IAF MATERIALS AND STRUCTURES SYMPOSIUM (C2)
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DETERMINATION OF THRUSTER CONFIGURATION AND EXPERIMENTAL VERIFICATION FOR BUOYANT ROVER CONCEPT

Abstract

Project Polaris is an international student organization that seeks to design the Star Rover, a novel vehicle that can explore Saturn's moon, Titan. This craft consists of a balloon, various engineering systems, and a payload which contains scientific instruments. Due to its high theoretical specific impulse, possibility to be chemically produced and low density, it was decided to use hydrogen gas to feed both the balloon and a set of cold gas thrusters. The balloon of the Star Rover controls the vertical movement while the thrusters control translation and attitude, specifically to counteract moment disturbances on the pitch and roll axes. It is important to consider the configuration and number of thrusters to be used. This decision should be made based on the directions of movement and stability of the rover, as well as the complexity of the thruster system.

To define the number and arrangement of the thrusters in the Star Rover, criteria such as mass,

stability, cost, complexity, force, degrees of freedom, and redundancy were taken into consideration. As a result, five possible different arrangements have been established, which have between two and six thrusters located on each axis, some of which include rotational control and stability with inertia wheels. The final configuration will be selected by conducting dynamics studies measuring fuel efficiency and stability.

To define the design of the thrusters, a 3D printed air thruster prototype was made, which was connected to a compressor using a pipe line. Four nozzle designs, all meant to produce 30 N, were tested: one subsonic and three supersonic with converging half angles of 15, 40, and 65 degrees, in order to maximize experimental performance. In order to measure the thrust produced, a load cell was used; it was placed at the front of the thruster, which itself was placed in a light mobile support. Force produced by the thruster would push the load sensor, yielding a thrust measurement. In addition, the pressure at the chamber was measured with a pressure transducer.

This paper will discuss rationale for selecting thruster configurations, thruster design, and testing