



Engineering: Microgravity Experiments of Solid Waste Conversion into Useful Commodities

Internship – Summer 2018

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Abstract

This Summer I participated in two projects at Kennedy Space Center in Cape Canaveral, Florida. The projects focus on the NASA's Deep Space Gateway applications for future Mars travel. All of these projects use recycling technology to use resources found on Earth and on other planets for fuel and other environmental applications.

The first project I took the lead on is "Plasma Arc Gasification." Plasma is a high temperature and very efficient way to process waste to create usable byproducts. The plasma chamber in temperature is comparable to that of the sun and this energy will help create an environment in which the waste can be recycled properly for not only plant support, but also for possible fuel application as well. I performed the tests in a quartz tube, which is used to hold the waste (cotton, plastics, nylon, paper and a human waste simulant) and the waste is then combusted using O_2 (present in air) into gases such as H_2 , H_2O , CH_4 and CO_2 . I determined which gases are present using a Fourier-transform infrared spectroscopy (FTIR) machine, which analyzes the peaks of the gases using liquid nitrogen. Problems arose in the beginning from the reactor emitting electromagnetic waves (EMI) that interfered with the technology of the experiment, specifically the thermocouples. This was solved through multiple tests with the positioning of the thermocouple power supply further away from the plasma reactor. I worked with another intern, Daniel Santander, who developed a space plant chamber which uses CO_2 and H_2O (harvested from the plasma reactor) to grow plants in space. The chamber possesses a CO_2 monitor, which controls the amount of gas that enters the chamber, along with a water integration system to supply the amount of water needed for proper plant growth. This technology will then be used for plant growth in space for the Astronauts on future space flights and possibly on the International Space Station (ISS).

The second project I worked on is the "Orbital Syngas / Commodity Augmentation Reactor (OSCAR)" which focuses on the issues experienced in long-duration space flight regarding waste disposal. In previous space flight missions, waste was stored on board and returned to Earth for disposal. This technique is not applicable to long space flight missions to Mars due to the rocket being months away from Earth. OSCAR is using microgravity waste disposal techniques to produce fuels from the recycled waste. The waste is converted to syngas through a thermal degradation process. This process helps create an environmentally friendly way to dispose and reuse trash on board the space craft. Currently waste is being tested in the form of cotton and plastics. OSCAR is designed as a microgravity reactor that is currently being tested in a drop tower rig at Glenn Research Center. I helped design the 3D model for the insulation that will line the reactor. The first few trials, I dissolved the plastic of the mold in acetone. This method worked, but was very costly. I then received a silicone material to construct the mold from Swamp Works here at Kennedy. Through multiple trials with the silicone, this method worked best for developing the end pieces of the insulation for the chamber.