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METHANE-OXYGEN SPACE ROCKETS TEST BENCH H-IMP ITALIAN FACILITY NON-STATIONARY PERFORMANCES NUMERICAL SIMULATION

Abstract

A new space propulsion facility, named H-IMP, is currently under construction at the Italian Aerospace Research Center (CIRA), located in Capua (South of Italy). This plant will be a test bench able to proof space rockets demonstrators up to 6 kN of thrust, using methane and oxygen, both in the liquid phase and in the gaseous phase. The main purpose of H-IMP is to experimentally assist the designing and building of innovative propulsion systems, carrying out tests mainly on small combustion chambers and using advanced optics/laser diagnostics. The facility is expected to be operative in December 2022.

By requirements, the H-IMP facility, will be sized to feed demonstrators with an operating pressure up to 62 bar, and with flow rates up to 1.5 kg/s of oxygen and 0.5 kg/s of methane (both liquid and gaseous) and the test duration is foreseen for 30 sec.

In this facility kind, the management of the processes to storage and transport the cryogenic or gaseous fluids up to the test article is very complex and delicate. This is because the system must guarantee strong time stability during the 30 seconds of test without a significative oscillation of the oxidizing and fuel mass flow rate, pressure, and temperature. In addition, the ignition phase is required to be realised in few seconds (less than two) and with regular (almost linear) fluids flow rates increase, analogously for the shutdown phase.

With the aim of perfecting the choice of the components necessary for the correct functioning of the system, non-stationary simulations have been carried out in different facility operating conditions. The numerical modelling software EcosimPro has been used. The activity has been mainly realized to support the facility design phase that has been recently concluded.

From these simulations the various criticalities with respect to the demonstrators' requests have emerged. In particular characteristics of each flow control valve in terms of response time and pressure losses have been set, both for on-off valves and flow regulation valve. The effects of the lines length and diameter have been evaluated and the optimal parameters to be used to set the PID systems have been calculated. The whole nominal facility performances have been obtained. The detailed results of this mentioned analysis will be presented in the paper.