Executive Summary

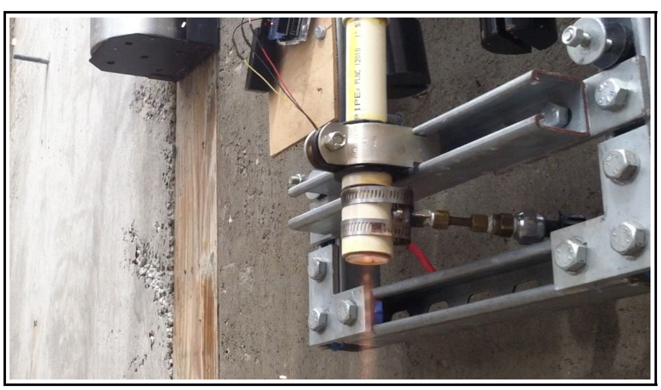
This month, I repeated the test on February 23rd but used a 500 ml Soda Stream® bottle as the Pressure/Propellant Tank (PPT) versus the 1000 mL PPT. The objective was to test the performance of the rocket engine to see if there was a noticeable difference. All other parameters where the same as the 02/23 test. Time to ignition was 0.4 sec and burn time was 6.0 sec. I surmise that the short ignition time was due to the fuel core being stored in a dry bag for six months.

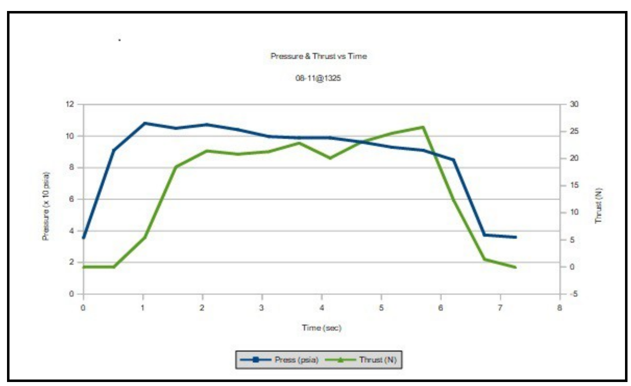
Also, this month, I used the ignition surface flux scaling parameter (0.2 gm/cm^2/sec) to designed a new 6-point star fuel core. The 6-point star configuration increased the surface area over the 5-point design. As such, the new fuel core can be made ~ 1.5 cm shorter than the 5-point design. The decrease in fuel core length will result in a mass savings for the overall flight system. Ignition occurred in 0.6 sec and burn time was 5.8 sec. The initial test results show a slight increase in performance over the 5-point design.

Finally, I used an endoscope to take pictures of the PLA/$KMnO_4$ fuel core after a test. The recession of the PLA/$KMnO_4$ fuel core seems to be evenly distributed along the length of the fuel core. This implies that, if designed properly, most of the fuel core can be consumed in the burn.

Technical Stuff

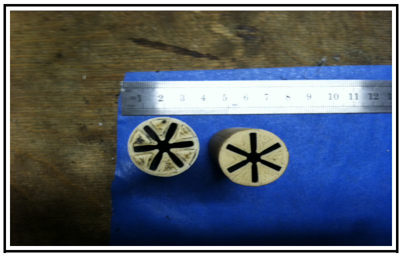
This month, I reconfigured the test stand adapter to accept the 500 ml Soda Stream® bottle. My last engine test was in February and used the 1000 ml Soda Stream® bottle. My objective was to compare the two test. There is ~ 8 psig pressure difference between the two bottles at the end of the test run. All other parameters were the same as the February test. I used a 13.5 cm, three segment PLA/$KMnO_4$ fuel core which had been stored in a dry bag (zip lock bag with desiccant) since February (~ 6 months). Ignition occurred in ~ 0.4 sec and burn time was ~ 6.0 sec. There was no reduction in performance. In fact, the performance of the engine was above average. The average chamber pressure was ~ 98.1 psia with a peak pressure of ~ 108.1 psia. The average thrust was ~ 22.1 N with a peak of ~ 25.8 N. I surmise that the fuel core being stored in a dry bag for six months contributed to the improved performance, another parameter to investigate.

