Journal of Chemical and Pharmaceutical Sciences ISSN: 0974-2115

IMPROVEMENT OF NEEM BIODIESEL PROPERTIES BY USING NANO ADDITIVES-REVIEW

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ABSTRACT

The depletion of fossil fuels as well as the deterioration of environment has forced to focus on the development of alternate energy sources. Biodiesel is a viable substitute for petroleum based diesel fuels. Among the various fuels, the biodiesel from neem has potential alternate energy sources. This report deals with biodiesel obtained from neem oil which are mono alkyl esters produced by using 'Two step transesterification' process. The major advantage of the neem oil is improved lubricity, high cetane number and cleaner emissions, highly available, but also within the limitations. However, this oil alone will not solve the dependence on foreign oil, because of its high viscosity, high density, high flash point and low calorific value, high sulphur content. The properties of the neem biodiesel can be improved by the addition of neem biodiesel with suitable nano additives there by to overcome the drawbacks found in the neem oil as an alternate fuel when compared to ordinary diesel fuels. Using neem biodiesel leads to low environmental impact, ease of handling, and possibility of use without need for major adjustment of existing engines.

Keywords: Biodiesel, Neem oil, Additives.

INTRODUCTION

Fossil fuels such as oil, coal, natural gas have limited reserves that are expected not to last for a long period. Hence there is an urgent need for suitable alternate fuels for diesel engines without any major modification. As an alternative fuel for petro diesel in the transportation sector, biodiesel can be the viable solution for environmental problems. These factors have to make biodiesel usage more adaptable and attractive to current energy scenario, which are ensure energy security, environmental sustainability and also to boost rural development by shifting of power from petro to agro industry simultaneously. Biodiesel is made from fresh or used vegetables through transesterification and is a diesel substitute and requires very little or no engine modifications up to 20% blend and minor modification for higher percentage blends. The use of biodiesel results in substantial reduction of un-burnt hydrocarbons, carbon monoxide and particulate matters. It has almost no sulphur, no aromatics and has about 10 % built in oxygen, which helps it to burn fully. Its higher cetane number improves the combustion.

Biodiesel: Biodiesel refers to a diesel equivalent product made from vegetable oils (both edible and non edible oil) or animal fats and alcohols. Typical raw materials of biodiesel are rapeseed oil, canola oil, soyabean oil, sunflower oil and palm oil, beef and sheep tallow and poultry oil from animal sources and cooking oil are also sources of raw materials. There are various other biodiesel sources like fish oil, cotton seed oil, algae ,neem, seasame, tobacco etc., When compared to fossil fuel ,the amount of oxygen present in the biodiesel is very high .It tends to better combustion, reduction in emissions of hydro carbon, carbon monoxide and smoke intensity.

Need for neem oil as an alternate feedstock for biodiesel: By rough estimate India has nearly 20 million neem trees. Neem trees start bearing to harvesting seeds within 3-5 years and full production may be started in 10 years, and this will continue up to 150-200 years of age. So the surplus amount of neem trees are available in India, this factor tends to neem oil will become a potential supplier of biodiesel in future. When compared other types feedstock's for biodiesel like cotton seed, babassu, soyabean, linseed oil etc all are need special attention for its growth. But neem oil has naturally growing capacity and also it serves as a long period of useful applications.

Method for production of biodiesel: There are four ways to use neat vegetable oils in diesel engines, direct use or blending in diesel fuel, Micro emulsions process, thermal cracking of vegetable oils, transesterification

Direct use or blending in diesel fuel: Vegetable oil can be mixed with diesel fuel and used directly for running an engine. The direct use of vegetable oil or the use of oil blends have generally been consider to be unsatisfactory and impractical for both direct and indirect diesel engines. It has been proven that the use of 100% vegetable oil was also possible with some minor modifications to the fuel system. Major problems have been associated with the use of pure vegetable oils as fuel in compression ignition engines, mainly due to increased viscosity.

Micro emulsion process: Micro emulsion are isotropic, clear or translucent, thermodynamically stable dispersion of oil, water, surfactant, and often a small amphiphilic molecule, called a co-surfactant. The droplet diameters in micro emulsion range from 100 to 1000. Because of their alcohol contents, micro emulsion have lower volumetric heating values than diesel fuels, but these alcohols have high latent heat of vaporization and tend to cool the combustion chamber, which reduces nozzle choking.

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Thermal cracking: Pyrolysis is the conversion of one substance into another by means of heat or by heat with the aid of a catalyst. Pyrolysis and catalytic cracking of oils and fats results in production of alkanes, alkenes, alkadienes, cycloalkanes, alkyl benezenes, carboxylic acids, aromatic and small amounts of gaseous products. It involves heating in the absence of air or oxygen and cleaveage of chemical bonds to yield small molecules.

