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DESIGN AND VALIDATION OF A LAB-SCALE METHALOX FUEL PLANT FOR IN-SITU PROPELLANT PRODUCTION ON MARS

Abstract

In-situ resource utilization (ISRU) has been identified as a potentially key feature of all proposed Mars missions involving human exploration. The unique atmospheric and geological features on Mars allow for in-situ production of methalox (liquid methane-liquid oxygen) propellant, which would make Mars return missions more feasible. Methalox is easier to handle and store compared to conventional liquid hydrogen propellant. For example, SpaceX has unveiled plans for a reusable launch vehicle, Starship, and the accompanying Mars mission architecture, which relies on in-situ propellant production to supply fuel for the trip back to Earth. Before such a system can be deployed on Mars, a feasibility study and rigorous tests at smaller scales must be conducted on Earth.

UBC Mars Colony's phase one of this project consisted of the design, construction, and subsequent testing of a demonstration reactor, our Sabatier Fuel Reactor, which is governed by the Sabatier reaction, as well as an investigation into the feasibility of a reactor from an operational perspective. Factors include the complexity of day-to-day operation, maintenance, part replaceability, and others. The reactor fits within two cubic metres and requires an maximum of 1.8 kilowatts to operate. With custom PCBs to route the signal and control lines of all components, the reactor regulates the reaction within a standard profile and requires only one person to operate. In-house experimental results are planned to be compared with simulation results to provide guidelines towards future improvements. By the end of phase one, a functional reactor including all core components was ready for long-term operation and served as a baseline towards the next phase. For the phase two of this project, UBC Mars Colony will investigate optimal reactor parameters by running and improving the demonstration reactor from phase one. We will aim to collect experimental data using various catalysts to inform optimal reactor designs that maximize yield, minimize cost, and improve ease of maintenance.

UBC Mars Colony is an undergraduate engineering design team at the University of British Columbia (Vancouver campus). There are over 40 undergraduate students that have contributed to this project

since its conception in April 2019. The team meets on average once a week and has operated within a limited budget of $25,000 for the entirety of the Sabatier Fuel Plant project.