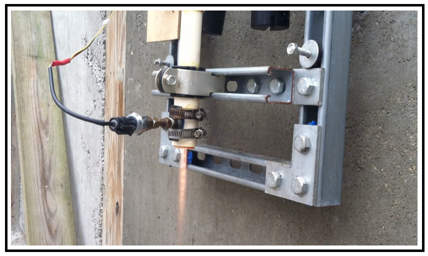


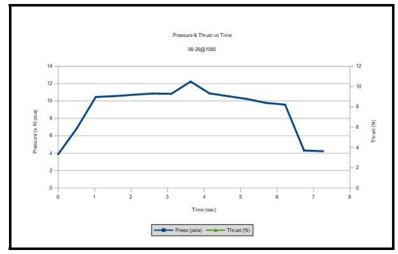


Also, this month, I used the ignition surface flux scaling parameter (0.2 gm/cm^2/sec) to design a new 6-point star fuel core (see picture below, after infusion). The 6-point star configuration increased the surface area over the 5-point design. As such, the new fuel core can be made ~ 1.5 cm shorter than the 5-point design (12 cm long vs 13.5 cm). The decrease in fuel core length will result in a mass savings for the overall flight system. Ignition occurred in ~ 0.6 sec and burn time was ~ 5.8 sec (one week in the dry bag).

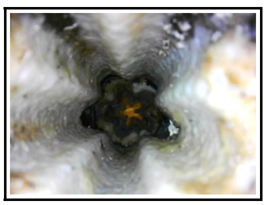
The average chamber pressure was ~ 106.1 psia with a peak pressure of ~ 122.4 psia. Unfortunately, I forgot to initialize the load cell before turning it on. As such, I don't have thrust data. However, I estimated the thrust based on average chamber pressure and average throat area to be ~ 24.0 N. I used a coefficient of thrust of 0.9 which is based on previous test. The characteristic velocity was ~ 1,670 m/sec which is about 104% of theory. The initial test results show a slight increase in performance over the 5-point design.

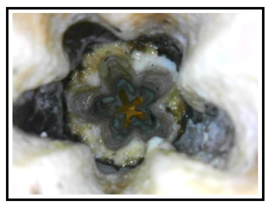


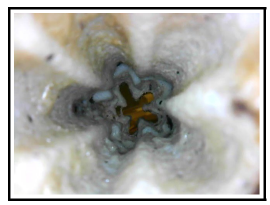


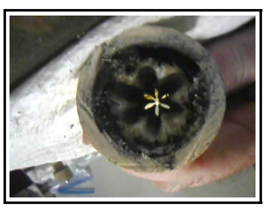


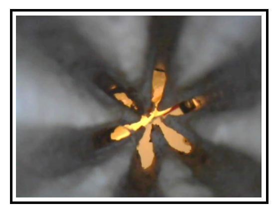
Also, this month, I've added a new diagnostic tool, an endoscope. Now I can take pictures of the PLA/$KMnO_4$ fuel core after a test. The first set of pictures below show the Aug 11 test of the 5-point high flux fuel core design. The second set show the Aug 23 test of the new higher flux 6-point design.











Please note the evenest of the burn. The recession of the PLA/$KMnO_4$ fuel core seems to be evenly distributed along the length of the fuel core. This is not typical of a hybrid fuel and implies that, if designed properly, most of the fuel core can be consumed in the burn. Also note that the fuel core is discolored with the infusion of $KMnO_4$ after the burn. This verifies an earlier statement I made about the $KMnO_4$ being evenly distributed through the volume of the fuel core. Finally, note the charred rings where the segments join together. The segmentation does not appear to effect the performance.

Also, this month, I continued to upgrade my rocket engine test stand for higher thrust. I poured concrete for two more 4' x 8' sections of the concrete reinforced wall. I have three more 4' x 8' sections to finish, some smaller sections, and finally a blast shield.

Also, the 1000 ml Soda Stream® bottle failed during a high pressure test. The failure occurred at the bottle cap to CPVC adapter. I've been using this bottle since Jun 2021 with over 66 high pressure test between 120 and 140 psig, not bad. As such, I've begun keeping track of the number of high pressure test using the 500 ml Soda Stream® bottle. I've designated the first test as Pressure/Propellant Tank (PPT) #101.

Finally, I continue to work on the flight system. I've purchased a bonified launch rail and aerodynamic rail guide buttons. With a little higher thrust, I should have aerodynamic control after the rocket glider leaves the launch rail.

Next month, I'll do two more test of the higher flux 6-point design leaving the infused fuel cores in a dry bag for two weeks and three weeks. If I get good test results, I plan to freeze the design and finish the flight system.