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Extended Abstract

Experimental Investigations on Combustion Characteristics of Jatropha biodiesel (JME) and its Diesel Blends for Tubular Combustor Application

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Abstract

Scarcity of fossil fuels and their negative impact on environment drive the research in the field of alternative fuels. Biodiesel is one such promising alternative fuel that is used in automobile, gas turbine, boiler and other furnace applications. In the present study, combustion characteristics of biodiesel (Jatropha methyl ester) and its diesel blends in gas turbine like combustor have been studied experimentally. An airblast atomizer along with axial swirler (swirler no. 0.76) is employed to investigate the combustion characteristics. During the experiment, heat rate (24 kW), Air to liquid ratio (ALR=2) and air temperature (600K) was kept constant. For different equivalence ratio, spray and flame characterization, flame temperature, combustion efficiency and emission parameters such as carbon dioxide (CO_2), Carbon monoxide (CO), Nitrogen oxide (NO_x) and unburned hydrocarbon (UHC) were determined. It is found that the flame temperature increases with increase in JME percentage in diesel whereas and major pollutants such as CO, CO_2 and UHC emissions decrease but the NOx emissions increases. The obtained results indicate that the biodiesel can be promising fuel for gas turbine power plants instead of fossil fuels

Keywords:

Biodiesel; Combustion; Emission; Flame structure;Jatropha methylester

Introduction

At present, globe is facing a problem of global warming and climate change, due to high pollutants emitted by the conventional fossil fuels. Hence, there is need to use fuels which are renewable and produces lesser environment damage. The major alternative fuels. Presently used are alcohol, bioethanol and biomass etc. Biofuels like JME derived from Jatropha plant (Ratanjot) is one of the most promising alternative fuels .Many researchers studied C.I. engine performance and emission of JME and its blends. They reported that it results in reduced brake power and increases specific fuel consumption (SFC) as percentage of biodiesel increased. Emission characteristic in term of CO, UHC, smoke decreases but NO_x is slightly higher. Hashimoto et al. carries out combustion characteristic of palm methyl ester for gas turbine combustor at atmospheric pressure and high temperature air (617 K) and found that adiabatic flame temperature, emission CO_2, CO, UHC and NO_x were lesser than conventional diesel. So far extensive research work in the area of biodiesel as fuel for intermittent combustion devices such I.C. engines has been carried out. But very little information is available on use of these fuels in continuous combustion like gas turbine and liquid fuel burners using JME derived from Jatropha oil found in India.

Experimentation

1. Experimentation was carried out as follows.
2. The air compressor was switched on and air pressure maintained at 4 bars by pressure regulating valve and supplied to an airblast atomizer.
3. The fuel supply pressure is maintained at 7 bars with nitrogen gas.
4. Air-fuel ratio maintained stoichiometric condition using air rotameter and fuel rotameter.
5. The air to liquid ratio (ALR) is maintained 2 throughout the experiment 4.

The spray structure was captured using digital camera (canon 5X, speed 3 frames/sec). After the spray study, air-fuel mixture was ignited by the spark plugs and open diffused flame obtained at different air fuel ratio and again captured by digital camera .To study flame temperature and exhaust emission, injection unit was fitted to combustion chamber, the primary air was supplied through the swirler. Having after obtaining stable flame, an equivalence ratio was varied

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Results and Discussion

The combustion Characteristics of biodiesel and its diesel blends were investigated for different equivalence ratios. The details are as under

- Spray structure
- Flame appearance
- CO_2 emission
- CO emission
- NO_xemissions
- UHC emission
- Exhaust gas temperature
- Axial temperature distribution
- Combustion efficiency

Conclusions

Based on the results obtained from the measurements, the following conclusions were drawn. The flame luminosity decreased with increase JME content in blends, indicating the presence of less soot in the flames in biodiesel flame as compared to diesel. By using biodiesel, lower emission of CO_2, CO, UHC were obtained as compared to diesel fuel.NO emission is slightly higher for biodiesel blend. NO can be reduced by using lean mixture. Considerable enhancements were noticed in CO and CO_2 emission with increase in equivalence ratio (φ).Combustion efficiency was observed same for diesel and biodiesel blends. It is concluded that biodiesel blends can be successfully used for continuous combustion applications like gas turbine and oil furnace.

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