66th International Astronautical Congress 2015

SPACE PROPULSION SYMPOSIUM (C4)
Interactive Presentations (IP)

Author: Prof. Benveniste Natan
Technion – Israel Institute of Technology, Israel, aerben@technion.ac.il

Ms. Arza Hadad
Technion – Israel Institute of Technology, Israel, arza@tx.technion.ac.il
Dr. Dan Grinstein
Technion – Israel Institute of Technology, Israel, dan.grinstein@gmail.com

THEORETICAL MODELING OF THE COMBUSTION OF GEL FUEL DROPLETS

Abstract

Safety and performance play an important role in the choice of a propulsion system. In a search for increased safety without a loss of performance, we focus on gelled fuels and propellants. Gelled fuels and propellants have the potential of providing increased safety while giving the possibility of enhanced performance through the use of energetic additives.

Gels are prepared by mixed liquid fuels with a gelling agent. The gelling agent changes the rheological properties of the fuel and as a result the liquid fuel becomes a yield stress non-Newtonian fluid. During storage, the gel fuel has an extremely high viscosity and it behaves like a solid. When the fuel flows through the feeding tubes and the injectors, it undergoes shear stress. Under shear stress, the viscosity of the fuel decreases, which makes possible the atomization and combustion of the fuel.

Owing to this unique behavior, gel fuels are the best compromise between solid and liquid fuels: On one hand, there is throttleability and reduced sensitivity to impacts, on the other, better suitability to the use of solid energetic additives and reduced risk of leakages and spillages.

The gelling agent can be an inorganic as well as an organic substance. Using an organic gellant means that gellant burns with the fuel and contributes to the energy content of the fuel, and therefore, is, from this point of view, preferable to an inorganic gellant. Organic gellant based gel fuels are the subject of this work.

In particular, we look at the combustion of a single gel fuel droplet. The understanding of the combustion behavior of a single droplet would be very beneficial for the understanding and prediction of spray combustion behavior and for the increase of gel fuel combustion efficiency.

Experimental work showed that a gel fuel droplet has a particular periodical burning mechanism. This behavior is included in the mathematical numerical model of the combustion of a single hydrocarbon gel fuel droplet that we present here.