International Conference on Computational and Experimental Methods in Mechanical Engineering
G.L. Bajaj Institute of Technology and Management, Greater Noida (U.P) India ICCEMME-2017
8th- 9th December 2017, www.conferenceworld.in ISBN: 978-93-86171-85-6

Combustion Characteristics of Biodiesel in Compression Ignition Engine

Devashish Tomer[1], Shivam Kumar Goel[1], Dhanji Kumar Gupta[1], Vishvaraj Saharawat[1], H. S. Pali[1]

Mechanical Engineering Department, Noida Institute of Engineering and Technology, India

ABSTRACT

Environment friendly alternate energy sources need to be developed in order to meet the forthcoming demand for fossil fuels because these fuels are major source of air pollution and forex deficit. Biodiesel being renewable fuel which can be produced from vegetable oil using transesterification. Production of biodiesel is dependent on feedstock quality specially moisture content and free fatty acid content. Jatrophacurcus plant, Neem tree oil, Karanja oil, Polanga oil, soybean crude oil, hazel nut kernel oil, Koroch oil seed, crude oil, palm oil, cotton seed oil etc. can be used to form biodiesel. Biodiesel, an alternate fuel can act as a blend along with diesel so that C.I. engine becomes more efficient and eco-friendly. Engine characteristics in combustion and emissions is depends upon the biodiesel blends along with diesel fuel. The power output of biodiesel was nearly equal to that of diesel fuel whereas brake specific fuel consumption were higher for biodiesel due to is calorific value. Biodiesel emits lower carbon monoxide, un-burnt hydrocarbon and smoke except NOx. Biodiesel is helpful for better combustion due to enriched oxygen content. It gives higher in-cylinder pressure and better heat release rate.

Keywords: Biodegradable, Biodiesel, Biomass, Renewable Energy, Transesterification.

I INTRODUCTION

This is a well known fact that the combustion of fossil fuels is increasing day by day in today's scenario. Majority of the worlds energy needs are supplied through petrochemical sources, coal and natural gases. The rapidly increasing prices and uncertainties concerning petroleum availability has mandate the researchers to search for sustainable alternative fuel sources for diesel engine applications that are superior to conventional fossil fuels in terms of performance, emissions and combustion characteristics.

II ENERGY CRISES

Industrial development and population growth have led to a surge in the global demand for energy in recent years. Energy crisis is the result of limited/narrow utilization of alternated energy sources and fossil fuel extravaganza. The planet earth is suffering from disproportionate energy mix. Owing to excessive dependence on fossil fuels even for the next two decades, fossil fuels are subjected to depletion.

Consumption of world primary energy is increasing sharply every year and this will lead to future energy crisis. Shortages of fossil fuels were found in many countries. China experienced severe energy shortages towards the end of 2005 and again in early 2008. During the latter crisis they suffered severe damage to power networks along with diesel and coal shortages[1]. Nepal experienced severe energy crisis in 2015 when India created an economic blockade to Nepal. Nepal faced the shortages of various kinds of petroleum products which affected severely on Nepal's economy. And there are several other countries which are affected by the scarcity of fossil fuels. Many considerations have been taken to eradicate such problems.

2.1. Energy Scenario

Around 41% of total electricity generation across the globe relies on coal fired power plants. Despite severe environmental threats leading to global warming via greenhouse gas effect, the share of such utilization is unparalleled in advanced countries like China, Australia and other European states[2]. We have just witnessed 23rd International Climate Change Conference in Paris where global leaders gathered together to justify on their participation and contribute in resolving issues dealing with severe climate change.

India's power sector is one of the most diversified in the world. Sources of power generation range from conventional sources such as coal, lignite, natural gas, oil, hydro and nuclear power to viable non-conventional sources such as wind, solar, and agricultural and domestic waste. Electricity demand in the country has increased rapidly and is expected to rise further in the years to come.

III Alternative Fuels for Diesel Engine - Biodiesel

This is a well known fact that the combustion of fossil fuels is increasing day by day in today's scenario. Majority of the worlds energy needs are supplied through petrochemical sources, coal and natural gases. Rising petroleum prices and increasing threat to the environment from exhaust emissions and global warming have generated intense international interest in developing alternative nonpetroleum fuels for engines. Recently, biodiesel has become attractive because of its environmental benefits and the facts that it is non-toxic, biodegradable and can be made from renewable resources[3].

Therefore, in the verge of finding an alternative fuel the biodiesel is found as the most promoting for both the substitution of fossil fuel and also for the socio-economic development of the global world.

