EXPERIMENTAL DETERMINATION OF FLAMMABILITY LIMIT AND QUENCHING DIAMETER FOR VARIOUS BIODIESEL BLENDS.

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Abstract

The engine required combustible mixture for combustion process. Each fuel have different flammability limit. Flammability is defined the ability to ignite and burn when exposed to an open flame. Fuel have higher and lower flammability limit. Fuel burnt with air at lean and rich mixture. Too rich and too lean mixture is not burned. Quenching diameter is that diameter at which flame is could not pass through that diameter and extinguish. Therefore for design combustion chamber, the diameter should higher than quenching diameter. In this paper, determine the flammability limit of biodiesel blend and quenching limit and compared result with diesel (baseline).

In the experiment, maintain constant fuel injection pressure 4 bar and air pressure 3 bar and vary the flow rate of fuel from 10ml/min to 60 ml/min and air 2 LPM to18 LPM. For find out quenching diameter use copper pipe having length 150mm and different inside diameter (5,7,9,11,15 mm) and pass the flame of different cross section pipe maintaining the same fuel and air pressure for diesel ,J10 and J20.

Keywords: -Bio-Diesel, flammability limit, quenching diameter

Nomenclatures: - J 10 (10 % Jatropha biodiesel + 90 % diesel) J20 (20 % Jatropha biodiesel + 80 % diesel)

Introduction

The lower and upper flammability limits of a fuel are key tools for predicting fire, assessing the possibility of explosion, and designing protection systems. Knowledge about the risks involved with the explosion of both gaseous and vaporized liquid fuel mixtures with air is very important to guarantee safety in industrial, domestic, and aeronautical applications. Currently, most countries use various standard experimental tests, which lead to different experimental values for these limits. A comprehensive literature review of the flammability limits of combustible mixtures is developed here in order to organize the theoretical and practical knowledge of the subject. The main focus of this paper is determining the flammability limit and quenching diameter of bio-diesel blend. In addition, the description of methodology for experiments to find the upper and lower limits of flammability limit of bio-diesel blend compared with diesel and finds the quenching diameter of biodiesel blend. In the experiment we control the air-fuel ratio supplied to air blast nozzle, the mixtures were ignited to determine the LFL and UFL for diesel and biodiesel blend and result is compared with data published in the literature review.

[1]**Digvijay B. Kulshreshtha1 et al. [Feb2011]** in pressure-swirl atomizer, a swirling motion is imparted to the fuel, leading it under the action of the centrifugal force to spread out in the form of a hollow cone as soon as it leaves the exit orifice. This kind of atomizer finds its use in gas turbines and liquid propellant rockets. This paper presents the experimental investigations of air assisted pressure swirl atomizer for spray cone angle and penetration length at different injection pressure differential ranging from 3 bar to 18 bar in an increment of 3 bar. The results are then compared with conventional pressure swirl atomizer; with same nozzle dimensions, same inlet pressure and temperature, same mass flow rate and same injection pressure differential. [2]**D.P.Gardiner et al. [Aug-2005]** In this report examine the flammable fuel/air mixtures were carried out to form in fuel tanks containing blends of ethanol and gasoline. The current project followed an earlier project in which an experimental technique and a mathematical model were developed to investigate the flammability issue. The ethanol/gasoline blends evaluated in the first project were experimental fuels originally produced for vehicle drivability studies. These blends (referred to as E85 fuels) contained about 70-80% ethanol and a variety of hydrocarbon components.

[3]**Artur N. Gutkowski et al.** Flames in propane/air mixtures propagating in square *ds* and circular *dc* ducts of small sizes have been experimentally investigated. An influence of the direction of flame propagation, cross-section and dimensions of the duct on the flame propagation velocity in the stoichiometric mixture has been determined. Experimental results have shown that the direction of flame propagation has an insignificant influence on the flame propagation velocity *SL*, for both circular and square ducts. The quenching distance (square duct) and the quenching diameter (circular duct) have been determined and compared. For lean mixtures, quenching distances and diameters are almost the same for downward and upward flame propagation. For rich mixtures, quenching limits for downward and upward propagating flames coincide up to $\Phi = 1.55$, then these limits split up. The quenching diameter is greater than the quenching distance for mixtures with the equivalence ratio $\Phi \sim 0.6 \div 1.55$. The existence of this difference is probably caused by the dead space.

