World Academy of Science, Engineering and Technology
International Journal of Aerospace and Mechanical Engineering
Vol:16, No:05, 2022

Extracting an Experimental Relation between SMD, Mass Flow Rate, Velocity and Pressure in Swirl Fuel Atomizers

Authors : Mohammad Hassan Ziraksaz

Abstract : Fuel atomizers are used in a wide range of IC engines, turbojets and a variety of liquid propellant rocket engines. As the fuel spray fully develops its characters approach their ultimate amounts. Fuel spray characters such as SMD, injection pressure, mass flow rate, droplet velocity and spray cone angle play important roles to atomize the liquid fuel to finely atomized fuel droplets and finally form the fine fuel spray. Well performed, fully developed, fine spray without any defections, brings the idea of finding an experimental relation between the main effective spray characters. Extracting an experimental relation between SMD and other fuel spray physical characters in swirl fuel atomizers is the main scope of this experimental work. Droplet velocity, fuel mass flow rate, SMD and spray cone angle are the parameters which are measured. A set of twelve reverse engineering atomizers without any spray defections and a set of eight original atomizers as referenced well-performed spray are contributed in this work. More than 350 tests, mostly repeated, were performed. This work shows that although spray cone angle plays a very effective role in spray formation, after formation, it smoothly approaches to an almost constant amount while the other characters are changed to create fine droplets. Therefore, the work to find the relation between the characters is focused on SMD, droplet velocity, fuel mass flow rate, and injection pressure. The process of fuel spray formation begins in 5 Psig injection pressures, where a tiny fuel onion attaches to the injector tip and ended in 250 Psig injection pressure, were fully developed fine fuel spray forms. Injection pressure is gradually increased to observe how the spray forms. In each step, all parameters are measured and recorded carefully to provide a data bank. Various diagrams have been drawn to study the behavior of the parameters in more detail. Experiments and graphs show that the power equation can best show changes in parameters. The SMD experimental relation with pressure P, fuel mass flow rate Q˙ and droplet velocity V extracted individually in pairs. Therefore, the proportional relation of SMD with other parameters is founded. Now it is time to find an experimental relation including all the parameters. Using obtained proportional relation, replacing the parameters with experimentally measured ones and drawing the graphs of experimental SMD versus proportion SMD (SMD_P), a correctional equation and consequently the final experimental equation is obtained. This experimental equation is specified to use for swirl fuel atomizers and the use of this experimental equation in different conditions shows about 3% error, which is expected to achieve lower error and consequently higher accuracy by increasing the number of experiments and increasing the accuracy of data collection.

Keywords : droplet velocity, experimental relation, mass flow rate, SMD, swirl fuel atomizer
Conference Title : ICAPES 2022 : International Conference on Aerospace, Propulsion and Energy Sciences
Conference Location : Sydney, Australia
Conference Dates : May 16-17, 2022