3.1. Biodiesel

Biodiesel is mono-alkyl esters of long chain fatty acids derived from renewable feed stock like vegetable oils and animal fats. It is produced by Transesterification in which, oil or fat is reacted with a monohydric alcohol in presence of a catalyst. This process decreases the viscosity, density and flash point of the raw material. The biodiesel molecular structure consisting of linear esters, allows similar physical–chemical properties compared to mineral diesel oil[4]. A large variety of plants that produce non-edible oils can be considered for biodiesel production such as MadhucaIndica (Mahua), Jatrophacurcas (RatanJyot), Pongamiapinnata (Karanja), Soapnut

(Sapindusmukorossi) and Meliaazadirachta (Neem)etc. are easily available in developing countries and are very economical comparable to edible oils.

3.2. Biofuel Scenario

In recent years, bioenergy has drawn attention as a sustainable energy source that may help cope with rising energy prices, but also maybe provide income to poor farmers and rural communities around the globe. Rising fuel prices, growing energy demand, concerns over global warming from GHG emissions and increased openness to renewable energy resources, domestic energy security, and the push for expansion into new markets for crops in the face of world trade outlooks are all factors driving interest in expanding bioenergy use. However, developing countries with tropical climates may have a comparative advantage in growing energy rich biomass; and second-generation technologies could enable expansion of the range of feedstock used from the traditional sugarcane, maize, and rapeseed to grasses and trees that can thrive in less fertile and more drought prone regions. Potentially adverse impacts from a rapid bioenergy expansion include upward pressure on international food prices, making staple crops less affordable for poor consumers[5].

Growth demands energy. India is the world's fifth largest consumer of energy, and by 2030 it is expected to become the third largest, overtaking Japan and Russia. India has only 0.4 percent of the world's proven oil reserves. It is also projected to run out of coal, its primary source of energy, in forty years. Its domestic natural gas reserves are limited as well. In biofuels, the country has a ray of hope in providing energy security. The Indian approach to biofuels, in particular, is somewhat different to the current international approaches. An indicative target of 20% blending of biofuels, both for bio-diesel and bio-ethanol, by 2017 is proposed.

IV COMBUSTION IN DIESEL ENGINE

Combustion may be defined as a relatively rapid chemical combination of hydrogen and carbon in fuel with oxygen in air resulting in liberation of energy in the form of heat.

4.1. How does a diesel engine combust?

The diesel internal combustion engine differs from the gasoline powered Otto cycle by using highly compressed hot air to ignite the fuel rather than using a spark plug compression ignition rather than spark ignition). In the diesel engine, only air is initially introduced into the combustion chamber.

4.2. What is the pressure to ignite diesel?

Diesel engines have no spark plugs to ignite the fuel. In the cylinder, the pressure is so great the temperature is very high. The pressure is so great (16:1 or 16.1337 bar) that the temperature becomes high enough to ignite the fuel without a spark plug.

V LITERATURE REVIEWS

S. Kalligeros et al. [2003] described the fuel consumption and exhaust emissions measurements from a single cylinder, stationary diesel engine. The engine was fuelled with pure marine diesel fuel and blends containing two types of biodiesel, at proportions up to 50%. The two types of biodiesel appeared to have equal performance, and irrespective of the raw material used for their production, their addition to the marine diesel fuel improved the particulate matter, unburned hydrocarbons, nitrogen oxide and carbon monoxide emissions[6].

Avinash Kumar Agarwal et al. [2007] reviewed the production, characterization and current statuses of vegetable oil and biodiesel as well as the experimental research work carried out in various countries. This paper touches upon well-to-wheel greenhouse gas emissions, well-to-wheel efficiencies, fuel versatility, infrastructure, availability, economics, engine performance and emissions, effect on wear, lubricating oil etc. The properties and specifications of ethanol blended with diesel and gasoline fuel were also discussed. Special emphasis is placed on the factors critical to the potential commercial use of these blends. The effect of the fuel on engine performance and emissions (SI as well as compression ignition (CI) engines), and material compatibility is also considered [7].

Valeri I. Golovitchev et al. [2009] They compiled the liquid fuel properties and the existing detailed mechanism of methyl butanoate ester (MB) oxidation was supplemented by sub mechanism of two proposed fuel constituent components C7H16, and C7H8O to represent the combustion model for rape seed methyl ester. The detailed combustion mechanism was validated using shock tube ignition delay data under diesel engine conditions[8].