Biodiesel: -

Production of biodiesel

In the present work the preparation of biodiesel from *Jatropha* oil produced by two-phase solvent extraction. In the experimental study use 1litr jatropha oil, 40gms sodium hydroxide pellet as a catalyst, 250ml methanol as a extraction solvent, extraction temperature 35 °C, extraction time 30 min. first of all obtain the chain reaction therefore use 250 ml of methanol add 40 gms sodium hydroxide pellet in barosile placed on magnetic separator for 30 min so sodium hydroxide pellet dissolved completely after that this solution is mixed with jatropha oil. After mixing the solution form chain reaction so that container placed on magnetic separator for 120 min at 60 °C. If reaction is completed form 2 layer one is biodiesel and other is fatty acid then it is placed in separating funnel for 24 hrs and collect the fatty acid .After that obtain oil stored in container where mixed with water and passed through silica gel to remove the soap contain in oil this process is called as transesterification phase . Then the mixture is placed in separating funnel for 24 hrs after that remove soap. The remaining oil is obtain is nothing but jatropha biodiesel.

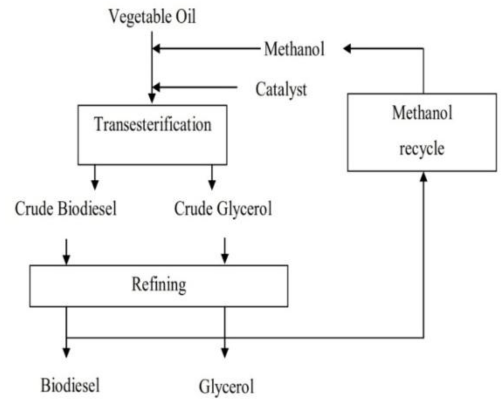


Fig. 4.1 Basic scheme for biodiesel production via transesterification process with alkali catalyst

Fig1: - Jatropaha biodiesel

Preparation of blend

Biodiesel is a liquid fuel, technically known as a mono alkyl ester, made from fats or oils and alcohols. Bio- Diesel (for example: B10, B20). B10 contain 10 % Jatropha biodiesel + 90 % diesel and mixed properly.

Properties of Biodiesel and its blend compared with neat diesel

Sn.	Properties	Diesel	Jatropa Biodiesel	J10	J20
1	Density (Kg/m3)	822	915	843.56	854.76
2	Viscosity (cSt)	2.086	6 to 8	3.13	3.84
3	Calorific Value (MJ/kg)	42	37 to 39	40	41
4	Flash point (°C)	50	170	160	150
5	Cetane No.	48-56	52-56	50-54	50-54

Experimental setup: -In the experimental set up, use fuel tank having capacity of 1litr and water tank having capacity of 3 liter. Fuel tank is placed inside the water tank having two heaters are placed to increase the water temperature at 80 ^{0}C which is measured by K type thermometer. Increase the water temperature as a result diesel and biodiesel temperature increases up to 50^{0}C. With the help of control valve supply the fuel in the vaporizer so it can vaporize the fuel and supply to nozzle.

At the other end compressed air is having variable pressure is supply to nozzle. As a result obtain the fine spray of air fuel mixture is ignite to form flame. Supplying the fuel and air quantity find out the flame is blown on and blown off at changing the air pressure ranging from 4,6,and 8 bar and fuel pressure is constant and effect of flame on this pressure is find out the flammability limit of biodiesel blend J10, J20 and diesel.

