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PROPOSED METHALOX FUEL PLANT FOR IN-SITU PROPELLANT PRODUCTION ON MARS USING PRESSURIZED CARGO MODULES

Abstract

In-situ resource production (ISRU) has been conclusively identified as a 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 is easier to handle and store compared to conventional liquid hydrogen propellant. Elon Musk has unveiled plans for SpaceX's Starship and an accompanying Mars mission architecture, which relies on in-situ propellant production to supply fuel for the trip back to Earth. Paul, Lamontagne and Senna (2017) proposed a cargo version of Starship that would feature a (customizable) pressurized cargo module maximized for internal volume. Employing this concept, the UBC Mars Colony team has developed a complete proposal for a methalox fuel production plant. The plant utilizes the pressurized cargo modules for the main structural housing. Detailed plans for collection of carbon dioxide and hydrogen are included along with all chemical, mechanical, and electrical reactor components for the production of liquid methane and liquid oxygen. Storage requirements, power production, and environmental challenges (temperature, pressure, radiation, dust) are all discussed. The design is inherently scalable to meet future demand. An economic plan for the deployment of this plant is also included. A complete, ready-to-deploy proposal for a methalox fuel plant of this scale has not been previously demonstrated. The use of pressurized ITS modules allows for novel configurations and operation. A lab-scale test reactor was designed and constructed to help find critical parameters required for the full fuel plant proposal. 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 once a week only and has operated within a limited budget of $25,000 for the entirety of the Sabatier Fuel Plant project.$