I. M. Atadashi et al. [2010] reviewed the technologies used for the biodiesel separation and purification, biodiesel quality, and its effects on diesel engines. Biodiesel biodegradability, lubricity, stability, economic importance, and gaseous emissions have been discussed [9].

C.D. Rakopoulos et al [2011] His experimental test were conducted on a turbo charged diesel engine in order to investigate the formation mechanism of nitric oxide, smoke, and combustion noise radiation during hot starting for various alternating fuel blends. The experimental tests matrix included three different fuels, neat diesel fuel and two blends of diesel fuel i.e. biodiesel or n-butanol. During the starting event the biodiesel blend resulted in deterioration of both pollutant emissions as well as increased combustions instability, while the normal butanol blend decreased significantly exaust gas opacity but increased notably NO emission[10].

S. Sivalakshmi et al [2012] They evaluated the effect of using diethyl ether as additive to biodiesel on the combustion, performance and emission characteristics at different loads and constant engine speeds. The results indicate that peak cylinder pressure and heat release rate is higher for BD5 (5% by volume) than those of neat biodiesel at almost all engine loads. The break thermal efficiency of diethyl ether blended biodiesel is higher as compared to biodiesel[11].

VI CONCLUSION

Production of biodiesel fuels which are biodegradable and renewable and having usage as blends with diesel fuels has a positive impact on diesel engine. After examining all the parameters with specific data, biodiesel

fuels helped in increasing the efficiency of C.I and better combustion. Biodiesel fuel as a blend with diesel fuel, combustion characteristics at different stages changed. By the use of biodiesel fuels in diesel engines it is found that these fuels emit less carbon monoxide, unburned hydrocarbon and smoke except NOx . It generated high in-cylinder pressure and better cetane rating In terms of power output, biodiesel fuels and diesel fuels acts almost the same. Biodiesel increase NOx emissions at some extent due to high temprature and high concentrations of oxygen atoms. After examining, exhaust temperature for biodiesel fuels is higher than diesel fuels due to increase quantity of fuel injected. Wall temperature for diesel fuel is higher than for biodiesel fuels due to lubricating effect of biodiesel fuels. After examining all parameters, one of the main advantage of using biodiesel fuels is that it can be used in the existing C.I. engines in order to improve their performance. Blends of biodiesel fuels with diesel fuels can be used to improve the engine characteristics.

REFERENCE

[1] B.P. Statically reviews 2017.

[2] Energy Information Administration

[3] A. Murugesan, C. Umarani, R. Subramanian and N. Nedunchezhian, Bio-diesel as an alternative fuel for diesel engines—A review, Renewable and Sustainable Energy Reviews Volume 13, Issue 3, April 2009, 653-662.

[4] F. Ma and M. A. Hanna, Biodiesel Production: A review, Bioresource Technology, Volume 70, Issue 1, October 1999, 1-15.

[5] S. Msangi, T. Sulser, M. Rosegrant, R. V. Santos and C. Ringler, Global Scenario for Biofuels: Impacts and Implications, International Food Research Policy Institute.

[6] S. Kalligeros, F. Zannikos, S. Stournas, E. Lois, G. Anastopoulos, C. Teas and F. Sakellaropoulos, An investigation of using biodiesel/marine diesel blends on the performance of a stationary diesel engine, Biomass and Bioenergy, Volume 24, Issue 2, February 2003, 141-149.

[7] A. V. Agarwal, Biofuels (alcohols and biodiesel) applications as fuels for internal combustion engines, Progress in Energy and Combustion Science, Volume 33, Issue 3, June 2007, 233-271.

[8] V. I. Golovitchev and J. Yang, Construction of combustion models for rapeseed methyl ester bio-diesel fuel for internal combustion engine applications, Biotechnology Advances, Volume 27, Issue 5, 2009, 641-655.

[9] I. M. Atadashi, M. K. Aroua and A. Aziz, High quality biodiesel and its diesel engine application: A review, Renewable and Sustainable Energy Reviews, Volume 4, Issue 7, Diesel Engine Fuelled with Neem Oil Methyl Ester, International Journal of Green Energy, Volume 9, Issue 3, 2012.2010, 1999-2008.

[10] C. D. Rakopoulos, K. A. Antonopoulos, D. T. Hountalas and E. G. Giakoumis, Comparative performance and emissions study of a direct injection Diesel engine using blends of Diesel fuel with vegetable oils or bio-diesels of various origins, Energy Conversion and Management, Volume 47, Issues 18-19, 2006, 3272-3287.