Open position for a 2 years Post-doctorate, expected starting date September / October 2017

EXPERIMENTAL CHARACTERISATION OF TRANSITORY FLOW INTO THE BUFFER RESERVOIR OF A ROCKET ENGINE LEADING UP TO AND BEYOND IGNITION AND VALIDATION OF THE LEONARD SOFTWARE CODE

Description

Idle-mode operation, of a rocket engine using a liquid combustible immediately after ignition is of operational importance during missions into space. The complete understanding of the ignition and idle-mode phases can only advance via the characterisation of the thermohydraulic flow of the combustible into the buffer reservoir (or dome) of the engine and its expulsion through injectors into the combustion chamber. Along with the liquid combustible there is also an inflow of neutral gas into the dome which, when heated, can lead to strong heat transfer and possible phase change. The work will combine both experimental and numerical simulation aspects. Experiments are carried out on the exisiting rig in Grenoble using substitute fluids in an attempt to quantify thermodynamically and mechanically the rapid heat transfer phenomena and consequences thereof in this non-equilibrium flow. Simulation of these events is carried out using the LEONARD code in Vernon at the Airbus-Safran-Launchers (ASL) research facility.

The research program should lead to the identification of the physics brought into play as a function of operating conditions and to validate the numerical code with the purpose of using it to faithfully model the thermohydraulics of the filling of the dome with liquid combustible. Subsequently, the validated code is to be integrated into the functional models presently used by Airbus-Safran-Launchers (ASL). Further tests will be carried out to ascertain how robust the system is to downstream pressure fluctuations. It is hoped to determine the transfer function of the dome during two-phase injection in idle-mode. The work program breaks down as follows into experimental and numerical elements.

The experimental rig with relevant instrumentation (pressure, temperature, flowrate, void fraction, rapid visualisation measurements) is presently operational in the LEGI. Liquid and gas flowrates can be fixed independently while gas and dome wall temperatures are also adjustable. There are two operating domes and two substitute liquids that can be used. The duration of the transitory phase of any single experiment can be set between some tens and some hundreds of milliseconds. Access to the transfer function will require the ad hoc installation of a modulation system.

For the numerical simulation the LEONARD code is designed to model the type of non-stationary multiphase 3-D flows that occur in the injection dome of a rocket engine. The code was initially developed by RS2N and more recently by ASL. Based on a seven equation two-phase model using the discrete equation method (Saurel & Abgrall (1999), Abgrall & Saurel (2003), Saurel et al., JFM 2008), the code should be capable of modelling this type of complex flow.

The comparison of experimental and numerical results should lead to validation and improvement of the numerical code with the objective of developing a precise predictive tool for the filling of the dome in both nominal and idle modes of operation for future application to real motor systems.

Profile

The candidate should have an excellent grounding in fluid mechanics, heat transfer and phase change and be willing to take control of both experimental and numerical simulation aspects of the project. Previous use of simulation codes presents distinct advantage.

Contacts for further information

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The post-doc will be granted by CNES (https://cnes.fr/fr/consulter-les-offres)

Deadline for application: June 1st, 2017