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Title

Investigation of Different Porous Injection Technologies in a LOX/CH4 Rocket Combustor with Optical Access at Sub-, Trans- and Supercritical Conditions

Authors

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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 an injection system based on the application of porous materials with different oxidizer injectors. 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 successfully implemented and operated from sub- to supercritical pressure conditions, with respect to the critical pressure of oxygen (35 to 65 bar tested), using the DLR Combustor Chamber "C". In this campaign optical investigations of the near injector combustion and flow field behavior at different penta-injector element were made. As fuel injector a metallic mesh (Rigimesh®) and Sinter bronze (CA-100) were used, and for the oxidizer 3 different technologies were tested: a conventional axial injector, a riffling injector and a helical swirl Injector, the last 2 were made using 3D-Printed technology.

For the visualization, high speed cameras were used for OH* emission (see Fig. 1) and Shadowgraphy (see Fig. 2) imaging respectively. Both porous materials showed a similar behavior in regard to flame stability, important to state that the metallic mesh generated a higher Pressure Loss if compared to the sinter bronze. In regard to the Oxidizer Injectors, Swirl injectors generated the most stable flame of all in all conditions, the Riffling injectors showed a stable flame for trans- and supercritical conditions and the axial injectors had an unstable combustion in the supercritical condition and could not be tested for trans- and subcritical conditions.

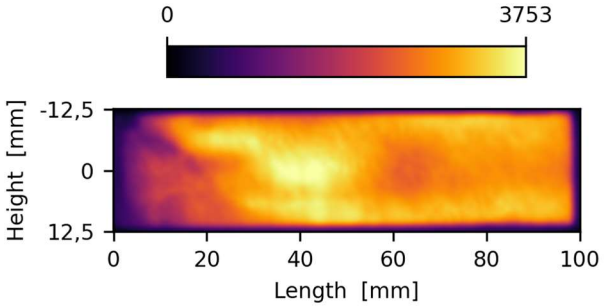

Fig 1: OH* imaging of the LOX/CH4 flame in the Swirl injector near field

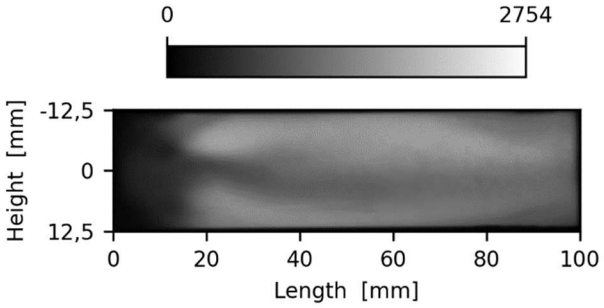

Fig 1: Shadowgraphy of the LOX/CH4 flame in the Swirl injector near field

References

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