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Corresponding author: HOFFMANN, Ivens Daniel
e-mail of corresponding author: *ivens.hoffmann@dlr.de*
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Title

Investigation on Pressure Loss and Spray Angle on Different 3D-Printed Helical Swirl Injectors

Authors

Ivens D. HOFFMANN [1], Dmitry I. Suslov [2], Jan C. Deeken[2], Justin Hardi[2]*
** Corresponding author*
[1] Institute of Space Systems, Stuttgart University, 70569 Stuttgart, Germany, ivens.hoffmann@dlr.de
[2] Institute of Space Propulsion, German Aerospace Center (DLR), 74219 Lampoldshausen, Germany

Abstract

For the performance and stability of liquid rocket engines, Injector behaviour is of utmost importance. A major problem is getting an effective chemical reaction and highly efficient homogeneous mixture of fuels at minimum chamber length. These processes are of great importance also in many other modern combustion systems (chemical industrial plants, heating systems, engines etc.) and lead to extreme high requirements to the injection equipment.

This article presents a concept for a Swirler LOX Injector using helical swirlers with different angles, length and position in the Injector.

The system has been designed based on DLR Lampoldshausen heritage within porous injection technologies [1] and possible future use at the DLR LUMEN Technology Demonstrator.

The setup has been tested at the Water Test Laboratory at DLR Lampoldshausen using Water to simulate LOX behavior at different pressures (from 0 to 20 bar pressure). For the visualization, high speed camera was used (Chronos CR21-1.0-16C) for Shadowgraphy (see Fig. 1 - Fig.3) imaging respectively, shadow imaging was used to study the spray angle at the injector post orifice and atomization. Pressure measurements were made using static pressure sensors at the LOX-Dome (before injector) and at some injectors directly before the swirler itself, to try to see the influence in pressure loss of the swirler in regard to the raw surface condition of the 3D-Printing Injector.

The helical swirler were differentiated in angle of the swirler (15, 30 and 45 degrees), Length of the swirler (Full turn - 360 degrees or half turn – 180 degrees) and position of the swirler (Entry, Middle and Exit) in regard to the Injector.

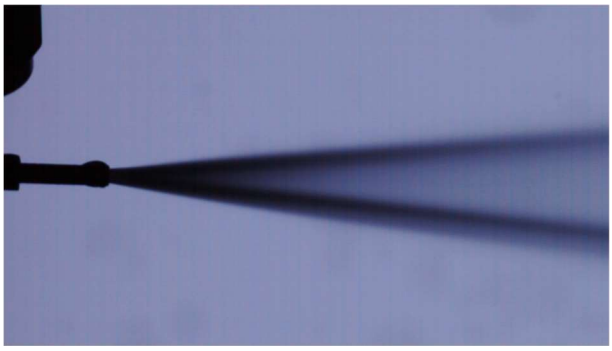

Fig 1: Mean Shadow Image of a 15° Helical Swirler

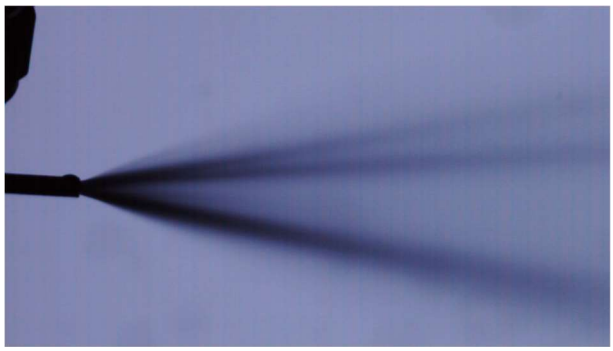

Fig 2: Mean Shadow Image of a 30° Helical Swirler

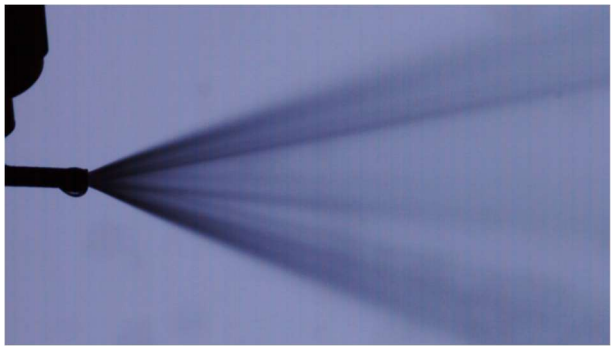

Fig 3: Mean Shadow Image of a 45° Helical Swirler

References

[1] J. Deeken, D. Suslov, O. J. Haidn, S. Schlechtriem: Combustion efficiency sensitivity studies of the API injector concept, In 49th Aerospace Sciences Meeting including the New Horizons Forum and Aerospace Exposition,2011, AIAA 2011-0793.