

Effect of Fuel Type on Design Parameters and Atomization Process for Pressure Swirl Atomizer and Dual Orifice Atomizer for High Bypass Turbofan Engine

Authors : Mohamed K. Khalil, Mohamed S. Ragab

Abstract : Atomizers are used in many engineering applications including diesel engines, petrol engines and spray combustion in furnaces as well as gas turbine engines. These atomizers are used to increase the specific surface area of the fuel, which achieve a high rate of fuel mixing and evaporation. In all combustion systems reduction in mean drop size is a challenge which has many advantages since it leads to rapid and easier ignition, higher volumetric heat release rate, wider burning range and lower exhaust concentrations of the pollutant emissions. Pressure atomizers have a different configuration for design such as swirl atomizer (simplex), dual orifice, spill return, plain orifice, duplex and fan spray. Simplex pressure atomizers are the most common type of all. Among all types of atomizers, pressure swirl types resemble a special category since they differ in quality of atomization, the reliability of operation, simplicity of construction and low expenditure of energy. But, the disadvantages of these atomizers are that they require very high injection pressure and have low discharge coefficient owing to the fact that the air core covers the majority of the atomizer orifice. To overcome these problems, dual orifice atomizer was designed. This paper proposes a detailed mathematical model design procedure for both pressure swirl atomizer (Simplex) and dual orifice atomizer, examines the effects of varying fuel type and makes a clear comparison between the two types. Using five types of fuel (JP-5, JA1, JP-4, Diesel and Bio-Diesel) as a case study, reveal the effect of changing fuel type and its properties on atomizers design and spray characteristics. Which effect on combustion process parameters; Sauter Mean Diameter (SMD), spray cone angle and sheet thickness with varying the discharge coefficient from 0.27 to 0.35 during takeoff for high bypass turbofan engines. The spray atomizer performance of the pressure swirl fuel injector was compared to the dual orifice fuel injector at the same differential pressure and discharge coefficient using Excel. The results are analyzed and handled to form the final reliability results for fuel injectors in high bypass turbofan engines. The results show that the Sauter Mean Diameter (SMD) in dual orifice atomizer is larger than Sauter Mean Diameter (SMD) in pressure swirl atomizer, the film thickness (h) in dual orifice atomizer is less than the film thickness (h) in pressure swirl atomizer. The Spray Cone Angle (α) in pressure swirl atomizer is larger than Spray Cone Angle (α) in dual orifice atomizer.

Keywords : gas turbine engines, atomization process, Sauter mean diameter, JP-5

Conference Title : ICAPGTE 2018 : International Conference on Aircraft Propulsion and Gas Turbine Engines

Conference Location : Barcelona, Spain

Conference Dates : October 29-30, 2018