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Spray Characteristics of Bio Fuel- A Review

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Abstract: **-- The depletion in fossil fuel and its increasing demand, along with the hazardous emission are some important issues which are leading scientist to research for alternative fuel to replace this fossil fuel. This alternative in case of C.I engines can be biodiesel. Biodiesel is basically a vegetable oil-or animal fat based diesel fuel consisting of long chain alkyl (methyl, ethyl, or propyl) esters. This review aims to study and discuss the result of various researches done by few researchers around the world, to study the spray characteristics of biodiesel fuel in controlled environment. These thoroughly conducted researches were aimed to identify a fuel in order to successfully replace the classical fuel for compression ignition engines without engine alteration. Spray process being an important part of C.I engine combustion process is one of the major research areas while performing these studies. In general, it was found that the biodiesel sprays penetrate faster and have narrow spray angle along with large droplet size compared to diesel. However, these studies are still in early stages and we believe that the mixture of biodiesel-ethanol-diesel fuel can be used to power C.I engines in terms of forming a fuel-air mixture, but further research is needed in order to assess the efficiency, pollution and reliability of the engine running with this fuel.**

***Keywords:*---** **Spray, Biofuel, Injection Pressure**

I. INTRODUCTION

Why should we use biodiesel? The major reason for using biodiesel is that it can increase engine performance and produce low emission when compared with conventional fuel. Biodiesel fuels can perform just as well as regular diesel fuels and can be used with diesel engine with less modification needed. One of the basic advantages of using biodiesel include longer engine life. Traditional diesel engines have a much higher rate of engine wear due to oil lubricant problem. Using biodiesel could improve lubricity levels inside the engine thus lengthen the engine durability.

One of the important characteristics of biodiesel fuels is that they have different fuel properties than diesel fuel. Because of this difference in properties, biodiesel have different spray behavior and fuel atomization characteristics compared to classic diesel. This is the main reason to research the spray characteristics and fuel droplet atomization parameters for biodiesel.

Fuel Atomization:-

A fuel atomizer is used for performing fuel atomization. In terms of automotive liquid fuels, atomization occurs by forcing fuel through a small jet (opening) under high pressure to break it into affine misted spray. This high pressure will force the fuel producing visible spray patterns that are needed for this research. Proper atomization is important for the engine efficiency and emission in order to have a complete combustion. There are various types of spray nozzle used for atomization process. Thus, spray pattern depends on the type of nozzle whereby each type of nozzle consists of different shaped orifice. Density, viscosity and surface tension also impact the atomization processes (Kipper et al., 2010).

Studies:- Xie et al., 2015 [1]Experimentally investigated macroscopic spray characteristics of different (0%-100%) blends of biodiesel derived from Drainage Oil and Diesel (BD0, BD20, BD50, BD80, BD100).The fuel injection quantities investigated for each injection pressure were as shown in Table No.1He found that Increasing the injection pressure will to increase in spray tip penetration, spray area and spray volume, whereas spray angle and average angle were insensitive. The spray angle, average angle increased significantly with increase in ambient pressure, which resulted in shorter and wider spray shape. Compared to blended fuel 100% diesel gave a larger spray angle and average angle.The spray area and spray volume increased significantly with increasing spray tip penetration. It was also observed that viscosity and surface tension of blend fuels increased with increase of blend ratio.

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Table No 1: Fuel Injection Quantities (mg/injection)

Injection press.(MPa)	BD0	BD20	BD50	BD80	BD100
60	17.06	16078	16.615	16.45	16.23
70	42.51	41.94	41.54	41.13	40.58
80	68.04	67.11	66.46	65.81	64.93
90	93.54	92.28	91.38	90.49	89.29
100	119.03	117.44	116.3	115.16	113.64

Avinash K. Agarwal et al.[2]was conducted studyto investigate the spray parameters of diesel and comparing them with jatropha and its blends from (0-100%).As compared to jatropha diesel has lower kinematic viscosity and density. In this research the properties like kinematic viscosity, volatility, Density of a test fuel were tried to brought close to the diesel and checking the spray parameters like spray tip penetration, spray angle etc were compared with diesel. The secondary fuel used in this experiment is jatropha and its blends i.e. J5, J20, J100.

