Visualization of Three-Dimensional Aerospike Nozzle Flow Using Schlieren Photography

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Currently, rocket nozzles are commonly designed in a bell shape, but this design has many limitations. As the pressure decreases, efficiency is lost due to the over-expansion of gases over the nozzles width. In order to combat this, the aerospike nozzle was designed with the geometry of an inverted bell-nozzle. This design allows for altitude compensation, meaning that it can adapt to all altitudes and not loose efficiency at any atmosphere. Unfortunately, aerospikes can be very long and heavy when at their full length, so a truncated design can help reduce weight, but truncating a spike can be detrimental to the thrust. This project is attempting to determine what aerospike length, or level truncation, will prove to be the most optimal in thrust efficiency. In order to test, a full-length aerospike through each nozzle, and the thrust, measured by a load cell, will recorded. Using a formula, the thrust coefficient will be found for each nozzle and compared. After experimentation it was found that, the 20% truncated aerospike nozzle yielded the best thrust coefficient, while also still reducing weight by being truncated. This can help rocketeers in the future build more practical altitude-compensating rockets that can hopefully achieve single-stage-to-orbit flights.

Awards Won:

American Institute of Aeronautics &amp

Astronautics: Third Award of $1000.00