

MICROGRAVITY SCIENCES AND PROCESSES (A2)
Microgravity Experiments from Sub-orbital to Orbital Platforms (3)

Author: Mr. Jerome Lacapere
Air Liquide, France, jerome.lacapere@airliquide.com

Mr. Julien Tanchon
France, julien.tanchon@airliquide.com

Dr. Benjamin Legrand
Centre National d'Etudes Spatiales (CNES), France, benjamin.legrand@cnes.fr

Mr. Yves Prel
Centre National d'Etudes Spatiales (CNES), France, yves.prel@cnes.fr

Mr. Vincent Leudiere
Centre National d'Etudes Spatiales (CNES), France, vincent.leudiere@cnes.fr

THERMAL DESTRATIFICATION TESTS WITH LIQUID NITROGEN IN PARABOLIC FLIGHTS

Abstract

Since 1999, a french-german Research Technology program COMPERE is dedicated to scientific understanding of fluid behaviors in launchers tanks particularly on cryogenic liquid in microgravity. Up to now, experiments permit to better understand liquid behaviors in tanks and benchmarks permit to validate some aspects of numerical codes. In this frame all the tests performed are with limited microgravity duration, geometry representativity, or using similitude fluid.

Air Liquide in cooperation with CNES decided to develop CFD tools able to simulate with a good accuracy the thermo-hydraulic behavior of cryogenic propellants in the tanks during all phases of a space launch (from tank pressurization on the pad up to the end of draining of upper stage tank, including future ballistic phases).

In order to prepare future representative tests with cryogenic liquids in sounding rockets or in other orbital flights, a first autonomous test bench "Cry0genic" has been realized by Air Liquide with CNES support. This test bench allowed us to perform some experiments with liquid nitrogen in low gravity conditions during parabolic flights (NOVSPACE A300 zero-g aircraft). It also allowed testing new technology for launcher tank like cryogenic level sensor.

These tests are dedicated to reproduce several phenomena occurring in space launchers cryogenic tanks: pressurisation, depressurisation, cryogenic liquid in contact with hot walls... These physical phases have been reproduced during parabolas to be in low Bond number conditions (the test cell diameter is also low in order to get low Bond numbers during parabolas).

This paper will present the test bench with the main results obtained.