Executive Summary

I spent most of the month identifying failure modes such as nozzle blow outs, pinhole leaks, and loose connections. Having resolved the problems, I had a successful test with a flow rate of ~ 23 ml/sec toward the end of the month. The thrust reached a peak of ~ 35 N and then declined ~ 24 N. Overall performance was pretty lousy with the c* and C_{eff} efficiency at 74% and 66% respectively. However, my O/F ratio was ~7.5, way to high.

Technical Stuff

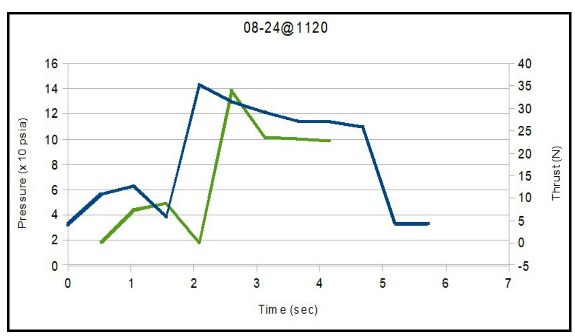
This month I made progress in identifying failure modes (i.e., I was plagued with problems). I had another nozzle blow out, a pinhole leak in the 1/2 inch CPVC FPT to slip adapter located below the oxidizer tank, another pinhole leak at the check valve located at the opening valve, and a connection vibrate loose on the load cell. The problem with the nozzles turned out to be a misprint of the PLA adapter, 20% infill vs 100% infill. I use a PLA adapter to mate the graphite phenolic nozzle to the 1" CPVC coupling. I printed out a batch of five adapters. After suspecting an incorrect print, I cut the last one open and observed the 20% infill. I corrected the print parameters and now I'm back on track.

It's not surprising that I developed a pinhole leak in the FPT to slip adapter and check valve. I've been using the same propellant tank assembly for more than two years. I've been over-stressing the hardware and it has held up remarkably. The simple fix was to replace the adapter and check valve. I'm upgrading my test stand and planned to build all new hardware over the next few months.

During one test, the voltage pin vibrated loose on the Arduino circuit board and I only got two load cell data points. I soldered the pins onto the circuit board making it a permanent connection.

For the past year, I've been using a 1/4" stainless steel mist nozzle with a 1.0 mm orifice for all test. With the 1.0 mm orifice, I get an initial HTPE flow rate of ~ 15 ml/sec when pressurized to 140 psig. The first parameter to change when scaling up in thrust would be the oxidizer flow rate. I used the same mist nozzle design but with a 1.5 mm orifice. Having resolved all of the problems, I finally got a good test with a flow rate of ~ 23 ml/sec at 140 psig.

In the test shown below, I used a mist nozzle with a 1.5 mm orifice and a variable PLA flow restricter with an initial ID of 10 mm. I kept all other parameters the same. I estimated a thrust of ~ 29 N. The test results are shown in the graph below.



The graph shows a peak combustion pressure of ~140 psia with a linear decline to ~110 psia and a peak thrust of ~35 N declining to ~24 N. I believe the peak pressure and thrust were due to a brief plug of PLA in the throat. This is clearly visible in the video of the test (Static Test). Ignition occurred in about 1.3 sec with a burn time of 3.0 sec. Although I had a really good thrust, my c* efficiency and thrust coefficient efficiency was ~74% and ~66% respectively. However, my O/F ratio was ~7.5, way to high (theoretical at 2.75). At the beginning of next month, I'll be trying to improve the efficiency of the characteristic velocity and thrust coefficient. If successful, I'll put together a flight system and launch the Mk I Viper.