Biofuels 2015 - Producing advantageous biofuels for heavy duty and jet engines - Thomas D Foust - National Renewable Energy Laboratory

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The world desires both higher efficiency engines and lower greenhouse gas (GHG) emitting biofuels. the continual improvement of the environmental requirements of ICAO (International Civil Aviation Organization) forces new research to be carried out.The use of renewable biofuels obtained from plants or fatty acids is very promising. At present, aviation accounts for about 2% of man-made emissions of CO2. Foreign companies in recent years (2008-2014) have been intensively studying the possibility of using alternative fuels without the need for modification of aircrafts and engines. The first flight of the airplane on biofuel took place in 2008. The British Airline Virgin Atlantic Airways Ltd is the proprietor of that aircraft. Boeing and its international partners are already working hard to bring biofuels from the testing stage to the manufacturing stage. Boeing 747-8 Freighter and the 787 Dreamliner made the first demonstration of transatlantic and transpacific flights on biofuels in 2011 and 2012 KLM began weekly flights by an Airbus A330-200 between Queen Beatrix International Airport, in Oranjestad, Aruba, and Amsterdam’s Schiphol Airport, Netherlands, using converted cooking oil as aircraft fuel. So far, Russia has not done commercial-scale biofuel production. However, this trend has a great future because of the presence of large sown areas and water surfaces in our country When using biofuel, the emission of smoke, solid carbon, carbon monoxide, sulfur and total carbon dioxide is decreased. The most economically feasible is a fuel that can be mixed in any proportion with conventional jet fuel and does not require the creation of an alternative ground fuel-supply infrastructure and ad hoc adjustment of aircraft engines. Thus, the use of bio-kerosene obtained from jatropha, instead of the traditional kerosene in aircraft would reduce "carbon trace" almost by 80%.To achieve these goals a large number of countries have passed provisions that require higher efficiency engines and lower GHG fuels. Experimental studies of the features of fuel–air sprays were performed at the Central Institute of Aviation Motors using laser diagnostics setup. The description of the test bench The setup is equipped with instruments for laser measurements of the quality of spraying and the rate of droplets by the light scattering. In this work, the physical studies were carried out using the method of Phase-Doppler anemometry (PDPA TSI, United States). Digital photography was carried out using a Canon XL_H1 three-matrix color camera-recorder (Japan). As an object of study, a double-channel fuel burner with combined centrifugal-airblast design. The channels of the nozzles are arranged concentrically. A pressure swirl pilot channel with a low rate of flow and cylindrical outlet nozzle is mounted on the burner axis. The main fuel feed channel is airblast with a ring nozzle. It is placed between the two air swirlers for better atomization of the liquid film and for stabilization of the fuel–air spray. The angles of the vane inclination of inner and peripheral swirlers relative to the axis of the device were 60° and 45°. The outer diameter of the fuel nozzle in a pneumatic atomizer is 22 mm and 1.1 mm in a centrifugal atomizer. A detailed description of the burner is given in where it was tested on various petroleum and alternative fuels.Unfortunately, these provisions have largely been developed independent of each other and can conflict with each other. For example the requirement to blend in ethanol at the 10% level into gasoline in the US decreases the distance traveled per volume basis (km/l) in current spark ignition engine powered cars due to the lower energy content of ethanol. In this section, we studied the atomization at normal conditions for three types of liquid: (1) water (kinematic viscosity νF =1.05 × 10–6 m2/s, surface tension σF = 73 × 10–3 N/m), (2) kerosene (νF = 1.9 × 10–6 m2/s, σF = 25 × 10–3 N/m), and (3) a mixture of diesel fuel with rapeseed oil in the ratio of 50 : 50 (νF = 13.7 × 10–6 m2/s, σF = 30 × 10–3 N/m), which imitated liquid biofuel. We used three methods of spraying: hydraulic (in which the energy of the liquid is used for spraying), pneumatic (spraying of liquid in the flows of air), and a combined centrifugal-pneumatic process, in which liquid spraying occurs due to the of the liquid state's own energy and the energy of air. The results of this series of experiments allow us to make some assumptions about the mechanism of the liquid film decay into droplets. The film of the fuel is formed as a result of the interflow of swirled liquid streams into a single stream along the length of the swirl chamber and the nozzle of the injector. In this case, one can assert that when the fluid moves through the caves of the injector, its outer layer is decelerated due to the friction with the surface and the velocity components diminish in this layer. This gives rise to the shear stresses along the fuel film thickness. We can assume that with an increase in the velocity, depending on the properties of the fluid and geometrical parameters of the atomizer, the shear of the layers becomes so significant that the outer sublayer is swirled in the opposite direction relative to the velocity vector efficiencies. This talk will discuss some possibilities for producing biofuels that look promising for being superior to current gasoline, diesel and jet fuels for use in the next generation of higher efficiency heavy duty engines.

Biography:

Thomas D Foust is the Director of the National Renewable Energy Laboratory's Bioenergy and Biofuels Center. He has over 25 years of experience in the biofuels field. His areas of expertise include feedstock production, biomass conversion technologies to fuels and products, and environmental and societal sustainability issues associated with biofuels. He has over 100 publications in the biomass field covering all aspects of biofuels technology. He has done PhD in Mechanical Engineering, MS in Mechanical Engineering from the Johns Hopkins University, and BS in Mechanical Engineering from the Pennsylvania State University. He is a licensed Professional Engineer.