Characterizing a Cold Gas Thruster System

Max Huggins – UCA Department of Physics and Astronomy

April 2, 2020

Abstract

A cold gas thruster (CGT) system was designed with pre-existing nozzle theory in mind. This paper deals with characterizing the system and provides an analysis of the force production for it. It was found that the CGT performed similarly to the predicted theory, but the data collected was not sufficient to characterize the system as was previously expected. This required the use of a more general analysis scheme.

1 Introduction

A cold gas thruster (CGT) is a system that uses expanding gas to generate a force. This force is typically used in reaction control systems (RCSs) to stabilize space craft or simply change their attitude. This paper is primarily concerned with reaction control systems to be developed for high altitude balloons (HABs.) These HABs experience intense and sporadic winds. Winds which make data collection for certain sensors difficult. There are several ways in which a RCS can achieve stabilization, but the method of choice here is the CGT.
There are several components important to the CGT RCS. Here, there will only be a brief discussion on these components such that the analysis is not lacking information.
The first consideration to make is the type of gas to be used. The primary question here is, *what makes one gas better than another?* One parameter that tries to answer this question is the *specific impulse* (I_{sp}). This is a value specific to a gas. Experimentally, it is measured by integrating a force (F) versus time (t) plot generated by a CGT using that gas. That will give the total impulse, this is divided by the change in weight of the gas through that time period (τ). In other words:

$$I_{sp} = \frac{\int_{t=0}^{\tau} F(t)dt}{mg} \tag{1}$$

where m is mass and g is acceleration due to gravity.This is an excellent start to creating a standard for how gases compare, but there is much more that should be considered. Factors such as safety, availability, cost, energy storage density, and so on all contribute to the choice of gas. Additionally, each one of these factors has a different weight per say depending on the scenario in which they are being applied. After consideration, the choice of gas for this system is CO_2.

The next component is the valve to be used to switch the system on or off. For this experiment it was a simple

2 The Data and Analysis

3 Results of Analysis

4 Conclusion

5 Nomenclature

6 References