The performance depends on the penetration of fuel in combustion chamber, more is the penetration more will be the efficiency. The chamber pressure is varied for different readings. Higher the pressure inside the chamber less is the penetration. The penetration also depends on the viscosity of the fuel diesel has less viscosity than jatropha. The formations of droplets are also important for the proper combustion of fuel inside the chamber. These overall parameters were kept in mind and accordingly some data was analyzed. The investigations are as under

Table No.02; Peak intensity length of jatropha and its blends:-

Fuel	Total length(mm)			
	1 bar	4 bar	7 bar	9 bar
Diesel	0	6	15.7	16.1
J5	0	9.5	13	16
J20	4	8	10.5	17.5
J100	7	11.5	17.5	19.5

The above table specifies the length of penetration of diesel and blends of jatropha at different chamber pressure when the fuel is injected from a distance of 6.77cm.It can be concluded from above table that jatropha blend are more stable during combustion and while atomization from location 2 as compared to location 1. This means that longer is the penetration spray length more uniform will be the rate of atomization and combustion. The chamber pressure reduces the penetration increasing the density at spray tip and many difficult for atomization. Increasing the jatropha oil concentration in blends increases the viscosity of blend making it difficult to atomize.

Barabas et al.[3]performed research study of spray characteristics of bio ethanol blend. In his research spray characteristics of bio ethanol blend were compared with pure diesel, pure petrol, and petrol diesel mixture. The constituents of diesel and petrol present in each of the fuel taken were as follows.

1) Diesel fuel:- 100% diesel
2) Biodiesel:- 100% biodiesel
3) Biodiesel + diesel:- 30% biodiesel,70% diesel
4) Ethanol blend: - 25% biodiesel,70% diesel, 5% ethanol.

The research was carried out in a pressure chamber in presence of nitrogen. Jet injection pressure was 50mpa and chamber pressure was 1mpa. The results found were:-

1) Spray Penetration:-

- Jet penetrating variation depends on time is depicted.
- In case of biodiesel & of diesel biodiesel blend, the penetration is lower, specially in early phase of jet development.
- The mixture of diesel biodiesel ethanol in first 3ms of jet development behaves same as diesel.

2) Spray Cone Angle:-

It is observed that spraying diesel and mixture of biodiesel diesel ethanol takes place with very similar angles but biodiesel and mixture of biodiesel diesel dispenses more.

3) Spray Velocity:-

- Jet peak variation depends on time.
- Change in biodiesel, ethanol diesel mixture & pure diesel is similar.

The spray characteristics of ethanol blend and that of diesel biodiesel and its mixture are very close. Resemblance between spray characteristics of ethanol blend and diesel fuel is because of their properties such

as density, kinematic viscosity & surface tension are very close.

Abdullah Adam et al.[4] performed research analysis of spray characteristics of straight vegetable oil fuel, in which effect of biofuel kinematic viscosity on fuel spray were studied. The performance results are as follows-

1. Spray Penetration

- ♣ The observations were noted at ambient temp. of 298k. Where fuel injection pressure was 40 MPa and time after start of injection was 0.5ms.
- ♣ Straight vegetable oil spray penetration was shorter than diesel fuel.
- ♣ Due to high value of kinematic viscosity for straight vegetable oil spray boundary did not formed branches like shape.

2. Spray Behavior

- ♣ At the end of injection where temperature inside chamber reduced rapidly, large size of fuel droplet have difficulty to automize completely.
- ♣ Due to difficulty in automization of size of droplet it leads to development of carbon deposits around nozzle
- ♣ High temperature can decrease kinematic viscosity level of straight vegetable oil.

Spray characteristics such as spray penetration cone angle is highly affected by kinematic viscosity of straight vegetable oil fuel due to having high kinematic viscosity than diesel fuel. Diesel fuel have haze state whereas straight vegetable oil surrounds with droplets of big size.The straight vegetable oil fuel shows the same phenomena of droplet at high and low injection pressure. High ambient temperature spray will reduce kinematic viscosity value of straight vegetable oil and thus could improve its spray atomization at end of injection.

CONCLUSION:

The most popular method for the application of ethanol as a fuel in CI engines is the blending of ethanol with diesel. An increase in ethanol percentage and temperature resulted in the decrease of viscosity and density of ethanol diesel blends. Investigation of neat ethanol sprays in CI engines was conducted by very few researchers. The ethanol blended fuel in CI engines can be classified into ethanol-diesel blend and ethanol-biodiesel blend. The addition of biodiesel as blend stabilizer is the prevailing method because it has the advantage of increasing the bio fuel concentration in diesel fuel. Increase of ethanol concentration in e-diesel and ethanol biodiesel generally resulted in the decrease of spray penetration and SMD. However, spray angle is increased with increase in the ethanol percentage in e-diesel. The more study on liquid phase penetration and SMD in e-diesel and e-biodiesel is required.

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