Executive Summary

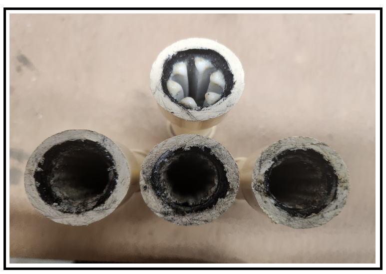
This month, I had three launch attempts of the MkI Viper rocket glider. The first launch attempt, I used the fuel cores from the second infusion at 40 gm/L, I did not have ignition. I had two successful launches using the fuel cores from the first infusion at 50 gm/L. This further suggest that the concentration level is to low. Also this month, I've noticed a greater PLA mass flow rate using the lower concentration. The O/F ratio dropped from 3.0 to 2.3. Finally, I started working on scaling factors for a class II rocket engine.

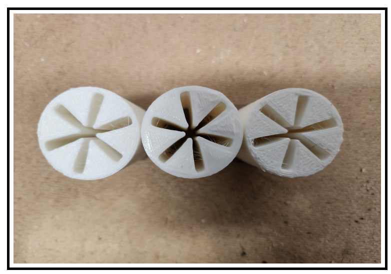
Technical Stuff

This month, I had three launch attempts of the MkI Viper rocket glider. The first launch attempt, I used the fuel cores from the second infusion at 40 gm/L, I did not have ignition. This further suggest that the concentration level is to low.

I had two successful launches using the fuel cores from the first infusion at 50 gm/L (video). I had some control in the early stage of the launch. The Viper pitched down and flew near horizontally. I managed to deploy the paraglider at engine burnout and right before crashing into the ground. The damage was minimal and I was able to have a second launch with similar results. This too crashed into the ground. In this case, the damage was greater. I plan to redo a lot of the structure next month.

In the last three successful launches, I've noticed an enhanced burn (ref: picture on the left). The fuel core at the top is a typical burn at 60 to 70 gm/L concentration. The three at the bottom are enhanced burns at 50 gm/L concentration.





I originally thought it might be the unstabilized HTP vs the stabilized HTP. But, this is not the case. With the fuel core at bottom left, I used unstabilized HTP and the two at bottom right, I used stabilized HTP. I surmise that it is the $KMnO_4$ concentration at 50 gm/L that is giving me these results. The increase in PLA mass flow rate results in an O/F ratio of ~2.3. Theory is ~3.0. If the extra PLA is actually reacting with the HTP in the mixing chamber and not just flowing out the nozzle, this would be a significant result. There is some indication that it is reacting with the HTP because the Viper seems to be leaving the rail guide at higher velocities. I feel justified in returning to an instrumented rocket engine test to verify these results.

Also this month, I been working on scaling factors. I plan to use four scaling factors; O/F = const (p. 494 of ref), L α D (p. 492), $G_{ox}D$ = const (p. 498), and m_{dot}/D = const (p. 498). Where O/F is the oxidizer to fuel ratio, L is length, D is diameter, G_{ox} is the oxidizer mass flux, and m_{dot} is the oxidizer mass flow rate. Based on previous test results, I've used these scaling factors to produce my first scaled up fuel core (pictured on the right). It is designed to produce 30 N of thrust. However, I expect growing pains. Especially since the O/F ratio and m_{dot} may change due to the enhanced burn.

Next month, I plan to measure the thrust and chamber pressure for the enhanced burn. Also, I will continue to work on the scaling factors. I may or may not get to experiment with the new fuel cores as this requires a whole new engine design.

Reference

"Fundamentals of Hybrid Rocket Combustion and Propulsion", edited by Martin J. Chiaverine and Kenneth K. Kuo, Progress in Astronautics and Aeronautics, Frank K. Lu, Editor-in-Cheif, Volume 218, Copyright © 2007 by the American Institute of Aeronautics and Astronautics