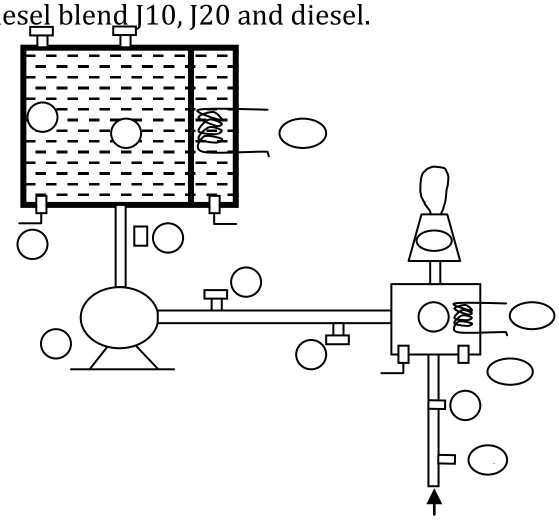


Fig2a: - Experimental set up line diagram

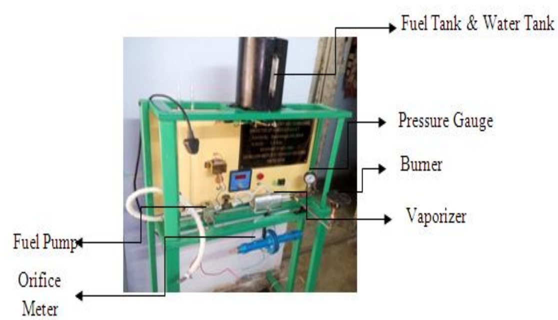


Fig2b: - Experimental set up

For finding the quenching diameter of fuel use copper pipe having length 150 mm and diameter range is 3mm to 16mm are use. 5 set of copper pipe having different inside diameter (5mm, 7mm, 9mm, 11mm, 15mm).The copper pipe of variable diameter is placed in above the flame so that flame is passed from that pipe. The quenching diameter for diesel, J10 and J20 are 5mm where flame is blown off at air supply 10 LPM and fuel supply 40 ml/min.

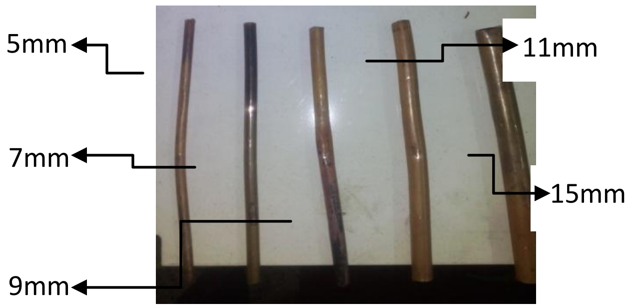


Fig3: - Copper pipe

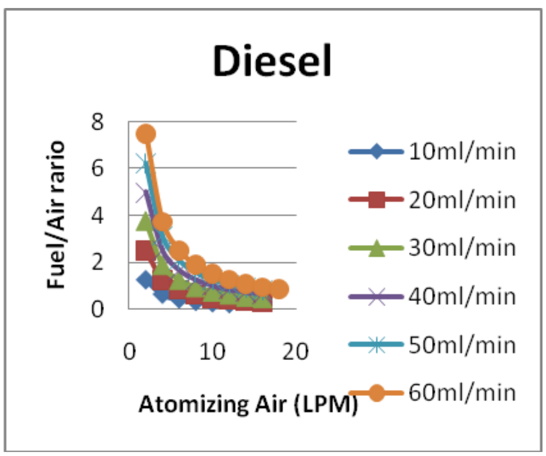
RESULT AND DISCUSSION

OPEN FLAME: -

Fuel:-Diesel

Air pressure: - 3 bar

Injection fuel pressure: - 4 bar



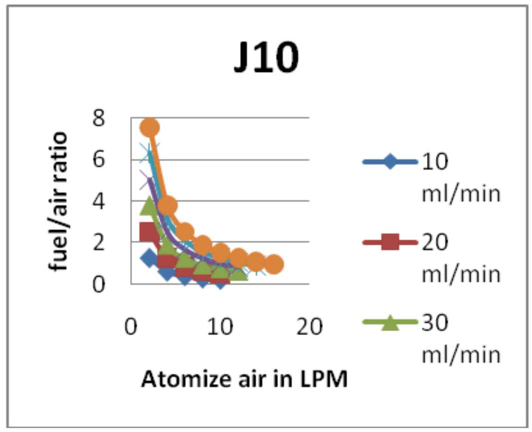
Graph 1: - Fuel air ratio for Diesel flame is blown on and blown off

From Graph 1 shows the fuel air ratio for diesel flame is blown on and blown off at air supply in LPM and fuel supply in ml/min. From graph it shows that flame is blown on at 2 LPM by vary the fuel supply and blown out at 18 LPM for maximum fuel supply limit is 60 ml/min.

