the cost of preheating and the viscosity and density are standard and reliable of cost.
- Biodiesel from saturated and monounsaturated fatty acid methyl esters they reduce some exhaust and noise emissions blends improve the engine sound quality, trial, high percentage of biodiesel from saturated fatty acid.
- Vegetable oils fuels effecting Engine performance and emissions reduce soot formation, and Pollutant emissions HC emission from RO which reaches the highest level

It should that, due to their similar chemical-physical characteristics, pure vegetable oil and waste vegetable oil behave similarly. This implies that direct use of WVO in engines must be promoted as it represents an effective option for as waste recovery. WVO must be disposed, while vegetable oils are expressly produced, subtracting space to the other crops, mainly food. This is particularly dangerous in developing countries, where people could be attracted by the incentives and higher profits that energy crops may lead, decreasing the amount of available food.

Many studies on the application of SFO, RO, CO, SBO, PO, CNO, JO, CO, MO, LO, CSO, RSO and KO to CI engine had pointed out that most regulated emissions, such as those of HC, CO and PM are reduced through the use of biodiesel and its blends as a fuel in CI engine. Meanwhile, a number of authors have confirmed lower NOx emissions with biodiesel use.

The systematic assessment of spray characteristics of neat inedible vegetable oils and its blends, neat biodiesel and its blends for use as diesel engine fuels is required.

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