Transesterification: Transesterification is a chemical reaction between triglyceride and alcohol in the presence of catalyst. It consists of a sequence of three consecutive reversible reactions where triglycerides and converted to diglycerides and then diglycerides are coverted to monoglycerides followed by the conversion to monoglycerides to glycerol. In each step an ester is produced and thus three ester molecules are produced from one molecule of triglycerides.Out of these three method tranestreification is the most viable process adopted known so far for the lowering of viscosity. It also gives glycerol as a byproduct which has a commercial value.A catalyst is usually used to improve the reaction rate and yield because the reaction is reversible, excess alcohol is used to shift the equilibrium to the product side. Oil or fat reacts with alcohol (methanol,ethanol). This reaction is called transesterification.

Optimization of transesterification process: N.Nagarajan et al has been suggested that the temperature, catalyst amount, molar ratio of alcohol to oil and the reaction time were optimized. Experiments were conducted with NAOH was dissolved in methanol ,then the mixture was stirred and maintained at 55°c for approximately one hour. The reaction products were kept in a separating funnel for about 24 hours. During the transesterification process the final product were neem oil methyl ester and glycerol. The glycerol can be separated out by using gravity separation method then the ester was washed with 10% by volume of warm water at 70°c.

Yogesh Tamboli et al. have carried out the feasibility testing of VCR engine using various blend of neem oil. The formation of methyl esters by transesterification of vegetable oil required raw oil, 15% of methanol & 5% of sodium hydroxide on mass basis. However, transesterification is an equilibrium reaction in which excess alcohol is required to drive the reaction very close to completion. The vegetable oil was chemically reacted with an alcohol in presence of a catalyst to produce methyl esters. Glycerol was produced as a by-product of transesterification reaction.

Properties of diesel, need oil, nome(neem oil methyl ester):

Table.1.Properties of diesel, methyl ester

Property	Diesel	Neem Oil	Nome (Neem Biodiesel)
Viscosity (cst)	4.7	20.5-48.5	3.2-10.7
Density (kgm-3)	830	912-965	820-940
Heating value (Mj/kg)	42	32-40	39.6-40.2
Cetane number (°c)	45	31-51	48-53
Flash point (°c)	60	214	120
Fire point (°c)	65	222	128
Sulphur (ppm)	0.042	1990	473.8

Biodiesel in di engine: Engine tests were performed in a single cylinder, four stroke, naturally aspirated, water cooled direct injection diesel engine with bowl type piston. The engine was operated at a constant speed of 1500 rpm and standard injection pressure of 220 bar. The engine was coupled to an eddy current dynamometer for load measurement. The main measuring instruments were: electronic flow meter for fuel consumption, air flow measurement system, a TDC marker, an rpm indicator and a Kistler piezoelectric transducer for the combustion chamber pressure. A fast data acquisition system was used to record the pressure diagrams obtained by the piezoelectric transducers. The crank angle was measured by crank angle encoder which was mounted on the engine shaft .Exhaust emissions of CO, HC and NOx were measured with krypton 5 gas emission analyser. Smoke level was measured using diesel tune DX.230 smoke meter. The hardware for pressure measurement consists of a high speed data acquisition system and a digital signal processor.

RESULTS AND DISCUSSION PERFORMANCE

BRAKE THERMAL EFFICIENCY

R. C. Singh et al., Reported that DN5 showed the best peak load BTE followed by D100, DN10, DN15 and DN20. However increase in neem oil concentration in the fuel beyond 5% resulted in substantial drop in peak load BTE due to higher viscosity which in turn led to improper combustion and poor atomization characteristics.

Atul Dhar et al., has been reported that brake thermal efficiency was highest among all test fuels. All blends showed higher brake thermal efficiency than mineral diesel. Researcher found 20% efficiency with mineral diesel, 23% efficiency with pure biodiesel of 100% blend, which is 15% higher. They attributed this increase in brake thermal efficiency is due to presence of oxygen in the bio-diesel molecules which improves the combustion efficiency.

Journal of Chemical and Pharmaceutical Sciences ISSN: 0974-2115

N.Nagarajan et al . has been reported the brake thermal efficiency obtained from B 30 blend was (26.9%) lower than diesel, this is due to higher viscosity ,lower density, lower calorific value, higher cetane number. But BTE obtained from B20 blend ere (28.6%) more than the diesel fuel .this is due to improved lubricity, reduced friction and chemical composition. H. A. Shah et al investigated the different blends of neem oil with diesel (NB 10, NB20, NB30) fuelled for dual cylinder diesel engines. It was observed that 30% of neem oil blends gives the better emission test (in terms of carbon monoxide, carbon dioxide, hydrocarbon, smoke density) than other blend ratios of neem biodiesel**.** The cetane number, flash point and lubricity of the blended fuel are observed to be better than commercial diesel fuel.

