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Designing and Fabricating a Vortex Aerospike Rocket Engine

Cayden Shaffer, Whitewater High School, Fayetteville, GA, USA

ETSD076

Q1: Engineering Problem & Objectives

On average 51% of a rocket engine's weight is in the cooling system so finding an engine design that would drastically reduce the weight, complexity, and production cost of the engine would be extremely beneficial.

This prototype was designed and fabricated to test a rocket engine design that combines design principles from both vortex combustion chambers and aerospike nozzles.

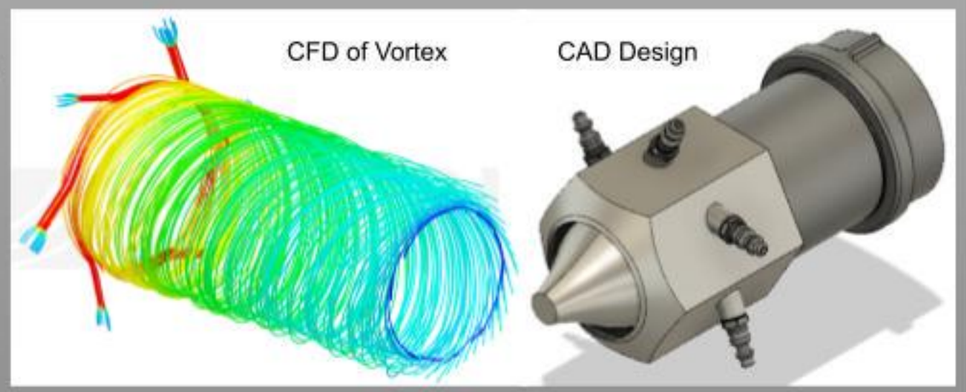
The Engineering Goals for this prototype were:

- The calculated price for a single unit at moderate production being less than $1000
- Be made out of simple parts and materials
- Have a thrust to weight ratio of greater than 50:1 at altitudes 0 km to 100km in 10 km increments
- Have a specific Impulse of 100 sec at altitudes 0 km to 100km in 10 km increments

Q2: Project Design

This design implements two main innovation in rocket engine design: Vortex Cooling and Aerospike Engine. The vortex cooling method creates a vortex of oxygen that isolates the combustion chamber wall from the heat of combustion in the center. The aerospike nozzle is alternet designed nozzle that is more efficient.

I validated the design and a CFD simulation. Through this testing campaign I dialed in values like: injector numbers, injector angle, O2 pressure, Fuel pressure, and nozzle geometry.



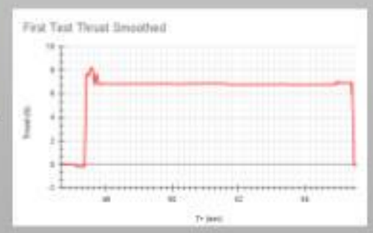
Q3: Data Analysis & Results

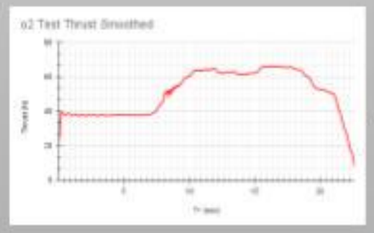
In the many tests I completed I took 4 data points: thrust, temperature of the nozzle, temperature of the combustion chamber, and chamber pressure.

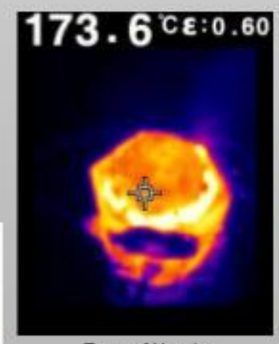
The temperature of the nozzle was consistently much higher than the temperature of combustion chamber.

Temp of Combustion Chamber

The thrust data collect with compressed air as an oxidizer was around 10-15 N or about a 1:1 ratio. With gaseous oxygen as my oxidizer the max thrust was around 68 N or 6:1







Temp of Nozzle

Q4: Interpretation & Conclusions

Two of the four engineering goals were met. The total price of the entire project was around $600. And all of the parts but the nozzle are easily accessible and widely available parts.
The two goals not reached were the thrust to weight ratio and specific impulse.

The main limitation that this project faced was that I was never able to get the nozzle professionally manufacturer by metal 3d printing. If this could be done then more propane and gaseous oxygen could be using in the combustion, increasing the thrust produced.

This project shows that stepping outside of the normal bounds of traditional rocket engine design can lead to new and innovative designs.