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USING DIFFERENTIAL PRESSURE SENSOR TO MEASURE NITROUS OXIDE LEVEL IN A TANK

Abstract

A method for measuring the level of liquid nitrous oxide oxidizer in a hybrid rocket motor oxidizer tank is presented. Presented approach is more accurate than the most commonly used method of this measurement, which employs weighting of the whole sounding rocket or an oxidizer tank. In our solution we use a differential pressure sensor to measure the change of pressure at the bottom of an oxidizer tank in comparison to the pressure of the gas phase above the liquid. Due to usage of a relatively short oxidizer tank, with height of 900 mm, and density of nitrous oxide being smaller than water, at 786.6 kg/m^3, measured pressure differences are small, which requires high resolution of the sensor.

Our system was prepared to work in a hybrid rocket motor of SimLE student organisation from Gdansk University of Technology (Gdansk, Poland). Developed propulsion system is designed to allow a sounding rocket with 4 kg of payload to accurately reach a flight altitude of 3000 m. The reason for accurate calculation of oxidizer amount in a tank is precise altitude planning for a sounding rocket launch which does not employ any active aerobraking system. For this flight strategy, accurate measurement of engine parameters is crucial.

The described system is theoretically able to measure liquid level up to 5 mm, which corresponds to roughly 50 g of nitrous oxide in the tank. Previous approach using a load cell, was able to measure minimally 100 g of weight difference. This method was susceptible to hysteresis due to friction and other external conditions on a launch rail. Projected level of measurement accuracy allows altitude planning with improved confidence, which is a goal of student rocketry competitions in which we participate. Preliminary results from hybrid rocket engine tests will be presented along with perspective for further method improvement.