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# A PAYLOAD FOR STUDYING DROPLETS IN SPACEFLIGHT ANALOGUES

**Abstract**

Over the next few decades, the energy scenario envisages the development of resilient energy networks based on the mix of energy from diversified sources and technologies. Combustion, as usually known and used, is an extremely simple process for generating energy but which produces pollutants. However, it is possible to develop new combustion technologies capable of overcoming this paradigm [1]. But this requires the carrying out of experiments in such conditions as to be able to concentrate only on the chemistry of the process, "forgetting" the associated complex fluid dynamics as it happens in microgravity. Aim of the paper is to present a payload designed for scientific investigation on droplets in spaceflight analogues like drop-towers or suborbital flights. Miniaturization, robustness and lightness have been the main design constraints. The payload, energetically autonomous and self-governing, is based on a number of test units (TU) (up to six) operating in parallel, each following the specific procedure foreseen, governed by a central unit (CU). Each TU consists of a single droplet test cell, a high speed imaging system and instrumentation for management/control and acquisition of analog/digital signals. In the present configuration, the payload is based on three TUs, two of which are dedicated to high pressure (up to 3 MPa) combustion tests of fuel droplet ; the third is dedicated to study the thermal behavior of emulsion droplets. The start/stop trigger of the payload is generated by an accelerometer when gravity attains a level less/greater than 10-1 g. In each TU, at the trigger START, a micro-pump feeds the programmed fuel quantity to form a droplet of defined diameter by a micro syringe needle. Then, the needle is retracted and the heating/ignition system is activated to heat/evaporate/burn the droplet. At

the START trigger the high speed CMOS cameras and the pressure, temperature, IR and UV sensors are activated. The payload is switched off with the trigger STOP. The CU is programmed to perform a droplet test in less than 10 seconds. The test can be repeated if the microgravity period is longer. In the paper, a detailed description of the thermo-fluid dynamics of the system and the optical diagnostics used to follow the processes exhibited by droplets and infer the wanted scientific quantities is given.
[1] D.L. Dietrich, R. Calabria, P. Massoli, V. Nayagam, F.A. Williams (2017), Experimental Observations of the Low-Temperature Burning of Decane/Hexanol Droplets in Microgravity, Combustion Science and Technology, 189:3, 520-554.