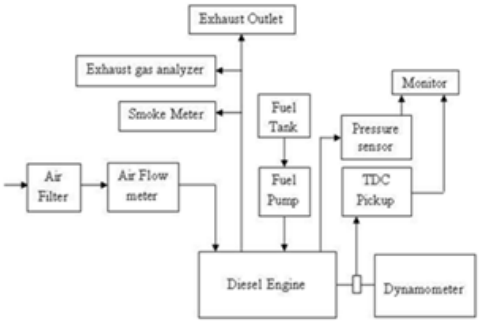

Figure.1.Schematic Arrangement of DI Engine Experimental Setup

Brake specific fuel consumption: Atul Dhar et al. have observed that BSFC for the bio diesel and its blend increased due to lower calorific value of biodiesel in comparison with mineral diesel. Researcher found 0.38 kg/kWh BSFC with mineral diesel, 0.36 kg/kWh BSFC with blend 5% Neem bio-diesel and 95% diesel, 0.4 kg/kWh BSFC with blend 100% Neem bio-diesel, which is 5.5% lower Researcher attributed that as the percentage of bio diesel increases break fuel consumption also increased.

Emissions

Oxides of nitrogen: N.Nagarajan et al ., have evaluated that NOx emissions in part loads at 25% and 50% in all blends and NOME were lowered compared to diesel. This is due to inefficient combustion because of its higher viscosity and poor mixture formation. However at 75%, 80% and 100% loads NOx emissions of all blends were higher than diesel.

H.H.M Masjuki et al., has been investigated that the NOx obtained from PB20X fuel is 20% lower than NOx obtained from pure diesel.It can be examined that NOx increases due to high combustion temperature with lean condition. Hence, individual fuels combustion temperature is responsible to produce NOx emission. It can be revealed from test results that 1% additive is helpful to reduce combustion temperature by allowing high fuel conversion into thermal work as compared to PB20 fuel.

M.Shahabuddin et al., has been reported that the 123 ppm with using pure diesel ,while 95 ppm with using B20X.They investigated that the NOx obtained from bio diesel PB20X (20% blended biodiesel with 1% additive) is 29.47% lower than NOx obtained from pure diesel. This phenomenon showed that PB20X fuel is the optimum composition in order to achieve better fuel quality with less NOx formation. In addition, with the presence of additive, the combustion temperature could be reduced which cause to control the NOx, Moreover the flame temperature also reduced dramatically which cause complete fuel combustion. Another fact is, the blended fuel with additives reduced the friction between the cylinder wall and piston thus the heat loss is controlled in the cylinder and result in considerable reduction in NOx.

problems identified in neem biodiesel as an alternate fuel for diesel engines: The major drawbacks present in the neem oil is high sulphur content (1990 ppm) ,brake thermal efficiency of neem blends were lower than diesel throughout the entire range showing the poor combustion characteristics of methyl ester due to high viscosity and poor volatility compared to ordinary diesel fuels, the overall efficiency also found very low. These are all the major drawbacks occurred in neem biodiesel as alternate fuel for diesel engines. The above mentioned problems can be overcome by following approaches.

Overcome method

Nano particle additives: Nano particles represent one of the most studied structures in nanotechnology and nano science because of the wide range of application arising from their unique optical, physical and chemical properties. Nano particles additives are used to enhance the properties of the fuels.

J.Bennet et al., has been reported to control the stability of diesel fuel, it get degrades by heterolytic and other sulphur and nitrogen containing molecules that results from this mechanism it may tends to formation of sediments and also produced deposits in critical fueling locations such as fuel injector ,resulting in power loss, smoke and higher overall emissions .So this type of problem can be rectified by using amine based additives ,sometimes combined with dispersants are used to control the stability of diesel fuel.

G.Tsanaktsidis et al ., has been reported that additives were used to remove the water residues of diesel and jet liquid hydrocarbons fuels. Here the additives are thermal polyasparate anion, a derivative biopolymer of aspartic acid. The presence of water residues can creates huge problems such as corrosion of engine parts, pipeline and storage reservoirs, ice formation at very low temperatures. So water removal can be improved the physiochemical properties of fuels.

CONCLUSIONS

This paper presents an overview of the recent investigations in the study of biodiesel production, drawbacks of biodiesel used in diesel engines. Here concluded that the nano particles additives are must for biodiesel when it can be fuelled for diesel engine and also their storage, transportation in different climatic regions. So that it realize the dream of using bio-diesels to extend the fossil fuel availability. Hence it is concluded that there is a benefit in addition of additive in neem bio-diesel in terms of better brake thermal efficiency, BSFC and emissions performance.

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