Fuel:-J10

Air pressure: - 3 bar

Injection fuel pressure: - 4 bar



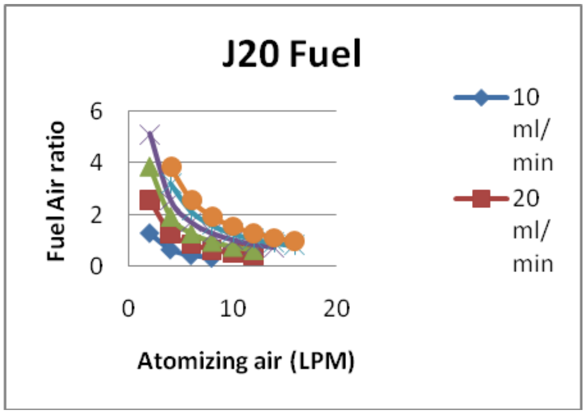
Graph 2: - Fuel air ratio for J10 flame is blown on and blown off

From Graph 2 shows the fuel air ratio for J10 flame is blown on and blown off at air supply in LPM and fuel supply in ml/min. From graph it shows that flame is blown on at 2 LPM by vary the fuel supply and blown out at 16 LPM for maximum fuel supply limit is 60 ml/min.

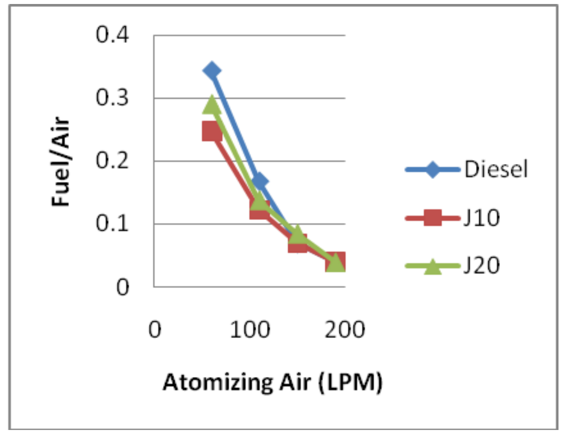
Fuel:-J20

Air pressure: - 3 bar

Injection fuel pressure: - 4 bar



Graph 3: - Fuel air ratio for J20 flame is blown on and blown off



Graph 4: - Comparison of Fuel air ration for diesel, J10 and J20

From Graph 3 shows the fuel air ratio for J20 flame is blown on and blown off at air supply in LPM and fuel supply in ml/min. From graph it shows that flame is blown on at 2 LPM by vary the fuel supply and blown out at 16 LPM for maximum fuel supply limit is 60 ml/min.

Close flame: -

Fuel: - Diesel, J10 and J20

Primary Air Pressure: - 2 bar

Injection Fuel Pressure: - 2 bar

Atomizing air Pressure: - 1 bar

Atomizing air quantity: - 10 LPM

Diameter in mm	**Quenching limit**		
	Diesel	J10	J20
5	**Flame quench**	**Flame quench**	**Flame quench**
7	**Flame quench**	**Flame quench**	**Flame quench**
9	Flame blown on	Flame blown on	Flame blown on
11	Flame blown on	Flame blown on	Flame blown on
15	Flame blown on	Flame blown on	Flame blown on

From Graph 4 shows the Comparison of Fuel air ration for diesel, J10 and J20 for close flame from graph it shows that for supply same quantity of air fuel air ratio is maximum for diesel and minimum for J10. There for it is cleared that for obtained the flame quantity of fuel required is less in diesel than J1o and J20.

6.4 Quenching diameter

Atomized air pressure:-4bar

Injection fuel pressure:-4bar

Air supply:-10 LPM

Fuel supply: - 40ml/min

Table 1: - Quenching diameter where flame is blown on and blown off for diesel, J10 and J20.

Conclusion: -

The experimental investigation is focused on analyzing the flammability limit and quenching diameter for various biodiesel blends.

For study the experiment I have analyzed for close flame we increase the primary air supply in LPM. Fuel air ratio decreases and flame does not burn because of quantity of air supply increases so that air is not proper mixed with fuel due to the increase in velocity of fuel. For close flame J10 is faster blown off than J20 than diesel.

For open flame we increases the fuel supply in ml/min the flame is blown off at maximum quantity of air supply because of air/fuel increases so that flame is blown at lean side.

In open flame study diesel is faster blown on as compared to biodiesel blend and biodiesel is fast blown off because viscosity of biodiesel is more as compared to diesel.

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