Impact of Characteristic Length L* on a Green 1-Newton Bi-Propellant Thruster which is based on HTP and Kerosene

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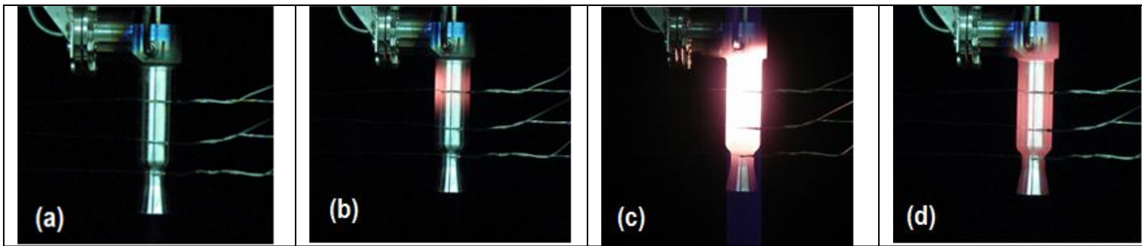
A 1N attitude control thruster, based on the green propellants: highly concentrated hydrogen peroxide and kerosene, is currently developed under ESTEC contract.

A significant experimental effort was performed in order to investigate systematically auto-ignition limits, steady state performance and pulse mode performance. The work is described in detail in [1]. A characteristic length of approximately L*=2500mm was selected. Recommendations about 1520mm < L* < 1780mm for HTP with RP-1 are provided by [2]. But no further information about real chamber dimensions thruster design details is provided.

Hot firing tests performed at Fotec indicated that chamber dimensions are sufficient to reliable ignite and also efficiently combust the propellants. The thruster tests did not show any sign that auto-ignition or combustion efficiency is affected by too small chamber volumes. In the contrary, with the selected injector principle, the tests showed the initiation of combustion near the injector plane and in the upper half of the cylindrical part of the thrust chamber (Figure 1 b).



t = 10s (initiation H2O2 mass flow)	t = 40s (initiation bi-prop. mode operation)	t= 50s (steady state operation)	t = 80s (after de-activation)

Figure 1: GRASP DM thruster hot firing

It is an important part of the thruster design process to find out the minimum necessary thrust chamber volume. That means, what are the lower limits of L* that are at necessary for obtaining reliable auto-ignition and sufficient combustion efficiencies. Additionally, the minimization of combustion chamber volume will provide further reduction of time lags for thrust rise and thrust decay after activation and de-activation of the thruster, and therefore will improve pulse mode performance.

Starting with minimum L* values that were successfully tested, three additional thrust chamber dimensions with successive reduction of the cylindrical part length will be investigated. The experimental data base will provide the opportunity to validate analytical design tools.

[1] Woschnak, A., Krejci, D., Schiebl, M., Scharlemann, C., Development of a Green Bi-Propellant Hydrogen Peroxide Thruster for Attitude Control on Satellites, Advances in Aerospace Sciences, Propulsion Physics, Vol. 4, (to be published).

[2] Huzel, D., Huang, D., Modern Engineering for Design of Liquid Propellant Rocket Engines, AIAA – Progress in Astronautics and Aeronautics, 1992.