Engineering Science and Technology, an International Journal xxx (2018) xxx–xxx

HOSTED BY

ELSEVIER

Contents lists available at ScienceDirect

Engineering Science and Technology, an International Journal

journal homepage: www.elsevier.com/locate/jestch

Full Length Article

Experimental analysis of combustion characteristics of CI DI VCR engine using mixture of two biodiesel blend with diesel

B.R. Hosamani [a,*], V.V. Katti [b]

[a] BLDEA'S Dr.PGH College of Engineering and Technology, Vijaypur, India
[b] KLS V. D. Rural Institute of Technology, Haliyal, India

ARTICLE INFO

Article history:
Received 6 December 2017
Revised 4 May 2018
Accepted 27 May 2018
Available online xxxx

Keywords:
Simarouba
Jatropha
Mixture of biodiesels
Combustion
Heat release rate

ABSTRACT

To meet the ever increasing energy demand of the world needs an urgent research to find an alternate fuel for diesel. Biodiesel can be a promising alternate for diesel engine in the years to come. The objective of the present experimental work is to investigate the combustion characteristics of VCR engine using mixture of two biodiesel blend with diesel at 100% or rated load, at constant speed. Simarouba and Jatropha oil are used to prepare, respective biodiesel and mixed in the volume ratio of 75:25, and is designated as B100. The combustion characteristics investigated are cylinder gas pressure, net heat and cumulative heat release, rate of pressure rise, and the mass fraction burned. Investigation is carried out varying load from zero to 100% or rated load of engine with an increment of 20% each time. Influence of blends and compression ratio on the combustion characteristics of engine is investigated. The results reveal that blends results in higher cylinder gas pressure, lesser heat release, higher rate of pressure rise and increased combustion duration. Increasing CR improve the combustion characteristics of engine.

1. Introduction

Petroleum fuels are depleting at a rapid rate because of increased number of automobiles and their liberal consumption in view of improved world economy. Automobiles are the main contributors to environmental pollution, creating human health problems and also a source of global warming particularly in metros. Hence there is a need to address the problem of fuel and emissions by substituting alternate energy sources like biodiesel. This has triggered the researchers to find the fuel which can replace the petroleum fuel and can also reduce harmful emissions. Biodiesel are the alternate source of energy for automobiles and other energy sectors. Biodiesel can be produced from different source of vegetable oils such as edible and non edible oils. Vegetable oils are transformed to their respective methyl esters using the transesterification method which is widely used for production of biodiesel [1,2]. Biodiesels are renewable, biodegradable, non-toxic, oxygenated fuel [3–5]. Physical and chemical properties of biodiesel fuel are comparable to diesel. India is fourth largest petroleum fuel consumer in the world and is not self sufficient [6,7]. To satisfy the energy needs of the country, 70–80% of petroleum fuel is imported spending huge amount of foreign exchange [8]. Producing liquid fuel indigenously can attain two requirements, first producing biodiesel as substitute fuel to diesel and reduce the import of petroleum fuel [9]. Second India turns out to be energy independent and increases its economic status by saving foreign exchange.

Biodiesel or methyl esters hold the promise as alternate fuel to diesel engine with or without modification to present day engines [10,11]. Number of researchers carried out experimental investigations using different types of biodiesel. The outcome of the research done by various researchers' shows the similar results with a little variation in the thermal performance compared to neat diesel. It may be also observed that biodiesel enhances lubrication, reduces the wear of engine components [12,13]. The reduction in harmful emissions like CO, HC, particulate matter [14–17] and enhance the CO_2, and NO_x emissions in comparison to diesel is noted [11,18].

Diesel engine performance is characterised by measuring the different parameter such as brake specific fuel consumption, brake thermal efficiency, brake mean effective pressure, cylinder pressure and heat release [19–22].

The work carried out by various researchers on the combustion characteristics of CI engine using methyl ester blends are discussed in the following paragraphs.

* Corresponding author.
E-mail address: brhosamani@gmail.com (B.R. Hosamani).
Peer review under responsibility of Karabuk University.

https://doi.org/10.1016/j.jestch.2018.05.015

Please cite this article in press as: B.R. Hosamani, V.V. Katti, Experimental analysis of combustion characteristics of CI DI VCR engine using mixture of two biodiesel blend with diesel, Eng. Sci. Tech., Int. J. (2018), https://doi.org/10.1016/j.jestch.2018.05.015

Nomenclature

aTDC	after top dead centre, °CA
bTDC	before top dead centre, °CA
CA	crank angle, °
CHR	cumulative heat release, J
CP	cylinder pressure, bar
CI	compression ignition, –
DI	direct injection, –
MFB	mass fraction burned, %
NHR	net heat release, J/°CA
p	cylinder pressure, bar
RPR	rate of pressure rise, bar/°
S75	75 volume of Simarouba, %
J25	25 volume of Jatropha, %
VCR	variable compression ratio, –

Performance, emissions and combustion characteristics of VCR engine were investigated using Waste plastic oil and diesel blends and it is observed that the cylinder gas pressure and heat release was higher for the blends as compared to diesel. Increase in CR was results in improvement of thermal performance and reduction in the emissions as compared to diesel [23].

