P17101: Prototype Arcjet Satellite Thruster

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***Abstract*—A tabletop prototype of an arcjet electrothermal propulsion system was developed to supplement ongoing exploratory spacecraft development conducted by RIT Space Exploration (SPEX). The arcjet thruster demonstrates the degree of practicality in implementing electrothermal propulsion systems. The arcjet assembly generates an electrical arc across the thruster nozzle's throat, ionizing argon propellant in order to achieve a greater specific impulse compared to cold gas propulsion.**

I. Nomenclature

II. Introduction

Satellites in Earth orbit for long-duration missions in excess of 5–25 years encounter perturbations to their trajectories over time from residual atmospheric and orbital particles, or from variations in Earth's gravity field. These spacecraft perform short station-keeping maneuvers periodically to compensate for drift and orbital decay.

An electrothermal rocket engine is method of propulsion by which an inert gas stored at ambient temperature (cold gas) is released from a pressurized vessel or driven by a pump and heated electrically before being expelled out of a nozzle. Two proven methods of electrothermal propulsion are *resistojets*, which use conventional heat exchangers to heat the propellant, and *arcjets*, which pass the propellant through an electrical arc to heat the gas.

This type of propulsion system is advantageous for use by long-life satellites since the engines may be small in size, have few moving parts, and do not use combustible fuels. Resistojet and arcjet engines produce less thrust than chemical rocket engines, but are more efficient, do not require ignition, and are easy to store for long periods.

An arcjet, while more technically challenging, offers greater potential gains in efficiency over a resistojet thruster. A tabletop prototype thruster was designed and tested to explore the feasibility of this type of system with less strict requirements compared to the limitations of building a flight-worthy system. A tabletop version does not require integration with a spacecraft, and mass and spatial limitations are relaxed.

RIT Space Exploration (SPEX) provided a hypothetical use-case to serve as the foundation for this exploration into satellite propulsion. SPEX's hypothetical mission objective is to design a communicaitons satellite that is capable of maintaining a polar geostationary orbit for 10 years.

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III. Design Methodology

IV. System Overview

A. Thruster Design

B. Power Conditioning Unit

V. Testing

A. Test Stand

B. Data Acquisition

C. Safety Measures

VI. Results

VII. Conclusions and Recommendations

Acknowledgment

Thanks.

References