COMSOL Multiphysics® Thermal Simulations Of A Mars Simulating Environment Facility

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Abstract

This work describes the implementation with COMSOL Multiphysics® of a thermal simulation of a space environmental chamber, the SpaceQ chamber [1]. Space environment facilities are needed to simulate on Earth the expected performance of hardware and instrumentation that shall operate in space. The main goal of this work is to demonstrate the potential of COMSOL Multiphysics® to simulate the thermal gradients within the chamber, and use this to design future tests of space instrumentation in simulating facilities. We validate the model against the experimental measurements in the chamber. Here, we use the 'Heat transfer module' software package, model the properties of the chamber walls, inside atmosphere and refrigerating table, and consider conduction, convection and radiation in solids and gases and surface-surface radiation. For studies under Martian surface conditions, to test the operation of instrumentation of the ExoMars 2022 mission to Mars [2], the chamber is filled-in with CO2 at about 7 mbar, and the base is refrigerated down to 250K. This produces strong thermal gradients within the chamber, as the walls are in contact with the laboratory ambient. For vacuum tests, the chamber shall be used to bake components out and test degassing during the cruise phase in space or to validate the operation of instruments for the Moon. For this purpose, the chamber has an external heating blanket and the chamber is vacuumed to down to 10-3 mbar.

Reference

[1] Vakkada Ramachandran, A.; Nazarious, M.I.; Mathanlal, T.; Zorzano, M.-P.; Martín-Torres, J. Space Environmental Chamber for Planetary Studies. Sensors 2020, 20, 3996.
[2] Martín-Torres, Javier, et al. The HABIT (HabitAbility: Brine Irradiation and Temperature) Environmental Instrument for the ExoMars 2022 Surface Platform, Planetary and Space Science, vol. 190, 2020, p. 104968., doi:10.1016/j.pss.2020.104968.