Combustion, performance and emission characteristics of VCR engine were investigated using rice bran biodiesel and diesel blends and it was resulted in higher cylinder gas pressure for blends in comparison to diesel. Cylinder gas pressures increased with increase in CR from 15 to 18 and improve the performance of engine with reduced emissions of blends in comparison to diesel. Peak cylinder pressure attained at 11° aTDC in the expansion stroke for B40 blend which was lower than B20 blend and was at 6° aTDC [24].

Combustion, performance and emission characteristics of a VCR engine was investigated using Waste cooking oil methyl esters and its blends and the results indicated an improved pressure rise rate, lesser heat release, longer ignition delay, increased mass fraction burned in comparison with diesel [25].

Combustion characteristics were investigated using Corn oil methyl ester (COME) with DI diesel engine. COME be preheated for three different temperatures and supplied to engine. Cylinder gas pressure was higher; with lower heat release for the blends compared to diesel. Ignition delay was lesser, mass fraction burnt was slower and combustion period was lesser for COME blends as compare with diesel [26].

Combustion characteristics were investigated with Castor oil biodiesel and diesel blends using DI VCR engine. Results show improved combustion, performance characteristics of engine at higher compression ratio for the blends. Blends have lower ignition delay in comparison to diesel. Cylinder pressure was higher at CR18 for B50 blend. Heat release was higher for diesel at CR of 18. Mass of fuel burned was faster for B20 blend for CR of 15–18 [27].

Combustion characteristics were investigated using CI DI engine at constant speed with Waste cooking oil biodiesel it is noticed that BTE was lesser and BSEC was higher for biodiesel blends at rated load with reduced emissions in comparison to diesel. It was noticed that reduced ignition delay, lower heat release and longer combustion time of blends as compared to diesel. Waste cooking oil methyl ester may be a substitute for diesel [28].

Various combustion characteristics were investigated using Cotton seed biodiesel and blends in DI diesel engine, it results into higher cylinder pressure for the blend compared to diesel. Heat release, ignition delay and pressure rise rate was lower for blends as compared to diesel. Combustion was advanced and combustion time was increased for the blends as compared to diesel which may deteriorate the performance of the engine using biodiesel blend compared to diesel [29].

Combustion characteristics were investigated with micro algae and waste cooking oil biodiesel and their blends using common rail, turbocharged, and indirect injection engine. Cylinder gas pressure was higher for diesel at higher load compared to blends. There was no considerable variation in the cylinder gas pressure of methyl ester blends. Pressure rise rate was higher and heat release was lower for the methyl ester and its blends in comparison to neat diesel at 25% load, further increase in load eliminate the difference in the pressure rise rate and comparable with diesel. Increase in load on engine increases heat release for biodiesel blends and are comparable with diesel [30].

Combustion characteristics were investigated using single cylinder E6 Ricardo engine with waste fish oil biodiesel it was observed that cylinder pressure was higher compared to diesel. Heat release of biodiesel starts earlier compared to diesel was because of early start of combustion and also close to TDC [31].

Investigation of combustion and emission characteristics was carried out using waste cooking oil biodiesel and its blends using CI DI engine it was resulted into higher cylinder gas pressures for blends in comparison with diesel. Increased load on the engine increases cylinder gas pressure for the blends as well as diesel. Heat release for biodiesel blends was lower due to reduced delay for methyl ester blends as compared to diesel. Commencement of combustion was advanced and combustion duration was lesser for blends compared to diesel [32].

Combustion characteristics were investigated with cotton seed methyl esters and blends using diesel engine it was resulted into higher cylinder gas pressures, higher net and cumulative heat release rate for diesel in comparison to methyl ester blends. Maximum cylinder gas pressure for lower percentage of blends was comparable with diesel. Ignition delay, injection duration and combustion period were lesser for methyl ester blends compared to diesel. Pressure rise rate was lower for blends in comparison with diesel [33].

It is observed from literature review that combustion characteristics of constant CR and VCR engines were investigated using methyl esters and diesel blends. In open literature little work is available on the study of combustion characteristics of VCR engine using mixture of two biodiesel blend with diesel as fuel.

The main objective of the research is to propose an amicable blend of biodiesels with diesel and hence to increase the quantity of the potential biodiesel source as an alternate to the neat diesel and neat biodiesels. The reason behind the idea is, many oilseeds are available in small quantities and if the oil is extracted from these oilseeds and converted to their respective biodiesels the quantity available may be not be sufficient to rely upon a neat biodiesel. If two or more biodiesels are blended in proper proportion and used as an alternative, the total available fuel source will be increased and this will enhance the chances of using the biodiesels.

The present work is focused to test whether the biodiesel can be mixed and used as a blend with diesel in the engines. It is also intended to investigate the performance, emission and combustion characteristics of the engine using mixture of two biodiesel blends with diesel using CI DI VCR engine. The Simarouba and Jatropha biodiesel are produced and considered for the current investigations.

Please cite this article in press as: B.R. Hosamani, V.V. Katti, Experimental analysis of combustion characteristics of CI DI VCR engine using mixture of two biodiesel blend with diesel, Eng. Sci. Tech., Int. J. (2018), https://doi.org/10.1016/j.jestch.2018.05.015